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Urgent-start peritoneal dialysis in elderly patients with end-stage renal disease

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Running title: Urgent-start peritoneal dialysis

ABSTRACT

Objectives: To investigate the complications and survival of elderly patients with end-stage renal disease (ESRD) that received urgent-start peritoneal dialysis (USPD) or urgent-start hemodialysis (USHD), and to explore the value of peritoneal dialysis (PD) as the emergent dialysis method for elderly patients with ESRD.

Design: Retrospective cohort study.

Setting: Two tertiary care hospitals in Shanghai, China.

Participants: Chinese patients (n=542) >65 years of age with estimated glomerular filtration rate ≤15 ml/min/m^2 that received urgent-start dialysis between 01/01/2005 and 12/31/2015, and with at least 3 months of treatment. Patients who converted to other dialysis methods, regardless of the initial dialysis method were excluded, as well as those with comorbidities that could significantly affect their dialysis outcomes.

Primary and secondary outcome measures: Dialysis-related complications and survival were compared. Patients were followed until death, stopped PD, transfer to other dialysis centers, loss to follow-up, or 12/31/2016.

Results: There were 309 patients in the USPD group and 233 in the USHD group. The rate of dialysis-related complications within 30 days after catheter implantation was significant lower in the USPD group compared with the USHD group (4.5% vs. 10.7%, P=0.031). The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group, respectively (P=0.023). The multivariable Cox regression analysis showed that USHD (relative risk (RR)= 2.220, 95% confidence interval (CI): 1.298-3.790; P=0.004), age (RR=1.025, 95%CI: 1.013-1.043, P<0.001), and hypokalemia (RR=0.678, 95%CI: 0.487-0.970; P=0.032) were independently

associated with death.

Conclusions: Survival was slightly better for USPD compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Key words: peritoneal dialysis; hemodialysis; prognosis; elderly; end-stage renal disease

Strengths and limitations of this study

- Relatively small sample size from only two hospitals.
- Retrospective study, with all the inherent biases.
- The data were limited to those available from the medical charts.
- A strength of this study is the relatively long follow-up.

INTRODUCTION

End-stage renal disease (ESRD) is the end stage of chronic kidney disease (CKD), which is an important public health problem worldwide with high incidence, poor prognosis, high health care costs, and high socio-economic burden [1-10]. With the overall aging of the population, the prevalence of ESRD is on the rise worldwide. Dialysis often needs to be performed urgently in patients with ESRD due to silent disease, low health awareness, and late referral [11-14]. According to USRDS data reports, in 2010, 43% of the patients had been referred to a nephrologist for the first time at the time of initiating dialysis. Therefore, 30%-50% of patients needing dialysis start the procedure urgently, despite planned dialysis known as an ideal dialysis modality [12].

The elderly represents a special population for dialysis. In addition to having the highest prevalence of dialysis among all age groups [15, 16], elderly with ESRD can have dramatic consequences because of frailty, comorbidities, and less resistance to health issues, complicating the management of ESRD [17]. In addition, the hemodynamic stability of elderly individuals is relatively poor [17]. Previous studies showed that using peritoneal dialysis (PD) as the first dialysis method does not increase the risk of short-term complications in elderly patients with ESRD; in addition, the survival rate of the patients is also not evidently affected [18-20].

Urgent-start PD (USPD) refers to the initiation of PD treatment within 2 weeks after catheter implantation [21]. USPD is commonly applied by physicians in China [22]. USPD avoids temporary central venous catheter (CVC) and vascular access surgery in urgent-start hemodialysis (USHD), and thus reduces the risks of USHD and simplifies the treatment processes. The comparison between USPD and USHD has shown that

the risks of bacteremia and death are higher in the patients receiving USHD than in those receiving USPD [23, 24]. Nevertheless, there is a lack of such comparison for elderly patients.

Therefore, the aim of the present study was to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD, and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD.

PATIENTS AND METHODS

Study design and patients

This was a retrospective cohort study of patients >65 years of age that received urgent-start dialysis at the Shanghai Changzheng Hospital and Songjiang District Central Hospital between January 1st, 2005 and December 31st, 2015. The study was approved by the ethics committees of the Shanghai Changzheng Hospital and Songjiang District Central Hospital (No. 2019SL005).

ESRD was defined as an estimated glomerular filtration rate (eGFR) <15 ml/min/1.73 m^2 [15]. USPD was defined as PD that started within 2 weeks after catheter implantation. USHD was defined as dialysis that started without the establishment of long-term dialysis access or within 30 days after the establishment of long-term dialysis.

The inclusion criteria were: 1) >65 years of age; 2) eGFR ≤15 ml/min/m^2; and 3) received HD or PD for ≥3 months. The exclusion criteria were: 1) <65 years of age; 2) died within 3 months of dialysis or lost to follow up; 3) converted to other dialysis methods, regardless of the initial dialysis method; or 4) combined with severe respiratory diseases, severe acute heart failure, severe hyperkalemia (serum potassium

levels >6.5 mmol/L), or severe acidosis (bicarbonate radical levels <12 mmol/L).

USPD or USHD was selected according to the willingness of the patients and the decision of the physicians at the Nephrology Department according to the condition of the patients (vital signs, cardiac functions, and biochemical indexes). The patients were categorized into the USPD and USHD groups.

Dialysis methods

For the patients in the USPD group, a PD catheter was used as the access. All catheters were implanted by trained physicians after local anesthesia (5-10 ml of 1% lidocaine hydrochloride was applied layer by layer). After the catheter was implanted, the time of the dialysis initiation was decided by the physicians according to the clinical manifestations (vital signs, cardiac functions, and biochemical indexes). For all patients on PD, a swan-neck straight catheter was implanted, and glucose-based dialysate was used in all patients.

For the patients in the HD group, CVC was used as the access. All CVCs were implanted into the internal jugular vein or femoral vein by trained physicians. The patients in the USHD group received HD (4 h/time, volume of blood flow was 250-300 ml/min) or continuous renal replacement treatment (CRRT; 6-8 h/time, volume of blood flow was 180-300 ml/min).

Data collection

All the included patients were followed until loss to follow-up, death, or December 31, 2016. The demographic characteristics (sex, age, primary disease, and complications), residual renal function before dialysis, and clinical biochemical

indexes of patients were collected. The date of catheter implantation, time of dialysis initiation, and dialysis-related complications including infection-related complications (such as catheter-related infection and peritonitis) and non-infection-related complications (leakage, bleeding, catheter malposition, embolism, catheter obstruction, and hernia) were recorded. The outcomes (including death, conversion to HD, kidney transplantation, and transferred to other treatment centers), time of the outcomes, causes of the outcomes, time of the first peritonitis, times of peritonitis, and the catheter dysfunction events that required surgical interventions or conversion to HD within 3 months after the operation were recorded.

Statistical analysis

SPSS 19.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Continuous data with normal distribution are presented as means ± standard deviation, while continuous data without normal distribution are described as percentiles (P25, P75). The Mann-Whitney test or the Student t test was used, as appropriate. The Kaplan-Meier method and the log-rank test were used to analyze the survival of the patients. The factors that have been widely acknowledged to affect the survival of the patients, as well as the factors that were significantly different between the two groups at baseline, were entered in a multivariable models (logistic regression and Cox models). $P<0.05$ was considered statistically significant.

Patient and public involvement

The patients and the public were not involved in the design of this study, in the selection of the outcomes, in the conduct of the study, or in result dissemination.

RESULTS

Characteristics of the patients

Finally, 542 patients (283 males and 259 females) were included, 309 in the USPD group and 233 in the USHD group. Mean age of the patients was 73.1±5.6 years. The patients in the USPD accounted for 57% of all the dialysis patients, and the median time from catheter implantation to the start of dialysis was 4 (2-6) days. The patients in the USHD group received dialysis on the day of or the day after catheter implantation. Age, sex, and primary diseases were not significantly different between the two groups. The numbers of patients with coronary artery-related events or heart failure (NYHA III, grade IV) were not significantly different between the two groups. The Charlson comorbidity index (CCI) was also not significantly different between the two groups (Table 1). The duration of HD was 24.6+5.2 months and the duration of PD was 22.9+5.1 months. The eGFR, serum calcium levels, serum phosphorus levels, serum intact parathyroid hormone (iPTH), and blood lipid levels before dialysis were not significantly different between the two groups (Table 2).

Complications

Compared with the USHD group, the rate of dialysis-related complications within 30 days after catheter implantation was significant lower in the USPD group (4.5% vs. 10.7%, P=0.031). The rates of dialysis-related complications requiring re-catheterization (1.6% vs. 9.4%; P<0.001) and bacteremia (1.2% vs. 5.5%; P=0.006) were significantly lower in the USPD group than in the USHD group (Table 3). Logistic regression showed that after adjusting for demographic characteristics and

baseline data, USHD was an independent risk factor for dialysis-related complications compared with USPD (OR=2.121, 95% CI: 1.058-4.273, P=0.031).

Survival

The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group, respectively (P=0.023) (Figure 1). The multivariable Cox regression analysis showed that after adjusting for demographic characteristics and baseline data, USHD was an independent risk factor of death compared with USPD (relative risk (RR)= 2.220, 95% CI: 1.298-3.790; P=0.004). In addition, age (RR=1.025, 95%CI: 1.013-1.043, P<0.001) and hypokalemia (RR=0.678, 95%CI: 0.487-0.970; P=0.032) were also independently associated with death (Table 4).

DISCUSSION

Studies suggest that USPD is associated with better patient outcomes than USHD [23, 24], but there is a lack of comparison between USPD and USHD for elderly patients with ESRD. Therefore, this study aimed to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD, and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD. The results strongly suggest that survival was slightly better for USPD compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Elderly ESRD patients have several special features, including delayed initiation of dialysis, more complications, poor nutritional status, cognitive impairment, and

relatively low quality of life, which could lead to difficulties in the management of ESRD [17]. The mortality rate in elderly patients with ESRD is higher than in relatively younger patients receiving dialysis; in addition, the mortality rate is increasing with the increase of age [6, 17]. A previous study has already reported that the mortality rate increases by about 1.7 folds with every 10 years increase of the age in Chinese patients [6]. Previous studies have compared the mortality rates of elderly patients on HD or PD, but the results are inconsistent. Collins et al. [25] compared the data of patients on HD (n=99,048) and PD (n=18,110), and they observed that the survival of the patients >55 years old was significantly higher among those on PD compared with HD, after stratification for age and diabetes. The data in the 2009 USRDS database showed that after adjusting for age, gender, ethnicity, and comorbidities, the 1, 3, and 5-year survival rates of patients on PD were significantly higher than those on HD [26].

Several studies have demonstrated that PD could be used for emergent dialysis in patients with ESRD [27-29]. Early PD involves high risks of leakage, bleeding, and peritonitis within a short time after catheter implantation, which limit the application of PD in emergent dialysis. Nevertheless, the PD techniques have advanced greatly in recent years with the development of the Tenckhof catheter, closed liquid supply system with Y-type connection, advancement of catheterization methods, and application of automatic PD [30, 31]. Recent studies have shown that PD is safe and applicable as the emergent dialysis for the ESRD patients [32-37].

In the present study, the results showed that the occurrence of complications in the USPD group was significantly lower than in the USHD group. After adjustment for demographic characteristics and clinical data, USHD was independently associated with dialysis-related complications, compared with USPD. Using USPD in

elderly patients with ESRD could effectively reduce the risk of dialysis-related complications within 2 weeks after catheter implantation. No serious complications such as major bleeding, leakage, or organ rupture were found in the PD group, suggesting that the catheter implantation for USPD conducted by trained physicians was probably safe, but additional studies should be performed for confirmation.

Some previous studies showed that comparing with USHD, the survival rate of patients on USPD is not significantly different [18, 38]. Lobbedez et al. [18] observed that the survival and re-hospitalization rates were not significantly different between USPD and USHD. In the present study, USPD was associated with a slightly better overall survival at 3 years compared with USHD. Additional studies are necessary to examine this issue.

This study has limitations. The sample size was relatively small and from only two hospitals. The study was retrospective, with all the inherent biases, and the data was limited to those available in the medical charts. Prospective trials could be necessary to determine the exact benefits of USPD vs. USHD.

In conclusion, survival was slightly better for USPD compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Author contributions

Xiujuan Zang and Xiu Du carried out the studies, participated in collecting data, and drafted the manuscript. Lin Li and Changlin Mei performed the statistical analysis and participated in its design. All authors read and approved the final manuscript.

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None.

Disclosure Statement

All authors declare that they have no competing interests.

REFERENCES

1. Desai RM. Nephrology Update: End-Stage Renal Disease and Renal Replacement Therapy. *FP Essentials* 2016;444:23-9.
2. Collins AJ, Foley RN, Gilbertson DT, *et al.* United States Renal Data System public health surveillance of chronic kidney disease and end-stage renal disease. *Kidney Int Suppl (2011)* 2015;5(1):2-7.
3. *United States Renal Data System. USRDS 2014 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Vol. 2. Ch. 1: Incidence, prevalence, patient characteristics, and treatment modalities*. Bethesda: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2014.
4. Liyanage T, Ninomiya T, Jha V, *et al.* Worldwide access to treatment for end-stage kidney disease: a systematic review. *Lancet* 2015;385(9981):1975-82.
5. Zuo L, Wang M, Chinese Association of Blood Purification Management of Chinese Hospital A. Current burden and probable increasing incidence of ESRD in China. *Clin Nephrol* 2010;74 Suppl 1:S20-2.
6. Zhang L, Wang F, Wang L, *et al.* Prevalence of chronic kidney disease in China: a cross-sectional survey. *Lancet* 2012;379(9818):815-22.
7. Harris DCH, Davies SJ, Finkelstein FO, *et al.* Increasing access to integrated ESKD care as part of universal health coverage. *Kidney Int* 2019;95(4S):S1-S33.
8. Wang V, Vilme H, Maciejewski ML, *et al.* The Economic Burden of Chronic Kidney Disease and End-Stage Renal Disease. *Semin Nephrol* 2016;36(4):319-30.

9. Abbasi MA, Chertow GM, Hall YN. End-stage renal disease. *BMJ Clin Evid* 2010;2010

10. Perry MM, Howell S, Patel N. Protocols for treating patients with end-stage renal disease: a survey of nephrology fellowships. *Spec Care Dentist* 2017;37(2):57-61.

11. *U.S. Renal Data System: Chapter 1 Incidence, prevalence, patient characteristics and modality. In: USRDS 2012 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda: National Institutes of Health, Bethesda MD, National Institute of Diabetes and Digestive and Kidney Diseases, 2012.

12. Machowska A, Alscher MD, Vanga SR, *et al.* Offering Patients Therapy Options in Unplanned Start: Development and Implementation of an Education Program for Unplanned-Start Patients. *Adv Perit Dial* 2015;31:69-73.

13. Brown PA, Akbari A, Molnar AO, *et al.* Factors Associated with Unplanned Dialysis Starts in Patients followed by Nephrologists: A Retropective Cohort Study. *PLoS One* 2015;10(6):e0130080.

14. Marron B, Martinez Ocana JC, Salgueira M, *et al.* Analysis of patient flow into dialysis: role of education in choice of dialysis modality. *Perit Dial Int* 2005;25 Suppl 3:S56-9.

15. *Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease*, 2013.

16. Murphree DD, Thelen SM. Chronic kidney disease in primary care. *J Am Board Fam Med* 2010;23(4):542-50.

17. Stevens LA, Viswanathan G, Weiner DE. Chronic kidney disease and end-stage renal disease in the elderly population: current prevalence, future projections, and clinical significance. *Adv Chronic Kidney Dis* 2010;17(4):293-301.

18. Lobbedez T, Lecouf A, Ficheux M, *et al.* Is rapid initiation of peritoneal dialysis feasible in unplanned dialysis patients? A single-centre experience. *Nephrol Dial Transplant* 2008;23(10):3290-4.

19. Ghaffari A. Urgent-start peritoneal dialysis: a quality improvement report. *Am J Kidney Dis* 2012;59(3):400-8.

20. Alkatheeri AM, Blake PG, Gray D, *et al.* Success of Urgent-Start Peritoneal Dialysis in a Large Canadian Renal Program. *Perit Dial Int* 2016;36(2):171-6.

21. Webster AC, Nagler EV, Morton RL, *et al.* Chronic Kidney Disease. *Lancet* 2017;389(10075):1238-52.

22. Li WY, Wang YC, Hwang SJ, *et al.* Comparison of outcomes between emergent-start and planned-start peritoneal dialysis in incident ESRD patients: a prospective observational study. *BMC Nephrol* 2017;18(1):359.

23. Ivarsen P, Povlsen JV. Can peritoneal dialysis be applied for unplanned initiation of chronic dialysis? *Nephrol Dial Transplant* 2014;29(12):2201-6.

24. Koch M, Kohnle M, Trapp R, *et al.* Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis. *Nephrol Dial Transplant* 2012;27(1):375-80.

25. Collins AJ, Hao W, Xia H, *et al.* Mortality risks of peritoneal dialysis and hemodialysis. *Am J Kidney Dis* 1999;34(6):1065-74.

26. Liem YS, Wong JB, Hunink MG, *et al.* Comparison of hemodialysis and peritoneal dialysis survival in The Netherlands. *Kidney Int* 2007;71(2):153-8.

27. Fenton SS, Schaubel DE, Desmeules M, *et al.* Hemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. *Am J Kidney Dis* 1997;30(3):334-42.

28. Jaar BG, Coresh J, Plantinga LC, *et al.* Comparing the risk for death with peritoneal dialysis and hemodialysis in a national cohort of patients with chronic kidney disease. *Ann Intern Med* 2005;143(3):174-83.

29. Weinhandl ED, Foley RN, Gilbertson DT, *et al.* Propensity-matched mortality comparison of incident hemodialysis and peritoneal dialysis patients. *J Am Soc Nephrol* 2010;21(3):499-506.

30. Bargman JM, Girsberger M. Visions in a Crystal Ball: The Future of Peritoneal Dialysis. *Blood Purif* 2018;45(1-3):218-23.

31. Bargman JM. New technologies in peritoneal dialysis. *Clin J Am Soc Nephrol* 2007;2(3):576-80.

32. Zang XJ, Yang B, Du X, *et al.* Urgent-start peritoneal dialysis and patient outcomes: a systematic review and meta-analysis. *Eur Rev Med Pharmacol Sci* 2019;23(5):2158-66.

33. Wojtaszek E, Grzejszczak A, Grygiel K, *et al.* Urgent-Start Peritoneal Dialysis as a Bridge to Definitive Chronic Renal Replacement Therapy: Short- and Long-Term Outcomes. *Front Physiol* 2018;9:1830.

34. Ponce D, Brabo AM, Balbi AL. Urgent start peritoneal dialysis. *Curr Opin Nephrol Hypertens* 2018;27(6):478-86.

35. Blake PG, Jain AK. Urgent Start Peritoneal Dialysis: Defining What It Is and Why It Matters. *Clin J Am Soc Nephrol* 2018;13(8):1278-9.

36. Jin H, Ni Z, Mou S, *et al.* Feasibility of Urgent-Start Peritoneal Dialysis in Older

Patients with End-Stage Renal Disease: A Single-Center Experience. *Perit Dial Int* 2018;38(2):125-30.

37. Jin H, Fang W, Zhu M, *et al.* Urgent-Start Peritoneal Dialysis and Hemodialysis in ESRD Patients: Complications and Outcomes. *PLoS One* 2016;11(11):e0166181.

38. Patel PR, Kallen AJ, Arduino MJ. Epidemiology, surveillance, and prevention of bloodstream infections in hemodialysis patients. *Am J Kidney Dis* 2010;56(3):566-77.

Figure legends

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

Table 1. Comparisons of the baseline data

Parameter	USPD (n=309)	USHD (n=233)	P
Males [n (%)]	179 (57.9)	123 (52.8)	0.248
Age (years)	73.1±5.6	72.6±7.5	0.622
Primary disease			
Chronic glomerulonephritis [n (%)]	116 (37.4)	119 (51.1)	0.065
Diabetic nephropathy [n (%)]	105 (34.00)	170 (7.3)	0.002
Hypertensive renal lesion [n (%)]	161 (5.2)	114 (4.9)	1.000
Lupus nephritis [n (%)]	65 (2.1)	30 (1.3)	1.000
Polycystic kidney [n (%)]	176 (5.7)	28 (12.2)	0.260
Unknown causes [n (%)]	67 (21.8)	43 (18.4)	0.502
Comorbidities			
Coronary artery-related events [n (%)]	76 (24.5)	74 (31.7)	0.440
Diabetes [n (%)]	152 (49.1)	74 (31.7)	0.090
Hypertension [n (%)]	175 (56.5)	131 (56.1)	0.816
Heart failure [n (%)]	128 (41.5)	142 (61.0)	0.061
Cerebrovascular events [n (%)]	35 (11.3)	45 (19.5)	0.209

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis.

Table 2. Comparisons of the baseline biochemical indexes

Index	USPD (n=309)	USHD (n=233)	P
eGFR (ml/min.1.73m^2)	5.3 (4.6,6.4)	5.6 (3.6,7.8)	0.738
Potassium (mmol/L)	3.9 (3.5,4.9)	4.0 (3.6,4.5)	0.427
Calcium (mmol/L)	1.89 (1.69,2.06)	1.99 (1.78,2.08)	0.212
Phosphorus (mmol/L)	1.91 (1.71,2.23)	1.62 (1.29,2.19)	0.010
iPTH (ng/L)	355.0 (217.5,504.0)	219.0 (127.5,449.0)	0.083
Serum albumin (g/L)	33.2±5.1	31.7±5.9	0.203
B-type natriuretic peptide (pg/mL)	299.0 (134.0,900.5)	479.0 (249.0,1480.0)	0.054
Hemoglobin (g/L)	82.0 (72.5,95.0)	82.0 (66.5,98.0)	0.888

All data are presented as median (P25, P75), except albumin (mean ± standard deviation).

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis; eGFR: estimated glomerular filtration rate; iPTH: intact parathyroid hormone.

Table 3. Complications within 30 days after catheter implantation

Complications	USPD (n=309)	USHD (n=233)	P
Dialysis-related complications [n (%)]	14 (4.5)	25 (10.7)	0.031
Infectious complications [n (%)]	4 (1.2)	9 (3.8)	0.014
Non-infectious complications [n (%)]	9 (2.9)	13 (5.5)	0.395
Complications requiring re-catheterization [n (%)]	5 (1.6)	22 (9.4)	<0.001
Bacteremia [n (%)]	4 (1.2)	13 (5.5)	0.006

Table 4. Multivariable Cox analysis of the independent factors for survival

Factor	RR	95%CI	P
Age (every 1 year increase)	1.025	1.013-1.043	<0.001
Serum potassium	0.678	0.487-0.970	0.032
Diabetes	1.705	0.978-2.967	0.067
USHD (comparing with USPD)	2.220	1.298-3.790	0.004

USHD: urgent-started hemodialysis; USPD: urgent-started peritoneal dialysis.

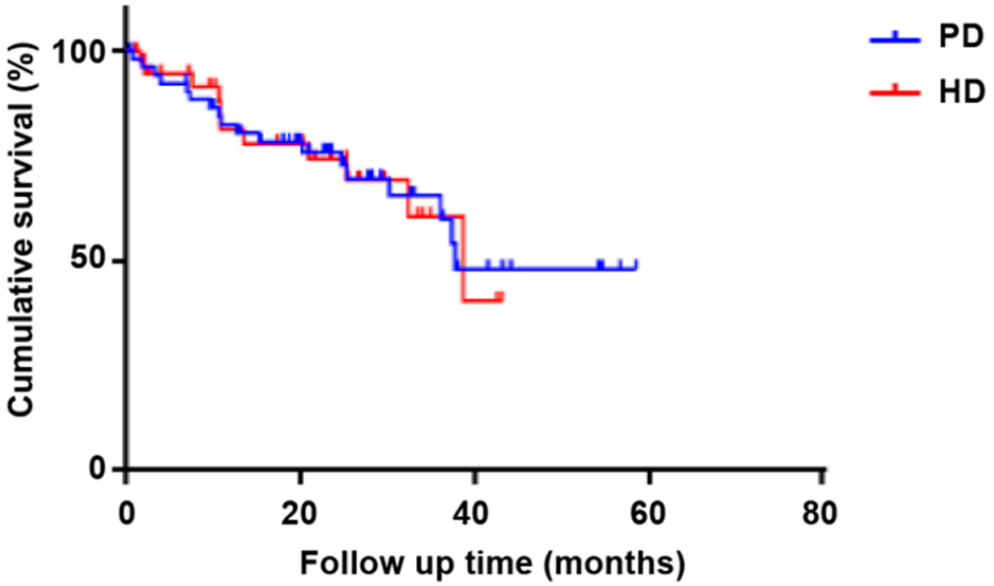

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

80x47mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	7
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Urgent-start peritoneal dialysis in elderly patients with end-stage renal disease

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ABSTRACT

Objectives: To investigate the complications and survival of elderly patients with end-stage renal disease (ESRD)that received urgent-start peritoneal dialysis (USPD)or urgent-start hemodialysis (USHD), and to explore the value of peritoneal dialysis (PD) as the emergent dialysis method for elderly patients with ESRD.

Design: Retrospective cohort study.

Setting: Two tertiary care hospitals in Shanghai, China.

Participants: Chinese patients (n=542)>65 years of age with estimated glomerular filtration rate ≤15 ml/min/m^2that received urgent-start dialysis between 01/01/2005 and 12/31/2015, and with at least 3 months of treatment. Patients who converted to other dialysis methods, regardless of the initial dialysis method, were excluded, as well as those with comorbidities that could significantly affect their dialysis outcomes.

Primary and secondary outcome measures: Dialysis-related complications and survival were compared. Patients were followed until death, stopped PD, transfer to other dialysis centers, loss to follow-up, or 12/31/2016.

Results: There were 309 patients in the USPD group and 233 in the USHD group. The rate of dialysis-related complications within 30 days after catheter implantation was significantly lower in the USPD group compared with the USHD group (4.5% vs. 10.7%, P=0.031). The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group, respectively (P=0.023). The multivariable Cox regression analysis showed that USHD (hazard ratio (HR)= 2.220, 95% confidence interval (CI): 1.298-3.790; P=0.004), age (HR=1.025, 95%CI: 1.013-1.043, P<0.001), and

hypokalemia (HR=0.678, 95%CI: 0.487-0.970; P=0.032) were independently associated with death.

Conclusions: USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Key words: peritoneal dialysis; hemodialysis; prognosis; elderly; end-stage renal disease

Strengths and limitations of this study

- Relatively small sample size from only two hospitals.
- Retrospective study, with all the inherent biases.
- The data were limited to those available from the medical charts.
- A strength of this study is the relatively long follow-up.

INTRODUCTION

End-stage renal disease (ESRD) is the end stage of chronic kidney disease (CKD), which is an important public health problem worldwide with high incidence, poor prognosis, high health care costs, and high socio-economic burden.[1-10] With the overall aging of the population, the prevalence of ESRD is on the rise worldwide. Dialysis often needs to be performed urgently in patients with ESRD due to silent disease, low health awareness, and late referral.[11-14] According to USRDS data reports, in 2010, 43% of the patients had been referred to a nephrologist for the first time at the time of initiating dialysis. Therefore, 30%-50% of patients needing dialysis start the procedure urgently, despite planned dialysis known as an ideal dialysis modality.[12]

The elderly represent a special population for dialysis. In addition to having the highest prevalence of dialysis among all age groups [15, 16], the elderly with ESRD can have dramatic consequences because of frailty, comorbidities, and less resistance to health issues, complicating the management of ESRD.[17] In addition, the hemodynamic stability of elderly individuals is relatively poor.[17] Previous studies showed that using peritoneal dialysis (PD) as the first dialysis method does not increase the risk of short-term complications in elderly patients with ESRD; in addition, the survival rate of the patients is also not evidently affected.[18-20]

Urgent-start PD (USPD) refers to the initiation of PD treatment within 2 weeks after catheter implantation.[21] USPD is commonly applied by physicians in China.[22] USPD avoids temporary central venous catheter (CVC) and vascular access surgery in urgent-start hemodialysis (USHD), and thus reduces the risks of USHD and simplifies the treatment processes. The comparison between USPD and USHD has shown that the risks of bacteremia and death are higher in the patients receiving USHD than in

those receiving USPD.[23, 24] Nevertheless, there is a lack of such comparison for elderly patients.

Therefore, the aim of the present study was to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD.

PATIENTS AND METHODS

Study design and patients

This was a retrospective cohort study of patients >65 years of age that received urgent-start dialysis at the Shanghai Changzheng Hospital and Songjiang District Central Hospital between January 1st, 2005, and December 31st, 2015. The study was approved by the ethics committees of the Shanghai Changzheng Hospital and Songjiang District Central Hospital (No. 2019SL005).

ESRD was defined as an estimated glomerular filtration rate (eGFR)<15 ml/min/1.73 m^2.[15] USPD was defined as PD that started within 2 weeks after catheter implantation. USHD was defined as dialysis that started without the establishment of long-term dialysis access or within 30 days after the establishment of long-term dialysis.

The inclusion criteria were: 1) >65 years of age; 2) eGFR ≤15 ml/min/m^2; and 3) received HD or PD for ≥3 months. The exclusion criteria were: 1) <65 years of age; 2) died within 3 months of dialysis or lost to follow up; 3) converted to other dialysis methods, regardless of the initial dialysis method; or 4) combined with severe respiratory diseases, severe acute heart failure, severe hyperkalemia (serum potassium levels >6.5 mmol/L), or severe acidosis (bicarbonate radical levels <12 mmol/L).

USPD or USHD was selected according to the willingness of the patients and the decision of the physicians at the Nephrology Department according to the condition of the patients (vital signs, cardiac functions, and biochemical indexes). The patients were categorized into the USPD and USHD groups.

Dialysis methods

For the patients in the USPD group, a PD catheter was used as access. All catheters were implanted by trained physicians after local anesthesia (5-10 ml of 1% lidocaine hydrochloride was applied layer by layer). After the catheter was implanted, the time of the dialysis initiation was decided by the physicians according to the clinical manifestations (vital signs, cardiac functions, and biochemical indexes). For all patients on PD, a swan-neck straight catheter was implanted, and glucose-based dialysate was used in all patients.

For the patients in the HD group, CVC was used as access. All CVCs were implanted into the internal jugular vein or femoral vein by trained physicians. The patients in the USHD group received HD (4 h/time, volume of blood flow was 250-300 ml/min) or continuous renal replacement treatment (CRRT; 6-8 h/time, volume of blood flow was 180-300 ml/min).

Data collection

All the included patients were followed until loss to follow-up, death, or December 31, 2016. The demographic characteristics (sex, age, primary disease, and complications), residual renal function before dialysis, and clinical and biochemical indexes of patients were collected. The date of catheter implantation, time of dialysis initiation, and dialysis-related complications, including infection-related complications (such as catheter-related infection and peritonitis) and

non-infection-related complications (leakage, bleeding, catheter malposition, embolism, catheter obstruction, and hernia) were recorded. The outcomes (including death, conversion to HD, kidney transplantation, and transferred to other treatment centers), time of the outcomes, causes of the outcomes, time of the first peritonitis, times of peritonitis, and the catheter dysfunction events that required surgical interventions or conversion to HD within 3 months after the operation were recorded.

Statistical analysis

SPSS 19.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Continuous data with normal distribution are presented as means ± standard deviation, while continuous data without normal distribution are described as percentiles (P25, P75). The Mann-Whitney test or the Student t-test was used, as appropriate. The Kaplan-Meier method and the log-rank test were used to analyze the survival of the patients. The factors that have been widely acknowledged to affect the survival of the patients, as well as the factors that were significantly different between the two groups at baseline, were entered in a multivariable models (logistic regression and Cox models); the results are presented as odds ratio (OR) and 95% confidence interval (CI). $P<0.05$ was considered statistically significant.

Patient and public involvement

The patients and the public were not involved in the design of this study, in the selection of the outcomes, in the conduct of the study, or in result dissemination.

RESULTS

Characteristics of the patients

Finally, 542 patients (283 males and 259 females) were included, 309 in the

USPD group, and 233 in the USHD group. The mean age of the patients was 73.1±5.6 years. The patients in the USPD accounted for 57% of all the dialysis patients, and the median time from catheter implantation to the start of dialysis was 4 (2-6) days. The patients in the USHD group received dialysis on the day of or the day after catheter implantation. Age, sex, and primary diseases were not significantly different between the two groups. The numbers of patients with coronary artery-related events or heart failure (NYHA III, grade IV) were not significantly different between the two groups. The Charlson comorbidity index (CCI) was also not significantly different between the two groups (Table 1). The duration of HD was longer than that of PD (24.6+5.2 months vs. 22.9+5.1 months, P<0.001). The eGFR, serum calcium levels, serum phosphorus levels, serum intact parathyroid hormone (iPTH), and blood lipid levels before dialysis were not significantly different between the two groups (Table 2).

Complications

Compared with the USHD group, the rate of dialysis-related complications within 30 days after catheter implantation was significantly lower in the USPD group (4.5% vs. 10.7%, P=0.031). The rates of dialysis-related complications requiring re-catheterization (1.6% vs. 9.4%; P<0.001) and bacteremia (1.2% vs. 5.5%; P=0.006) were significantly lower in the USPD group than in the USHD group (Table 3). Logistic regression showed that after adjusting for demographic characteristics and baseline data, USHD was an independent risk factor for dialysis-related complications compared with USPD (OR=2.121, 95% CI: 1.058-4.273, P=0.031).

Survival

The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group,

respectively (P=0.023) (Figure 1). The multivariable Cox regression analysis showed that after adjusting for demographic characteristics and baseline data, USHD was an independent risk factor of death compared with USPD (hazard ratio (HR)= 2.220, 95% CI: 1.298-3.790; P=0.004). In addition, age (HR=1.025, 95%CI: 1.013-1.043, P<0.001) and hypokalemia (HR=0.678, 95%CI: 0.487-0.970; P=0.032) were also independently associated with death (Table 4). A subgroup analysis showed that USHD had a worse prognosis than USPD in elderly diabetic patients (HR=2.81, 95%CI: 1.09-7.33, P=0.03) (Table 5).

DISCUSSION

Studies suggest that USPD is associated with better patient outcomes than USHD [23, 24], but there is a lack of comparison between USPD and USHD for elderly patients with ESRD. Therefore, this study aimed to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD. The results strongly suggest that USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Elderly ESRD patients have several special features, including delayed initiation of dialysis, more complications, poor nutritional status, cognitive impairment, and relatively low quality of life, which could lead to difficulties in the management of ESRD.[17] The mortality rate in elderly patients with ESRD is higher than in relatively younger patients receiving dialysis; in addition, the mortality rate is increasing with the increase of age.[6, 17] A previous study has already reported that the mortality rate

increases by about 1.7 folds with every 10 years increase of the age in Chinese patients.[6] Previous studies have compared the mortality rates of elderly patients on HD or PD, but the results are inconsistent. Collins et al. [25] compared the data of patients on HD (n=99,048) and PD (n=18,110), and they observed that the survival of the patients >55 years old was significantly higher among those on PD compared with HD, after stratification for age and diabetes. The data in the 2009 USRDS database showed that after adjusting for age, gender, ethnicity, and comorbidities, the 1, 3, and 5-year survival rates of patients on PD were significantly higher than those on HD.[26]

Several studies have demonstrated that PD could be used for emergent dialysis in patients with ESRD.[27-29] Early PD involves high risks of leakage, bleeding, and peritonitis within a short time after catheter implantation, which limits the application of PD in emergent dialysis. Nevertheless, the PD techniques have advanced greatly in recent years with the development of the Tenckhof catheter, closed liquid supply system with Y-type connection, advancement of catheterization methods, and application of automatic PD.[30, 31] Recent studies have shown that PD is safe and applicable as the emergent dialysis for ESRD patients.[32-37]

In the present study, the results showed that the occurrence of complications in the USPD group was significantly lower than in the USHD group. After adjustment for demographic characteristics and clinical data, USHD was independently associated with dialysis-related complications, compared with USPD. Using USPD in elderly patients with ESRD could effectively reduce the risk of dialysis-related complications within 2 weeks after catheter implantation. No serious complications such as major bleeding, leakage, or organ rupture were found in the PD group, suggesting that the catheter implantation for USPD conducted by trained physicians

was probably safe, but additional studies should be performed for confirmation.

Some previous studies showed that comparing with USHD, the survival rate of patients on USPD is not significantly different.[18, 38] Lobbedez et al. [18] observed that survival and re-hospitalization rates were not significantly different between USPD and USHD. In the present study, USPD was associated with a slightly better overall survival at 3 years compared with USHD. In addition, the present study showed that USHD had a worse prognosis than USPD in elderly diabetic patients. More complications within 30 days after catheter implantation in HD than PD might be a part of explanation. Previous studies reported conflicting results concerning the mortality of HD vs. PD. Indeed, a study showed that mortality was lower for PD in than for HD in non-diabetics, men <55 years of age, and in diabetics <55 years of age, but higher in diabetic women >55 years of age.[25] Lukowsky et al. [39] reported that PD led to better survival than HD in those patients, while a number of studies reported no significant survival difference between HD and PD.[40-46] On the other hand, a meta-analysis suggested that elderly diabetic patients might benefit more from HD than PD [47]. There is still controversy in this area. Additional studies are necessary to examine this issue, especially since the present study specifically examined USPD and USHD, while those previous studies examined all patients.

This study has limitations. The sample size was relatively small and from only two hospitals. The study was retrospective, with all the inherent biases, and the data was limited to those available in the medical charts. Because of the retrospective nature of the study, and the regulations in China, the exact cause of death can be known only if written in the patient chart. Otherwise, such data might be available upon request to the central State database, but access to those data requires special

authorization. As of now, the exact cause of death is missing for most patients. The patients on CRRT were included, but those patients are known to have high mortality rates, probably affecting the results. Furthermore, the usual rate of catheter dysfunction depends upon the method of implantation and is usually around 5%-8%.[48] We agree that this rate is low, but not so far than that of a study that reported a rate of 5.9% before a continuous quality improvement program and 1.5% after the program.[49] In our hospitals, even there is no official continuous quality improvement program, a strict protocol is followed, which could explain the low rate. Finally, as a retrospective study, no causality relationship could be established between the type of dialysis and the outcomes. These limitations might account, at least in part, for the differences observed between the present study and previous ones. Prospective trials could be necessary to determine the exact benefits of USPD vs. USHD.

In conclusion, USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Contributors

XJZ , XD, LL and CLM carried out the studies, participated in collecting data, and drafted the manuscript. LL and CLM performed the statistical analysis and participated in its design. All authors read and approved the final manuscript.

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Competing interests

None declared.

Patient consent for publication

Not required.

Ethics approval

The study was approved by the ethics committees of the Shanghai Changzheng Hospital and Songjiang District Central Hospital (No. 2019SL005).

Data availability statement

Data are available upon reasonable request.

REFERENCES

1. Desai RM. Nephrology Update: End-Stage Renal Disease and Renal Replacement Therapy. *FP Essentials* 2016; **444**:23-29.

2. Collins AJ, Foley RN, Gilbertson DT*, et al.* United States Renal Data System public health surveillance of chronic kidney disease and end-stage renal disease. *Kidney Int Suppl (2011)* 2015; **5**:2-7.

3. *United States Renal Data System. USRDS 2014 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Vol. 2. Ch. 1: Incidence, prevalence, patient characteristics, and treatment modalities*. Bethesda: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2014.

4. Liyanage T, Ninomiya T, Jha V*, et al.* Worldwide access to treatment for end-stage kidney disease: a systematic review. *Lancet* 2015; **385**:1975-82.

5. Zuo L, Wang M, Chinese Association of Blood Purification Management of Chinese Hospital A. Current burden and probable increasing incidence of ESRD in China. *Clin Nephrol* 2010; **74 Suppl 1**:S20-2.

6. Zhang L, Wang F, Wang L*, et al.* Prevalence of chronic kidney disease in China: a cross-sectional survey. *Lancet* 2012; **379**:815-22.

7. Harris DCH, Davies SJ, Finkelstein FO*, et al.* Increasing access to integrated ESKD care as part of universal health coverage. *Kidney Int* 2019; **95**:S1-S33.

8. Wang V, Vilme H, Maciejewski ML*, et al.* The Economic Burden of Chronic Kidney Disease and End-Stage Renal Disease. *Semin Nephrol* 2016; **36**:319-30.

9. Abbasi MA, Chertow GM, Hall YN. End-stage renal disease. *BMJ Clin Evid* 2010; **2010**

10. Perry MM, Howell S, Patel N. Protocols for treating patients with end-stage renal disease: a survey of nephrology fellowships. *Spec Care Dentist* 2017; **37**:57-61.

11. *U.S. Renal Data System: Chapter 1 Incidence, prevalence, patient characteristics and modality. In: USRDS 2012 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda: National Institutes of Health, Bethesda MD, National Institute of Diabetes and Digestive and Kidney Diseases, 2012.

12. Machowska A, Alscher MD, Vanga SR, *et al.* Offering Patients Therapy Options in Unplanned Start: Development and Implementation of an Education Program for Unplanned-Start Patients. *Adv Perit Dial* 2015; **31**:69-73.

13. Brown PA, Akbari A, Molnar AO, *et al.* Factors Associated with Unplanned Dialysis Starts in Patients followed by Nephrologists: A Retropective Cohort Study. *PLoS One* 2015; **10**:e0130080.

14. Marron B, Martinez Ocana JC, Salgueira M, *et al.* Analysis of patient flow into dialysis: role of education in choice of dialysis modality. *Perit Dial Int* 2005; **25 Suppl 3**:S56-9.

15. *Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease*. 2013.

16. Murphree DD, Thelen SM. Chronic kidney disease in primary care. *J Am Board Fam Med* 2010; **23**:542-50.

17. Stevens LA, Viswanathan G, Weiner DE. Chronic kidney disease and end-stage renal disease in the elderly population: current prevalence, future projections, and clinical significance. *Adv Chronic Kidney Dis* 2010; **17**:293-301.

18. Lobbedez T, Lecouf A, Ficheux M*, et al.* Is rapid initiation of peritoneal dialysis feasible in unplanned dialysis patients? A single-centre experience. *Nephrol Dial Transplant* 2008; **23**:3290-4.

19. Ghaffari A. Urgent-start peritoneal dialysis: a quality improvement report. *Am J Kidney Dis* 2012; **59**:400-8.

20. Alkatheeri AM, Blake PG, Gray D*, et al.* Success of Urgent-Start Peritoneal Dialysis in a Large Canadian Renal Program. *Perit Dial Int* 2016; **36**:171-6.

21. Webster AC, Nagler EV, Morton RL*, et al.* Chronic Kidney Disease. *Lancet* 2017; **389**:1238-52.

22. Li WY, Wang YC, Hwang SJ*, et al.* Comparison of outcomes between emergent-start and planned-start peritoneal dialysis in incident ESRD patients: a prospective observational study. *BMC Nephrol* 2017; **18**:359.

23. Ivarsen P, Povlsen JV. Can peritoneal dialysis be applied for unplanned initiation of chronic dialysis? *Nephrol Dial Transplant* 2014; **29**:2201-6.

24. Koch M, Kohnle M, Trapp R*, et al.* Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis. *Nephrol Dial Transplant* 2012; **27**:375-80.

25. Collins AJ, Hao W, Xia H*, et al.* Mortality risks of peritoneal dialysis and hemodialysis. *Am J Kidney Dis* 1999; **34**:1065-74.

26. Liem YS, Wong JB, Hunink MG*, et al.* Comparison of hemodialysis and peritoneal dialysis survival in The Netherlands. *Kidney Int* 2007; **71**:153-8.

27. Fenton SS, Schaubel DE, Desmeules M*, et al.* Hemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. *Am J Kidney Dis* 1997; **30**:334-42.

28. Jaar BG, Coresh J, Plantinga LC*, et al.* Comparing the risk for death with peritoneal dialysis and hemodialysis in a national cohort of patients with chronic

kidney disease. *Ann Intern Med* 2005; **143**:174-83.

29. Weinhandl ED, Foley RN, Gilbertson DT, *et al.* Propensity-matched mortality comparison of incident hemodialysis and peritoneal dialysis patients. *J Am Soc Nephrol* 2010; **21**:499-506.

30. Bargman JM, Girsberger M. Visions in a Crystal Ball: The Future of Peritoneal Dialysis. *Blood Purif* 2018; **45**:218-23.

31. Bargman JM. New technologies in peritoneal dialysis. *Clin J Am Soc Nephrol* 2007; **2**:576-80.

32. Zang XJ, Yang B, Du X, *et al.* Urgent-start peritoneal dialysis and patient outcomes: a systematic review and meta-analysis. *Eur Rev Med Pharmacol Sci* 2019; **23**:2158-66.

33. Wojtaszek E, Grzejszczak A, Grygiel K, *et al.* Urgent-Start Peritoneal Dialysis as a Bridge to Definitive Chronic Renal Replacement Therapy: Short- and Long-Term Outcomes. *Front Physiol* 2018; **9**:1830.

34. Ponce D, Brabo AM, Balbi AL. Urgent start peritoneal dialysis. *Curr Opin Nephrol Hypertens* 2018; **27**:478-86.

35. Blake PG, Jain AK. Urgent Start Peritoneal Dialysis: Defining What It Is and Why It Matters. *Clin J Am Soc Nephrol* 2018; **13**:1278-79.

36. Jin H, Ni Z, Mou S, *et al.* Feasibility of Urgent-Start Peritoneal Dialysis in Older Patients with End-Stage Renal Disease: A Single-Center Experience. *Perit Dial Int* 2018; **38**:125-30.

37. Jin H, Fang W, Zhu M, *et al.* Urgent-Start Peritoneal Dialysis and Hemodialysis in ESRD Patients: Complications and Outcomes. *PLoS One* 2016; **11**:e0166181.

38. Patel PR, Kallen AJ, Arduino MJ. Epidemiology, surveillance, and prevention of

bloodstream infections in hemodialysis patients. *Am J Kidney Dis* 2010; **56**:566-77.

39. Lukowsky LR, Mehrotra R, Kheifets L*, et al.* Comparing mortality of peritoneal and hemodialysis patients in the first 2 years of dialysis therapy: a marginal structural model analysis. *Clin J Am Soc Nephrol* 2013; **8**:619-28.

40. Lee CC, Sun CY, Wu MS. Long-term modality-related mortality analysis in incident dialysis patients. *Perit Dial Int* 2009; **29**:182-90.

41. Couchoud C, Bolignano D, Nistor I*, et al.* Dialysis modality choice in diabetic patients with end-stage kidney disease: a systematic review of the available evidence. *Nephrol Dial Transplant* 2015; **30**:310-20.

42. Heaf JG, Wehberg S. Relative survival of peritoneal dialysis and haemodialysis patients: effect of cohort and mode of dialysis initiation. *PLoS One* 2014; **9**:e90119.

43. Mircescu G, Stefan G, Garneata L*, et al.* Outcomes of dialytic modalities in a large incident registry cohort from Eastern Europe: the Romanian Renal Registry. *Int Urol Nephrol* 2014; **46**:443-51.

44. Marshall MR, Walker RC, Polkinghorne KR*, et al.* Survival on home dialysis in New Zealand. *PLoS One* 2014; **9**:e96847.

45. Waldum-Grevbo B, Leivestad T, Reisaeter AV*, et al.* Impact of initial dialysis modality on mortality: a propensity-matched study. *BMC Nephrol* 2015; **16**:179.

46. van de Luijtgaarden MW, Noordzij M, Stel VS*, et al.* Effects of comorbid and demographic factors on dialysis modality choice and related patient survival in Europe. *Nephrol Dial Transplant* 2011; **26**:2940-7.

47. Xue J, Li H, Zhou Q*, et al.* Comparison of peritoneal dialysis with hemodialysis on survival of diabetic patients with end-stage kidney disease: a meta-analysis of cohort studies. *Ren Fail* 2019; **41**:521-31.

48. Haggerty S, Roth S, Walsh D*, et al.* Guidelines for laparoscopic peritoneal dialysis access surgery. *Surg Endosc* 2014; **28**:3016-45.

49. Hu J, Liu Z, Liu J*, et al.* Reducing the occurrence rate of catheter dysfunction in peritoneal dialysis: a single-center experience about CQI. *Ren Fail* 2018; **40**:628-33.

Figure legends

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

Table 1. Comparisons of the baseline data

Parameter	USPD (n=309)	USHD (n=233)	P
Males [n (%)]	179 (57.9)	123 (52.8)	0.248
Age (years)	73.1±5.6	72.6±7.5	0.622
Duration of dialysis (months)	22.9+5.1	24.6+5.2	<0.001
Primary disease			
Chronic glomerulonephritis [n (%)]	116 (37.4)	119 (51.1)	0.065
Diabetic nephropathy [n (%)]	105 (34.00)	170 (7.3)	0.002
Hypertensive renal lesion [n (%)]	161 (5.2)	114 (4.9)	1.000
Lupus nephritis [n (%)]	65 (2.1)	30 (1.3)	1.000
Polycystic kidney [n (%)]	176 (5.7)	28 (12.2)	0.260
Unknown causes [n (%)]	67 (21.8)	43 (18.4)	0.502
Comorbidities			
Coronary artery-related events [n (%)]	76 (24.5)	74 (31.7)	0.440
Diabetes [n (%)]	152 (49.1)	74 (31.7)	0.090
Hypertension [n (%)]	175 (56.5)	131 (56.1)	0.816
Heart failure [n (%)]	128 (41.5)	142 (61.0)	0.061
Cerebrovascular events [n (%)]	35 (11.3)	45 (19.5)	0.209

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis.

Table 2. Comparisons of the baseline biochemical indexes

Index	USPD (n=309)	USHD (n=233)	P
eGFR (ml/min.1.73m^2)	5.3 (4.6,6.4)	5.6 (3.6,7.8)	0.738
Serum potassium (mmol/L)	3.9 (3.5,4.9)	4.0 (3.6,4.5)	0.427
Calcium (mmol/L)	1.89 (1.69,2.06)	1.99 (1.78,2.08)	0.212
Phosphorus (mmol/L)	1.91 (1.71,2.23)	1.62 (1.29,2.19)	0.010
iPTH (ng/L)	355.0 (217.5,504.0)	219.0 (127.5,449.0)	0.083
Serum albumin (g/L)	33.2±5.1	31.7±5.9	0.203
B-type natriuretic peptide (pg/mL)	299.0 (134.0,900.5)	479.0 (249.0,1480.0)	0.054
Hemoglobin (g/L)	82.0 (72.5,95.0)	82.0 (66.5,98.0)	0.888

All data are presented as median (P25, P75), except albumin (mean±standard deviation).

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis; eGFR: estimated glomerular filtration rate; iPTH: intact parathyroid hormone.

Table 3. Complications within 30 days after catheter implantation

Complications	USPD (n=309)	USHD (n=233)	P
Dialysis-related complications [n (%)]	14 (4.5)	25 (10.7)	0.031
Infectious complications [n (%)]	4 (1.2)	9 (3.8)	0.014
Non-infectious complications [n (%)]	9 (2.9)	13 (5.5)	0.395
Complications requiring re-catheterization [n (%)]	5 (1.6)	22 (9.4)	<0.001
Bacteremia [n (%)]	4 (1.2)	13 (5.5)	0.006

Table 4. Multivariable Cox analysis of the independent factors for survival

Factor	HR	95%CI	P
Age (every 1 year increase)	1.025	1.013-1.043	<0.001
Serum potassium (every 1 mmol/L increase)	0.678	0.487-0.970	0.032
Diabetes	1.705	0.978-2.967	0.067
USHD (comparing with USPD)	2.220	1.298-3.790	0.004

HR: hazard ratio; USHD: urgent-started hemodialysis; USPD: urgent-started peritoneal dialysis.

Table 5. Multivariable Cox analysis of the independent factors for survival in elderly patients with diabetes.

Factor	HR	95%CI	P
Serum albumin (every 1 g/L increase)	0.926	0.861-1.00	0.049
Serum potassium (every 1 mmol/L increase)	0.258	0.126-0.538	<0.001
USHD (comparing with USPD)	2.813	1.092-7.330	0.033

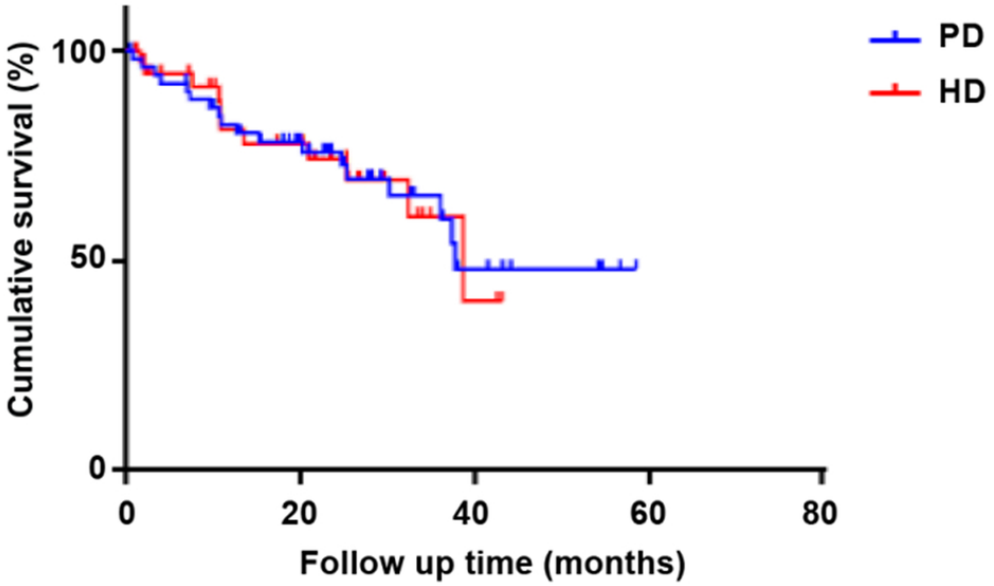

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

80x47mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	7
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Complications and outcomes of urgent-start peritoneal dialysis in elderly patients with end-stage renal disease in China: A retrospective cohort study

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Complications and outcomes of urgent-start peritoneal dialysis in elderly patients with end-stage renal disease in China: A retrospective cohort study

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Running title: Urgent-start peritoneal dialysis

ABSTRACT

Objectives: To investigate the complications and survival of elderly patients with end-stage renal disease (ESRD)that received urgent-start peritoneal dialysis (USPD)or urgent-start hemodialysis (USHD), and to explore the value of peritoneal dialysis (PD) as the emergent dialysis method for elderly patients with ESRD.

Design: Retrospective cohort study.

Setting: Two tertiary care hospitals in Shanghai, China.

Participants: Chinese patients (n=542)>65 years of age with estimated glomerular filtration rate ≤15 ml/min/m^2that received urgent-start dialysis between 01/01/2005 and 12/31/2015, and with at least 3 months of treatment. Patients who converted to other dialysis methods, regardless of the initial dialysis method, were excluded, as well as those with comorbidities that could significantly affect their dialysis outcomes.

Primary and secondary outcome measures: Dialysis-related complications and survival were compared. Patients were followed until death, stopped PD, transfer to other dialysis centers, loss to follow-up, or 12/31/2016.

Results: There were 309 patients in the USPD group and 233 in the USHD group. The rate of dialysis-related complications within 30 days after catheter implantation was significantly lower in the USPD group compared with the USHD group (4.5% vs. 10.7%, P=0.031). The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group, respectively (P=0.023). The multivariable Cox regression analysis showed that USHD (hazard ratio (HR)= 2.220, 95% confidence interval (CI): 1.298-3.790; P=0.004), age (HR=1.025, 95%CI: 1.013-1.043, P<0.001), and

hypokalemia (HR=0.678, 95%CI: 0.487-0.970; P=0.032) were independently associated with death.

Conclusions: USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Key words: peritoneal dialysis; hemodialysis; prognosis; elderly; end-stage renal disease

Strengths and limitations of this study

- Relatively small sample size from only two hospitals.
- Retrospective study, with all the inherent biases.
- The data were limited to those available from the medical charts.
- A strength of this study is the relatively long follow-up.

INTRODUCTION

End-stage renal disease (ESRD) is the end stage of chronic kidney disease (CKD), which is an important public health problem worldwide with high incidence, poor prognosis, high health care costs, and high socio-economic burden.[1-10] With the overall aging of the population, the prevalence of ESRD is on the rise worldwide. Dialysis often needs to be performed urgently in patients with ESRD due to silent disease, low health awareness, and late referral.[11-14] According to USRDS data reports, in 2010, 43% of the patients had been referred to a nephrologist for the first time at the time of initiating dialysis. Therefore, 30%-50% of patients needing dialysis start the procedure urgently, despite planned dialysis known as an ideal dialysis modality.[12]

The elderly represents a special population for dialysis. In addition to having the highest prevalence of dialysis among all age groups [15, 16], the elderly with ESRD can have dramatic consequences because of frailty, comorbidities, and less resistance to health issues, complicating the management of ESRD.[17] In addition, the hemodynamic stability of elderly individuals is relatively poor.[17] Previous studies showed that using peritoneal dialysis (PD) as the first dialysis method does not increase the risk of short-term complications in elderly patients with ESRD; in addition, the survival rate of the patients is also not evidently affected.[18-20]

Urgent-start PD (USPD) refers to the initiation of PD treatment within 2 weeks after catheter implantation.[21] USPD is commonly applied by physicians in China.[22] USPD avoids temporary central venous catheter (CVC) and vascular access surgery in urgent-start hemodialysis (USHD), and thus reduces the risks of USHD and simplifies the treatment processes. The comparison between USPD and USHD has shown that the risks of bacteremia and death are higher in the patients receiving USHD than in

those receiving USPD.[23, 24] Nevertheless, there is a lack of such comparison for elderly patients.

Therefore, the aim of the present study was to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD.

PATIENTS AND METHODS

Study design and patients

This was a retrospective cohort study of patients >65 years of age that received urgent-start dialysis at the Shanghai Changzheng Hospital and Songjiang District Central Hospital between January 1st, 2005, and December 31st, 2015. The study was approved by the ethics committees of the Shanghai Changzheng Hospital and Songjiang District Central Hospital (No. 2019SL005).

ESRD was defined as an estimated glomerular filtration rate (eGFR)<15 ml/min/1.73 m^2.[15] USPD was defined as PD that started within 2 weeks after catheter implantation. USHD was defined as dialysis that started without the establishment of long-term dialysis access or within 30 days after the establishment of long-term dialysis.

The inclusion criteria were: 1) >65 years of age; 2) eGFR ≤15 ml/min/m^2; and 3) received HD or PD for ≥3 months. The exclusion criteria were: 1) <65 years of age; 2) died within 3 months of dialysis or lost to follow up; 3) converted to other dialysis methods, regardless of the initial dialysis method; or 4) combined with severe respiratory diseases, severe acute heart failure, severe hyperkalemia (serum potassium levels >6.5 mmol/L), or severe acidosis (bicarbonate radical levels <12 mmol/L).

USPD or USHD was selected according to the willingness of the patients and the decision of the physicians at the Nephrology Department according to the condition of the patients (vital signs, cardiac functions, and biochemical indexes). The patients were categorized into the USPD and USHD groups.

Dialysis methods

For the patients in the USPD group, a PD catheter was used as access. All catheters were implanted by trained physicians after local anesthesia (5-10 ml of 1% lidocaine hydrochloride was applied layer by layer). After the catheter was implanted, the time of the dialysis initiation was decided by the physicians according to the clinical manifestations (vital signs, cardiac functions, and biochemical indexes). For all patients on PD, a swan-neck straight catheter was implanted, and glucose-based dialysate was used in all patients. All patients in the USPD group received continuous ambulatory PD (CAPD), four bags/day, 2 L/bag.

For the patients in the HD group, CVC was used as access. All CVCs were implanted into the internal jugular vein or femoral vein by trained physicians. The patients in the USHD group received HD (4 h/time, volume of blood flow was 250-300 ml/min) or continuous renal replacement treatment (CRRT; 6-8 h/time, volume of blood flow was 180-300 ml/min).

Data collection

All the included patients were followed until loss to follow-up, death, or December 31, 2016. The demographic characteristics (sex, age, primary disease, and complications), residual renal function before dialysis, and clinical and biochemical

indexes of patients were collected. The date of catheter implantation, time of dialysis initiation, and dialysis-related complications, including infection-related complications (such as catheter-related infection and peritonitis) and non-infection-related complications (leakage, bleeding, catheter malposition, embolism, catheter obstruction, and hernia) were recorded. The outcomes (including death, conversion to HD, kidney transplantation, and transferred to other treatment centers), time of the outcomes, causes of the outcomes, time of the first peritonitis, times of peritonitis, and the catheter dysfunction events that required surgical interventions or conversion to HD within 3 months after the operation were recorded.

Statistical analysis

SPSS 19.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Continuous data with normal distribution are presented as means ± standard deviation, while continuous data without normal distribution are described as percentiles (P25, P75). The Mann-Whitney test or the Student t-test was used, as appropriate. The Kaplan-Meier method and the log-rank test were used to analyze the survival of the patients. The factors that have been widely acknowledged to affect the survival of the patients, as well as the factors that were significantly different between the two groups at baseline, were entered in a multivariable models (logistic regression and Cox models); the results are presented as odds ratio (OR) and 95% confidence interval (CI). $P<0.05$ was considered statistically significant.

Patient and public involvement

The patients and the public were not involved in the design of this study, in the

selection of the outcomes, in the conduct of the study, or in result dissemination.

RESULTS

Characteristics of the patients

Finally, 542 patients (283 males and 259 females) were included, 309 in the USPD group, and 233 in the USHD group. The mean age of the patients was 73.1±5.6 years. The patients in the USPD accounted for 57% of all the dialysis patients, and the median time from catheter implantation to the start of dialysis was 4 (2-6) days. The patients in the USHD group received dialysis on the day of or the day after catheter implantation. Age, sex, and primary diseases were not significantly different between the two groups. The numbers of patients with coronary artery-related events or heart failure (NYHA III, grade IV) were not significantly different between the two groups. The Charlson comorbidity index (CCI) was also not significantly different between the two groups (Table 1). The duration of HD was longer than that of PD (24.6±5.2 months vs. 22.9±5.1 months, P<0.001). The eGFR, serum calcium levels, serum phosphorus levels, serum intact parathyroid hormone (iPTH), and blood lipid levels before dialysis were not significantly different between the two groups (Table 2).

Complications

Compared with the USHD group, the rate of dialysis-related complications within 30 days after catheter implantation was significantly lower in the USPD group (4.5% vs. 10.7%, P=0.031). The rates of dialysis-related complications requiring re-catheterization (1.6% vs. 9.4%; P<0.001) and bacteremia (1.2% vs. 5.5%; P=0.006) were significantly lower in the USPD group than in the USHD group (Table 3).

Logistic regression showed that after adjusting for demographic characteristics and baseline data, USHD was an independent risk factor for dialysis-related complications compared with USPD (OR=2.121, 95% CI: 1.058-4.273, P=0.031).

Survival

The 6-month and 1-, 2-, and 3-year survival rates were 95.3%, 91.4%, 86.6%, and 64.8% in the USPD group, and 92.2%, 85.7%, 70.2%, and 57.8% in the USHD group, respectively (P=0.023) (Figure 1). The multivariable Cox regression analysis showed that after adjusting for demographic characteristics and baseline data, USHD was an independent risk factor of death compared with USPD (hazard ratio (HR)= 2.220, 95% CI: 1.298-3.790; P=0.004). In addition, age (HR=1.025, 95%CI: 1.013-1.043, P<0.001) and hypokalemia (HR=0.678, 95%CI: 0.487-0.970; P=0.032) were also independently associated with death (Table 4). A subgroup analysis showed that USHD had a worse prognosis than USPD in elderly diabetic patients (HR=2.81, 95%CI: 1.09-7.33, P=0.03) (Table 5).

DISCUSSION

Studies suggest that USPD is associated with better patient outcomes than USHD [23, 24], but there is a lack of comparison between USPD and USHD for elderly patients with ESRD. Therefore, this study aimed to investigate the complications and survival of elderly patients with ESRD that received USPD or USHD and to explore the value of PD as the emergent dialysis method for elderly patients with ESRD. The results strongly suggest that USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than

USHD in elderly patients with ESRD.

Elderly ESRD patients have several special features, including delayed initiation of dialysis, more complications, poor nutritional status, cognitive impairment, and relatively low quality of life, which could lead to difficulties in the management of ESRD.[17] The mortality rate in elderly patients with ESRD is higher than in relatively younger patients receiving dialysis; in addition, the mortality rate is increasing with the increase of age.[6, 17] A previous study has already reported that the mortality rate increases by about 1.7 folds with every 10 years increase of the age in Chinese patients.[6] Previous studies have compared the mortality rates of elderly patients on HD or PD, but the results are inconsistent. Collins et al. [25] compared the data of patients on HD (n=99,048) and PD (n=18,110), and they observed that the survival of the patients >55 years old was significantly higher among those on PD compared with HD, after stratification for age and diabetes. The data in the 2009 USRDS database showed that after adjusting for age, gender, ethnicity, and comorbidities, the 1, 3, and 5-year survival rates of patients on PD were significantly higher than those on HD.[26]

Several studies have demonstrated that PD could be used for emergent dialysis in patients with ESRD.[27-29] Early PD involves high risks of leakage, bleeding, and peritonitis within a short time after catheter implantation, which limits the application of PD in emergent dialysis. Nevertheless, the PD techniques have advanced greatly in recent years with the development of the Tenckhof catheter, closed liquid supply system with Y-type connection, advancement of catheterization methods, and application of automatic PD.[30, 31] Recent studies have shown that PD is safe and applicable as the emergent dialysis for ESRD patients.[32-37]

In the present study, the results showed that the occurrence of complications in

the USPD group was significantly lower than in the USHD group. After adjustment for demographic characteristics and clinical data, USHD was independently associated with dialysis-related complications, compared with USPD. Using USPD in elderly patients with ESRD could effectively reduce the risk of dialysis-related complications within 2 weeks after catheter implantation. No serious complications such as major bleeding, leakage, or organ rupture were found in the PD group, suggesting that the catheter implantation for USPD conducted by trained physicians was probably safe, but additional studies should be performed for confirmation.

Some previous studies showed that comparing with USHD, the survival rate of patients on USPD is not significantly different.[18, 38] Lobbedez et al. [18] observed that survival and re-hospitalization rates were not significantly different between USPD and USHD. In the present study, USPD was associated with a slightly better overall survival at 3 years compared with USHD. In addition, the present study showed that USHD had a worse prognosis than USPD in elderly diabetic patients. More complications within 30 days after catheter implantation in HD than in PD might be a part of the explanation. Previous studies reported conflicting results concerning the mortality of HD vs. PD. Indeed, a study showed that mortality was lower for PD in than for HD in non-diabetics, men <55 years of age, and in diabetics <55 years of age, but higher in diabetic women >55 years of age.[25] Lukowsky et al. [39] reported that PD led to better survival than HD in those patients, while a number of studies reported no significant survival difference between HD and PD.[40-46] On the other hand, a meta-analysis suggested that elderly diabetic patients might benefit more from HD than PD [47]. There is still controversy in this area. Additional studies are necessary to examine this issue, especially since the present study specifically examined USPD

and USHD, while those previous studies examined all patients.

This study has limitations. The sample size was relatively small and from only two hospitals. The study was retrospective, with all the inherent biases, and the data was limited to those available in the medical charts. Because of the retrospective nature of the study, and the regulations in China, the exact cause of death can be known only if written in the patient chart. Otherwise, such data might be available upon request to the central State database, but access to those data requires special authorization. As of now, the exact cause of death is missing for most patients. The patients on CRRT were included, but those patients are known to have high mortality rates, probably affecting the results. Furthermore, the usual rate of catheter dysfunction depends upon the method of implantation and is usually around 5%-8%.[48] We agree that this rate is low, but not so far than that of a study that reported a rate of 5.9% before a continuous quality improvement program and 1.5% after the program.[49] In our hospitals, even there is no official continuous quality improvement program, a strict protocol is followed, which could explain the low rate. Finally, as a retrospective study, no causality relationship could be established between the type of dialysis and the outcomes. These limitations might account, at least in part, for the differences observed between the present study and previous ones. Prospective trials could be necessary to determine the exact benefits of USPD vs. USHD.

In conclusion, USPD was associated with slightly better survival compared with USHD. USPD was associated with fewer complications and better survival than USHD in elderly patients with ESRD.

Contributors

XJZ , XD, LL and CLM carried out the studies, participated in collecting data, and drafted the manuscript. LL and CLM performed the statistical analysis and participated in its design. All authors read and approved the final manuscript.

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Competing interests

None declared.

Patient consent for publication

Not required.

Ethics approval

The study was approved by the ethics committees of the Shanghai Changzheng Hospital and Songjiang District Central Hospital (No. 2019SL005).

Data availability statement

Data are available upon reasonable request.

REFERENCES

1. Desai RM. Nephrology Update: End-Stage Renal Disease and Renal Replacement Therapy. FP Essentials 2016; **444**:23-29.

2. Collins AJ, Foley RN, Gilbertson DT, et al. United States Renal Data System public health surveillance of chronic kidney disease and end-stage renal disease. Kidney *Int Suppl (2011)* 2015; **5**:2-7.

3. *United States Renal Data System. USRDS 2014 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Vol. 2. Ch. 1: Incidence, prevalence, patient characteristics, and treatment modalities*. Bethesda: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2014.

4. Liyanage T, Ninomiya T, Jha V, et al. Worldwide access to treatment for end-stage kidney disease: a systematic review. Lancet 2015; **385**:1975-82.

5. Zuo L, Wang M, Chinese Association of Blood Purification Management of Chinese Hospital A. Current burden and probable increasing incidence of ESRD in China. *Clin Nephrol* 2010; **74 Suppl 1**:S20-2.

6. Zhang L, Wang F, Wang L, et al. Prevalence of chronic kidney disease in China: a cross-sectional survey. Lancet 2012; **379**:815-22.

7. Harris DCH, Davies SJ, Finkelstein FO, et al. Increasing access to integrated ESKD care as part of universal health coverage. Kidney *Int* 2019; **95**:S1-S33.

8. Wang V, Vilme H, Maciejewski ML, et al. The Economic Burden of Chronic Kidney Disease and End-Stage Renal Disease. *Semin Nephrol* 2016;

36:319-30.

9. Abbasi MA, Chertow GM, Hall YN. End-stage renal disease. BMJ *Clin Evid* 2010; **2010**

10. Perry MM, Howell S, Patel N. Protocols for treating patients with end-stage renal disease: a survey of nephrology fellowships. *Spec Care Dentist* 2017; **37**:57-61.

11. *U.S. Renal Data System: Chapter 1 Incidence, prevalence, patient characteristics and modality. In: USRDS 2012 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States*. Bethesda: National Institutes of Health, Bethesda MD, National Institute of Diabetes and Digestive and Kidney Diseases, 2012.

12. Machowska A, Alscher MD, Vanga SR, et al. Offering Patients Therapy Options in Unplanned Start: Development and Implementation of an Education Program for Unplanned-Start Patients. *Adv Perit Dial* 2015; **31**:69-73.

13. Brown PA, Akbari A, Molnar AO, et al. Factors Associated with Unplanned Dialysis Starts in Patients followed by Nephrologists: A Retropective Cohort Study. *PLoS One* 2015; **10**:e0130080.

14. Marron B, Martinez Ocana JC, Salgueira M, et al. Analysis of patient flow into dialysis: role of education in choice of dialysis modality. *Perit Dial Int* 2005; **25 Suppl 3**:S56-9.

15. *Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group.*

KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. 2013.

16. Murphree DD, Thelen SM. Chronic kidney disease in primary care. *J Am* Board *Fam Med* 2010; **23**:542-50.

17. Stevens LA, Viswanathan G, Weiner DE. Chronic kidney disease and end-stage renal disease in the elderly population: current prevalence, future projections, and clinical significance. *Adv Chronic Kidney Dis* 2010; **17**:293-301.

18. Lobbedez T, Lecouf A, Ficheux M, et al. Is rapid initiation of peritoneal dialysis feasible in unplanned dialysis patients? A single-centre experience. *Nephrol Dial Transplant* 2008; **23**:3290-4.

19. Ghaffari A. Urgent-start peritoneal dialysis: a quality improvement report. *Am J* Kidney *Dis* 2012; **59**:400-8.

20. Alkatheeri AM, Blake PG, Gray D, et al. Success of Urgent-Start Peritoneal Dialysis in a Large Canadian Renal Program. *Perit Dial Int* 2016; **36**:171-6.

21. Webster AC, Nagler EV, Morton RL, et al. Chronic Kidney Disease. Lancet 2017; **389**:1238-52.

22. Li WY, Wang YC, Hwang SJ, et al. Comparison of outcomes between emergent-start and planned-start peritoneal dialysis in incident ESRD patients: a prospective observational study. BMC *Nephrol* 2017; **18**:359.

23. Ivarsen P, Povlsen JV. Can peritoneal dialysis be applied for unplanned initiation of chronic dialysis? *Nephrol Dial Transplant* 2014; **29**:2201-6.

24. Koch M, Kohnle M, Trapp R, et al. Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis. *Nephrol Dial Transplant* 2012; **27**:375-80.

25. Collins AJ, Hao W, Xia H, et al. Mortality risks of peritoneal dialysis and hemodialysis. *Am J* Kidney *Dis* 1999; **34**:1065-74.

26. Liem YS, Wong JB, Hunink MG, et al. Comparison of hemodialysis and peritoneal dialysis survival in The Netherlands. Kidney *Int* 2007; **71**:153-8.

27. Fenton SS, Schaubel DE, Desmeules M, et al. Hemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. *Am J* Kidney *Dis* 1997; **30**:334-42.

28. Jaar BG, Coresh J, Plantinga LC, et al. Comparing the risk for death with peritoneal dialysis and hemodialysis in a national cohort of patients with chronic kidney disease. *Ann Intern Med* 2005; **143**:174-83.

29. Weinhandl ED, Foley RN, Gilbertson DT, et al. Propensity-matched mortality comparison of incident hemodialysis and peritoneal dialysis patients. *J Am Soc Nephrol* 2010; **21**:499-506.

30. Bargman JM, Girsberger M. Visions in a Crystal Ball: The Future of Peritoneal Dialysis. Blood *Purif* 2018; **45**:218-23.

31. Bargman JM. New technologies in peritoneal dialysis. *Clin J Am Soc Nephrol* 2007; **2**:576-80.

32. Zang XJ, Yang B, Du X, et al. Urgent-start peritoneal dialysis and patient

outcomes: a systematic review and meta-analysis. *Eur Rev Med Pharmacol Sci* 2019; **23**:2158-66.

33. Wojtaszek E, Grzejszczak A, Grygiel K, et al. Urgent-Start Peritoneal Dialysis as a Bridge to Definitive Chronic Renal Replacement Therapy: Short- and Long-Term Outcomes. *Front Physiol* 2018; **9**:1830.

34. Ponce D, Brabo AM, Balbi AL. Urgent start peritoneal dialysis. *Curr Opin Nephrol Hypertens* 2018; **27**:478-86.

35. Blake PG, Jain AK. Urgent Start Peritoneal Dialysis: Defining What It Is and Why It Matters. *Clin J Am Soc Nephrol* 2018; **13**:1278-79.

36. Jin H, Ni Z, Mou S, et al. Feasibility of Urgent-Start Peritoneal Dialysis in Older Patients with End-Stage Renal Disease: A Single-Center Experience. *Perit Dial Int* 2018; **38**:125-30.

37. Jin H, Fang W, Zhu M, et al. Urgent-Start Peritoneal Dialysis and Hemodialysis in ESRD Patients: Complications and Outcomes. *PLoS One* 2016; **11**:e0166181.

38. Patel PR, Kallen AJ, Arduino MJ. Epidemiology, surveillance, and prevention of bloodstream infections in hemodialysis patients. *Am J Kidney Dis* 2010; **56**:566-77.

39. Lukowsky LR, Mehrotra R, Kheifets L, et al. Comparing mortality of peritoneal and hemodialysis patients in the first 2 years of dialysis therapy: a marginal structural model analysis. *Clin J Am Soc Nephrol* 2013; **8**:619-28.

40. Lee CC, Sun CY, Wu MS. Long-term modality-related mortality analysis in

incident dialysis patients. *Perit Dial Int* 2009; **29**:182-90.

41. Couchoud C, Bolignano D, Nistor I, et al. Dialysis modality choice in diabetic patients with end-stage kidney disease: a systematic review of the available evidence. *Nephrol Dial Transplant* 2015; **30**:310-20.
42. Heaf JG, Wehberg S. Relative survival of peritoneal dialysis and haemodialysis patients: effect of cohort and mode of dialysis initiation. *PLoS One* 2014; **9**:e90119.
43. Mircescu G, Stefan G, Garneata L, et al. Outcomes of dialytic modalities in a large incident registry cohort from Eastern Europe: the Romanian Renal Registry. *Int Urol Nephrol* 2014; **46**:443-51.
44. Marshall MR, Walker RC, Polkinghorne KR, et al. Survival on home dialysis in New Zealand. *PLoS One* 2014; **9**:e96847.
45. Waldum-Grevbo B, Leivestad T, Reisaeter AV, et al. Impact of initial dialysis modality on mortality: a propensity-matched study. BMC *Nephrol* 2015; **16**:179.
46. van de Luijtgaarden MW, Noordzij M, Stel VS, et al. Effects of comorbid and demographic factors on dialysis modality choice and related patient survival in Europe. *Nephrol Dial Transplant* 2011; **26**:2940-7.
47. Xue J, Li H, Zhou Q, et al. Comparison of peritoneal dialysis with hemodialysis on survival of diabetic patients with end-stage kidney disease: a meta-analysis of cohort studies. *Ren Fail* 2019; **41**:521-31.

48. Haggerty S, Roth S, Walsh D, et al. Guidelines for laparoscopic peritoneal dialysis access surgery. *Surg Endosc* 2014; **28**:3016-45.

49. Hu J, Liu Z, Liu J, et al. Reducing the occurrence rate of catheter dysfunction in peritoneal dialysis: a single-center experience about CQI. *Ren Fail* 2018; **40**:628-33.

Figure legends

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

Table 1. Comparisons of the baseline data

Parameter	USPD (n=309)	USHD (n=233)	P
Males [n (%)]	179 (57.9)	123 (52.8)	0.248
Age (years)	73.1±5.6	72.6±7.5	0.622
Duration of dialysis (months)	22.9±5.1	24.6±5.2	<0.001
Primary disease			
Chronic glomerulonephritis [n (%)]	116 (37.4)	119 (51.1)	0.065
Diabetic nephropathy [n (%)]	105 (34.0)	170 (7.3)	0.002
Hypertensive renal lesion [n (%)]	161 (5.2)	114 (4.9)	1.000
Lupus nephritis [n (%)]	65 (2.1)	30 (1.3)	1.000
Polycystic kidney [n (%)]	176 (5.7)	28 (12.2)	0.260
Unknown causes [n (%)]	67 (21.8)	43 (18.4)	0.502
Comorbidities			
Coronary artery-related events [n (%)]	76 (24.5)	74 (31.7)	0.440
Diabetes [n (%)]	152 (49.1)	74 (31.7)	0.090
Hypertension [n (%)]	175 (56.5)	131 (56.1)	0.816
Heart failure [n (%)]	128 (41.5)	142 (61.0)	0.061
Cerebrovascular events [n (%)]	35 (11.3)	45 (19.5)	0.209

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis.

Table 2. Comparisons of the baseline biochemical indexes

Index	USPD (n=309)	USHD (n=233)	P
eGFR (ml/min.1.73m^2)	5.3 (4.6,6.4)	5.6 (3.6,7.8)	0.738
Serum potassium (mmol/L)	3.9 (3.5,4.9)	4.0 (3.6,4.5)	0.427
Calcium (mmol/L)	1.89 (1.69,2.06)	1.99 (1.78,2.08)	0.212
Phosphorus (mmol/L)	1.91 (1.71,2.23)	1.62 (1.29,2.19)	0.010
iPTH (ng/L)	355.0 (217.5,504.0)	219.0 (127.5,449.0)	0.083
Serum albumin (g/L)	33.2±5.1	31.7±5.9	0.203
B-type natriuretic peptide (pg/mL)	299.0 (134.0,900.5)	479.0 (249.0,1480.0)	0.054
Hemoglobin (g/L)	82.0 (72.5,95.0)	82.0 (66.5,98.0)	0.888

All data are presented as median (P25, P75), except albumin (mean±standard deviation).

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis; eGFR: estimated glomerular filtration rate; iPTH: intact parathyroid hormone.

Table 3. Complications within 30 days after catheter implantation

Complications	USPD (n=309)	USHD (n=233)	P
Dialysis-related complications [n (%)]	14 (4.5)	25 (10.7)	0.031
Infectious complications [n (%)]	4 (1.2)	9 (3.8)	0.014
Non-infectious complications [n (%)]	9 (2.9)	13 (5.5)	0.395
Complications requiring re-catheterization [n (%)]	5 (1.6)	22 (9.4)	<0.001
Bacteremia [n (%)]	4 (1.2)	13 (5.5)	0.006

USPD: urgent-start peritoneal dialysis; USHD: urgent-start hemodialysis.

Table 4. Multivariable Cox analysis of the independent factors for survival

Factor	HR	95%CI	P
Age (every 1-year increase)	1.025	1.013-1.043	<0.001
Serum potassium (every 1 mmol/L increase)	0.678	0.487-0.970	0.032
Diabetes	1.705	0.978-2.967	0.067
USHD (comparing with USPD)	2.220	1.298-3.790	0.004

HR: hazard ratio; USHD: urgent-started hemodialysis; USPD: urgent-started peritoneal dialysis.

Table 5. Multivariable Cox analysis of the independent factors for survival in elderly patients with diabetes.

Factor	HR	95%CI	P
Serum albumin (every 1 g/L increase)	0.926	0.861-1.000	0.049
Serum potassium (every 1 mmol/L increase)	0.258	0.126-0.538	<0.001
USHD (comparing with USPD)	2.813	1.092-7.330	0.033

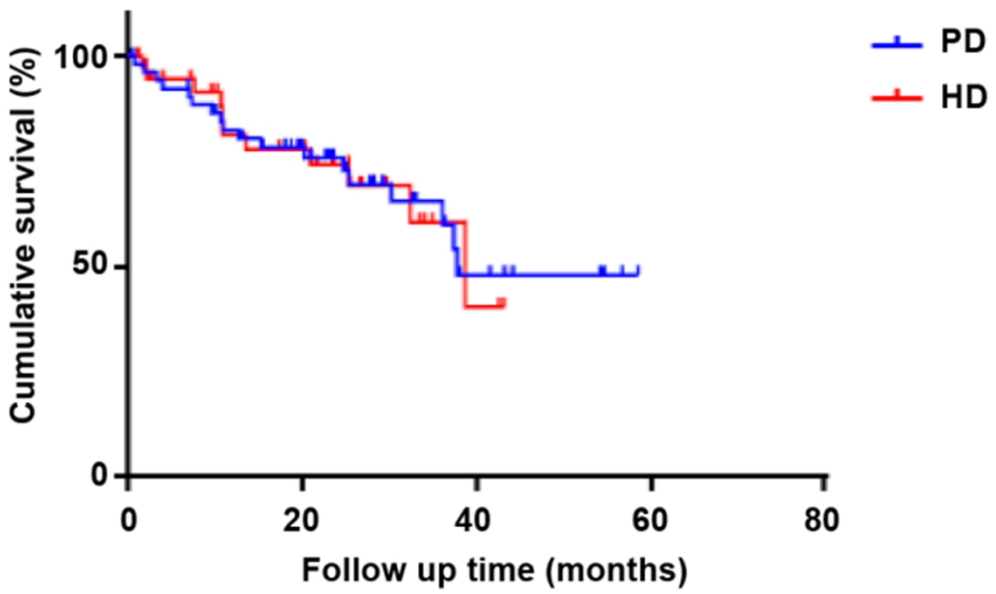

Figure 1. Survival rates of the patients in the peritoneal dialysis and hemodialysis groups. Kaplan-Meier survival analysis.

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	7
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.