World Journal of Diabetes

Submit a Manuscript: https://www.f6publishing.com

World J Diabetes 2024 September 15; 15(9): 1862-1873

DOI: 10.4239/wjd.v15.i9.1862

ISSN 1948-9358 (online)

REVIEW

Selection of dialysis methods for end-stage kidney disease patients with diabetes

Yao-Hua Hu, Ya-Li Liu, Ling-Fei Meng, Yi-Xian Zhang, Wen-Peng Cui

Specialty type: Endocrinology and metabolism

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade A, Grade A, Grade B, Grade C, Grade C

Novelty: Grade B, Grade B, Grade B

Creativity or Innovation: Grade B, Grade B, Grade B

Scientific Significance: Grade B, Grade B, Grade B

P-Reviewer: Cai L; Feizi A; Labusca L; Shalaby MN

Received: May 8, 2024

Revised: July 3, 2024

Accepted: July 29, 2024

Published online: September 15, 2024

Processing time: 110 Days and 17.2 Hours

Yao-Hua Hu, Ya-Li Liu, Ling-Fei Meng, Yi-Xian Zhang, Wen-Peng Cui, Department of Nephrology, The Second Hospital of Jilin University, Changchun 130041, Jilin Province, China

Corresponding author: Wen-Peng Cui, MD, PhD, Doctor, Professor, Department of Nephrology, The Second Hospital of Jilin University, No. 218 Ziqiang Street, Changchun 130041, Jilin Province, China. wenpengcui@163.com

Abstract

The increasing prevalence of diabetes has led to a growing population of end-stage kidney disease (ESKD) patients with diabetes. Currently, kidney transplantation is the best treatment option for ESKD patients; however, it is limited by the lack of donors. Therefore, dialysis has become the standard treatment for ESKD patients. However, the optimal dialysis method for diabetic ESKD patients remains controversial. ESKD patients with diabetes often present with complex conditions and numerous complications. Furthermore, these patients face a high risk of infection and technical failure, are more susceptible to malnutrition, have difficulty establishing vascular access, and experience more frequent blood sugar fluctuations than the general population. Therefore, this article reviews nine critical aspects: Survival rate, glucose metabolism disorder, infectious complications, cardiovascular events, residual renal function, quality of life, economic benefits, malnutrition, and volume load. This study aims to assist clinicians in selecting individualized treatment methods by comparing the advantages and disadvantages of hemodialysis and peritoneal dialysis, thereby improving patients' quality of life and survival rates.

Key Words: Diabetes; End-stage kidney disease; Hemodialysis; Peritoneal dialysis; Dialysis methods selection

Core Tip: The prevalence of diabetes is leading to an increase in the number of End-stage kidney disease (ESKD) patients with diabetes. Dialysis is the most commonly accepted treatment for ESKD patients. However, the optimal dialysis method for diabetic ESKD patients remains controversial. Diabetic ESKD patients often present with complex conditions and numerous complications. This article reviews recent literature on renal replacement therapy to determine the most suitable dialysis method for diabetic ESKD patients. This review is the first to evaluate the benefits of different dialysis types for diabetic ESKD patients across nine aspects.

Citation: Hu YH, Liu YL, Meng LF, Zhang YX, Cui WP. Selection of dialysis methods for end-stage kidney disease patients with diabetes. *World J Diabetes* 2024; 15(9): 1862-1873
URL: https://www.wjgnet.com/1948-9358/full/v15/i9/1862.htm
DOI: https://dx.doi.org/10.4239/wjd.v15.i9.1862

INTRODUCTION

End-stage kidney disease (ESKD) is a global health concern with a significantly high mortality rate[1,2]. The prevalence of ESKD in the United States increased by 41.8% from 2000 to 2019. Among Asians, the prevalence increased by 149.5%, the largest rise among all racial and ethnic groups[3]. The number of ESKD patients with diabetes is increasing with the rise in the prevalence of diabetes[4]. Currently, the commonly used treatment for ESKD includes hemodialysis (HD) and peritoneal dialysis (PD)[5,6]. ESKD patients with diabetes undergoing dialysis have higher cardiovascular risks and mortality rates than non-diabetic ESKD patients[7]. Furthermore, ESKD patients with diabetes are at increased risk of complications, including blood sugar fluctuations and infections. Therefore, dialysis treatment for ESKD patients with diabetes is more complicated. Selecting appropriate treatment strategies for these patients is crucial. This study specifically highlights the evidence types considered, including randomized controlled trials, cohort studies, large-sample retrospective studies (sample size ≥ 500), and case-control studies. This review aims to systematically organize and compile available evidence for a comprehensive analysis. Including high-quality studies ensures reliable and trustworthy results. Selecting the dialysis method with the greatest clinical advantages for patients has been challenging. However, there are only a few articles that suggest the type of dialysis method suitable for ESKD patients with diabetes, and the evidence presented is inconsistent[8,9]. This article reviews recent literature on renal replacement therapy to determine the most suitable dialysis method for diabetic ESKD patients, focusing on nine key aspects: Survival rate, glucose metabolism disorders, infectious complications, cardiovascular events, residual renal function (RRF), quality of life, economic benefits, malnutrition, and volume load.

LITERATURE SEARCH AND EVIDENCE SELECTION METHODS

A comprehensive literature search was conducted using the PubMed database. Initially, titles and abstracts were reviewed to identify relevant studies, followed by a thorough full-text evaluation to ensure scientific rigor and relevance. Studies were selected based on nine key criteria: Survival rate, glucose metabolism disorders, infectious complications, cardiovascular events, RRF, quality of life, economic benefits, malnutrition, and volume load. This study discusses these criteria in detail and provides clinical evidence to support the analysis, offering guidance for clinical practice. Studies evaluating diabetic patients undergoing HD or PD for ESKD and providing data on key assessment criteria were included. Articles were excluded if full texts were unavailable or data were incomplete.

COMPARISON OF DIFFERENT TREATMENT METHODS FOR DIABETIC ESKD PATIENTS

Survival rate

The survival rate of dialysis patients is an important indicator for evaluating patient benefit. However, the impact of dialysis methods on the survival of diabetic ESKD patients remains debated.

The survival rates of diabetic ESKD patients undergoing HD and PD are similar: Several studies have indicated that PD and HD offer comparable survival rates for diabetic ESKD patients[10-14]. A propensity-matched score study in Guangdong Province, China, compared the mortality rates of PD and HD in 268 ESKD patients with type 2 diabetes (T2D). The study revealed that PD and HD had similar mortality rates, both in the first 2 years and beyond 2 years of starting dialysis treatment[10]. Additionally, a propensity-matching score study on 210 diabetic ESKD patients from 2012 to 2019 indicated similar survival rates for T2D-ESKD patients undergoing PD and HD[11]. Similar results were observed in a Norwegian study[13]. However, all the aforementioned studies were retrospective. A 2020 systematic review of 214 papers, including 17 cohort studies and 113578 patients, found no significant difference in mortality risk between PD and HD (HR: 1.06, 95%CI: 0.99-1.14). Subgroup meta-analysis showed that patients with diabetes had HR: 1.09 (95%CI: 0.98-1.21), while those without diabetes had HR: 0.99 (95%CI: 0.90-1.09)[14]. No randomized controlled trial (RCT) to support this analysis requires further RCT verification.

Diabetic ESKD patients have a higher survival rate after PD than HD: Some studies have indicated that ESKD patients with diabetes have a higher survival rate with PD than with HD[15-17]. A 2010 retrospective study by Weinhandl *et al*[16] in the United States found that PD had a survival advantage over HD in the first year after starting dialysis, whereas HD had a survival advantage after one year. Furthermore, a 2016 Korean prospective cohort study on 902 diabetic patients indicated that according to the multivariate analysis, PD has a higher survival advantage than HD (HR: 0.59, 95%CI: 0.37-0.94, P = 0.03), and good blood sugar control is associated with better survival in PD patients[15]. Overall, these studies have indicated that the survival rate of diabetic patients undergoing dialysis is associated with dialysis method and time. With the continuous advancement of PD technology, the survival advantage of diabetic patients undergoing PD is gradually increasing. A 2018 single-center retrospective study in Shanghai, China, reported that the 3-year survival rate of PD patients was significantly higher than that of HD patients (log-rank = 5. 582, P = 0.018)[17]. Therefore, it can be inferred that PD offers increased survival rates for diabetic ESKD patients compared to HD.

Diabetic ESKD patients have a lower survival rate after PD than HD: Studies suggest that diabetic ESKD patients have a reduced survival rate with PD compared to HD[18-21]. A 2012 Canadian registry study found that the mortality rate of PD among elderly diabetic women was higher than that of HD[18]. Furthermore, a 2015 retrospective cohort study in Taiwan indicated similar results for ESKD patients with diabetes and a history of stroke. However, in ESKD patients without diabetes and a history of stroke, HD and PD had similar overall survival rates[19]. A 2017 retrospective study by I-Kuan Wang *et al*[20] suggested that the survival rate of elderly diabetic ESKD patients undergoing PD was lower than that for HD. A systematic review conducted by Cecile Couchoud *et al*[9] also revealed an elevated risk of mortality in elderly and frail patients undergoing PD treatment. A 2017 South Korean study confirmed this conclusion[21]. However, all these studies are based on clinical databases, and variables missing in the database cannot be adjusted, which may interfere with the results. Furthermore, the differences in the results of these studies may be caused by differences in the populations included. Table 1 indicates specific information on PD and HD survival studies.

Despite the similar survival rates for PD and HD, PD is often recommended as the first dialysis method, particularly for patients with a long life expectancy, younger age, and better glycemic control. For elderly and frail patients, the choice of PD treatment should be cautious[9]. Treatment decisions must be tailored to the individual, considering both patient preferences and comorbidities.

Glucose metabolism disorder

Blood glucose fluctuations are an important characteristic of aberrant glucose metabolism. Poor blood sugar control promotes the progression of diabetic nephropathy[22]. On the other hand, tight glycemic control reduces the risk of cardiovascular disease (CVD) and improves outcomes in acute coronary syndromes[23].

Glucose metabolism in diabetic ESKD patients receiving PD: Patients who undergo PD treatment are exposed to glucose dialysate for a long time, and the total glucose absorbed is 100-300 g/d, accounting for 20% of the total body energy[24]. Therefore, diabetic PD patients absorb large amounts of glucose and are prone to glucose metabolism disorders. Takatori *et al*[25] conducted a randomized controlled study and found that icodextrin helps control blood sugar and fluid levels in patients, thereby improving technical survival. In diabetic patients, icodextrin can reduce glucose intake; however, there are also risks of allergies and toxic accumulation of maltose. Therefore, new PD solutions suitable for diabetic patients require continuous research.

Glucose metabolism in diabetic ESKD patients receiving HD: A retrospective study in Nanjing, China, included 46 ESKD patients undergoing HD and found that these patients had greater blood sugar fluctuations than non-diabetic patients[26]. Furthermore, a study from China's People's Liberation Army General Hospital indicated that elderly diabetic ESKD patients receiving HD had higher blood sugar fluctuations on dialysis days than on non-dialysis days and experienced more frequent hypoglycemia[27]. Diabetic HD patients are primarily at risk for HD-related hypoglycemia. Using glucose-containing dialysate in these patients can reduce blood sugar fluctuations; however, HD-related hypoglycemia may still occur[28-30].

Comparison of blood glucose fluctuations between diabetic ESKD patients undergoing HD and PD: A retrospective study in Nanjing, China, compared glucose metabolism in 64 ESKD patients with T2D undergoing PD and HD. The study revealed that blood glucose fluctuations in diabetic patients undergoing HD were greater than in those undergoing PD. PD requires a larger dose of insulin than HD for the same blood glucose level[31], likely because PD patients consume excessive glucose from peritoneal dialysate and require more insulin. Furthermore, patients receiving HD develop insulin resistance and hyperglycemia because of insulin accumulation before dialysis and are prone to increased insulin sensitivity and prolonged exogenous insulin half-life after dialysis. Moreover, HD is associated with hypoglycemia, causing significant blood sugar fluctuation in patients. For patients with poor blood glucose control, PD is recommended as the initial dialysis method. Applying icodextrin PD solution can stabilize blood glucose, but attention must be paid to insulin dosage. Few articles address the impact of HD or PD on glucose metabolism in diabetic ESKD patients, and further confirmation requires RCTs or prospective studies.

Infectious complications

Diabetic patients have reduced immunity and are prone to infection[32]. Furthermore, infections are an important cause of increased mortality in diabetic dialysis patients.

Table 1 Summary of peritoneal dialysis and hemodialysis survival-related research information

Year of publication	Ref.	Literature source	Area	Research methods	Sample size	Follow-up time	Conclusion
2007	Couchoud *et al*[9]	*Nephrology Dialysis Transplantation*	France	Register for research	3512	2002-2005	Within 2 years, patients undergoing PD and HD had similar death outcomes
2010	Weinhand *et al*[16]	*J Am Soc Nephrol*	United States	Propensity matching study	12674	2003-2008	The overall intention-to-treat risk of mortality after dialysis initiation was 8% lower in the PD group than in matched HD patients
2012	Yeates *et al* [18]	*Nephrology Dialysis Transplantation*	Canada	Register for research	46839	1991-2007	Among patients with diabetes, the mortality rate of PD patients is higher than that of HD patients
2015	Waldum-Grevbo *et al* [13]	*BMC Nephrology*	Norway	Propensity matching study	1364	2005-2012	Five-year all-cause or cardiovascular mortality in PD as an initial dialysis modality is similar to HD
2015	Wang *et al* [19]	*International Urology and Nephrology*	Taiwan, China	Retrospective cohort study	1950	2000-2010	Among ESKD patients with a history of stroke, mortality in patients with diabetic PD is higher than that in patients with diabetic HD
2016	Lee *et al*[15]	*Medicine*	Korea	Prospective cohort study	902	2008. 8-2013. 12	Among diabetic dialysis patients, the overall survival rate of PD patients is significantly higher than that of HD patients
2017	Kim *et al*[21]	*The Korean Journal of Internal Medicine*	Korea	Register for research	32280	2005. 1. 1-2008. 12. 31	PD mortality rate is higher than HD in diabetic ESKD patients
2018	Wang *et al* [20]	*European Journal of Internal Medicine*	Taiwan, China	Retrospective cohort study	53103	2005. 1. 1-2011. 12. 31	Icodextrin mitigates the survival disadvantage of PD relative to HD in patients with diabetes
2021	Liu *et al*[10]	*International Urology and Nephrology*	China	Propensity matching study	268	2012. 1-2017. 12	In patients with type 2 diabetes, mortality rates are similar between PD and HD
2023	Xu *et al*[11]	*Ther Apher Dial*	China	Retrospective cohort study	281	2012. 1-2019. 12	Survival rates are similar in patients with diabetes and end-stage kidney disease treated with HD and PD

ESKD: End-stage kidney disease; HD: Hemodialysis; PD: Peritoneal dialysis.

Infection status of diabetic ESKD patients receiving PD: The main complications of PD infection include peritonitis, catheter outlet, and subcutaneous tunnel infection. Of these, peritonitis is the most common complication in patients undergoing PD. Furthermore, diabetes is an independent risk factor for death in peritonitis patients[33,34], which might be because diabetic patients are prone to multiple infections due to accelerated peritoneal fibrosis and persistent high blood sugar[32,35]. Some studies have found that diabetes does not increase the incidence of peritonitis (P < 0.01)[36]. However, the impact of diabetes on the incidence of catheter-related infections remains controversial, requiring further research[37,38]. Lee *et al*[39] conducted a retrospective study and indicated that diabetic ESKD patients who underwent stepped-up PD had shorter hospital stays and lower incidence of peritonitis than full-dose PD, which might be linked with fewer exchanges and less glucose exposure in the incremental PD group[40,41]. There are few studies on the application of incremental PD in diabetic patients, and more prospective studies are needed for confirmation.

Infection status of diabetic ESKD patients receiving HD: A study from Singapore on HD patients between January 1, 2010, and December 31, 2012, revealed that the incidence of catheter-related bloodstream infection and exit site infection was 0.75/1000 and 0.50/1000 catheter days, respectively[42]. Furthermore, the infection rate associated with HD performed with tunnel catheter is 17.6 times higher than that performed with arteriovenous fistula. The most common pathogenic bacteria is Staphylococcus aureus[43,44]. The 2022 USRDS data indicated that home HD patients have relatively stable hospitalization rates for sepsis[45]. Overall, the risk of death from catheter-related infections is increased in HD.

Comparison of infection complications between diabetic ESKD patients undergoing HD and PD: In addition to the risk of vascular access infection, patients undergoing HD are more susceptible to infection than those undergoing PD. A Danish study on 9997 ESKD patients revealed that HD has a higher incidence of bacteremia than PD. Diabetes is a risk factor for ESKD bacteremia[46]. However, some studies have found no significant difference in infection-related mortality between HD and PD (HR: 1.341, 95%CI: 0.453-3.969)[47]. Additionally, PD and HD patients had similar overall infection rates but different types of infection and risk over time. HD patients have a particularly high risk of bacteremia in the first 90 days, whereas the PD cohort shows no significant difference in peritonitis risk over time[48].

Patients with ESKD and comorbid diabetes may benefit from PD due to its advantages in preventing and managing infectious complications. Implementing an incremental PD approach could lower the incidence of infections and hospitalizations. Individualizing the selection of dialysis modality based on the patient's clinical circumstances is crucial to optimize treatment safety and efficacy. Current studies in this field are limited and warrant high-quality clinical research.

Cardiovascular events

The ESKD complicated by renal anemia is characterized by increased cardiac output, elevated extracellular fluid increasing cardiac preload, and secondary hyperparathyroidism, which can also result in left ventricular dysfunction, metabolic acidosis, and electrolyte disorders (such as hyperemia and potassium imbalance), can cause abnormalities in cardiac conduction and contractility[49]. All these factors keep the heart in a high-load state, causing ventricular dilation, hypertrophy, decreased myocardial contractility, and heart failure[50]. It has already been reported that CVD is the leading cause of death in diabetic patients on dialysis[51].

Morbidity and mortality of cardiovascular events in patients with ESKD: The literature suggests that ESKD patients have a higher cardiovascular morbidity rate. Korean National Health Insurance Service data from 2004 to 2007 have indicated the incidence rate of cardiovascular events in patients undergoing PD (37.3/1000 person-years) and HD (33.1/1000 person-years)[52]. A 2022 study from Singapore included 5,309 patients (4449 HD and 860 PD) and found that nearly one-third of the patients died from cardiovascular events[53]. In ESKD patients, regardless of PD or HD, more than half of the deaths from known causes are related to CVD (including stroke, acute myocardial infarction, arteriosclerotic heart disease, congestive heart failure (CHF), cardiovascular accident, and cardiac arrest)[45]. Furthermore, CVD is also a leading cause of death in diabetic ESKD patients[51].

Comparison of cardiovascular events between diabetic ESKD patients undergoing HD and PD: Non-diabetic patients receiving PD generally have more stable hemodynamics and a lower incidence of cardiovascular events than those undergoing HD[54,55]. In contrast, diabetic patients undergoing PD have a higher mortality rate from cardiovascular events than those on HD[47]. A Taiwan research group conducted a retrospective study using the propensity matching score method on 6516 patients in the HD and PD groups. The study found no significant difference in the overall risk of new major ischemic cardiac events in patients undergoing HD and PD. Moreover, patients undergoing HD have an increased risk of new-onset CHF than PD during the first year of treatment[54]. This might be because extracorporeal blood filtration during HD alters the hemodynamics, which increases the risk of cardiovascular complications. Diabetic patients have vascular calcification and are more susceptible to bleeding risks[55]. A prospective cohort study on 1347 (258 PD and 1089 HD) patients revealed that CVD-related mortality in diabetic patients receiving PD was significantly higher than those receiving HD (HD *vs* PD: HR: 0.37)[47], consistent with the research of Hu *et al*[56]. Studies indicate that HD is more effective in mitigating cardiovascular complications and reducing mortality rates in individuals with ESKD and comorbid diabetes. For patients with high-risk factors for cardiovascular events, HD may be the optimal dialysis modality for those with ESKD and diabetes.

RRF

Generally, RRF is measured by 24-hour urea and creatinine clearance; however, serum cystatin C can also be used to predict RRF[57]. Maintaining RRF is important and difficult for ESKD patients. Whether using PD or HD, RRF is closely related to patient survival[58,59]. PD has been observed to have a better protective effect on RRF than HD. Furthermore, with the improvements in the PD model and peritoneal dialysate, the protective effect of PD on RRF has become more prominent[57,60]. A retrospective study by Lee *et al*[39] found that incremental PD better protects the RRF of diabetic ESKD patients, allowing more free time for activities. This may be due to a lower glucose load and ultrafiltration, which reduces RRF loss[61]. Moreover, Htay *et al*[62] also indicated that using biocompatible PD fluid and less glucose exposure can better preserve the patient's RRF. The biocompatible PD fluid can reduce exposure to glucose degradation products, thereby reducing renal tubular epithelial cell apoptosis[63]. Diabetes is a risk factor for increased RRF loss. Compared to patients undergoing PD, those receiving HD experience more rapid RRF loss, possibly due to hemodynamic instability [64-67]. Current research indicates that PD has clear advantages in maintaining RRF in diabetic patients. This is mainly due to its hemodynamic stability and the use of biocompatible dialysate, which helps slow the loss of RRF. Therefore, PD is more suitable for these patients.

Quality of life

People with ESKD often experience anxiety, depression, and reduced quality of life[68,69]. The impact of dialysis treatment on lifestyle, disease burden, and quality of life is very important to patients and their families. The HD and PD methods have different effects on patient's quality of life, kidney disease burden, and depression in different countries [69].

Quality of life of diabetic ESKD patients undergoing PD: The PD treatment makes it easier for patients to work and socialize more often because they can stay at home. The application of automated PD (APD) brings more convenience to patients' lives. Sun *et al*[70] found that the patients undergoing APD had a higher quality of life than those receiving traditional PD, primarily because APD patients continued the treatment at night, allowing them to work and live normally during the day. The quality-of-life benefits of APD are widely recognized.

Quality of life of diabetic ESKD patients undergoing HD: Diabetic ESKD patients undergoing HD often suffer from protein-energy malnutrition and muscle atrophy, reducing their quality of life[71]. Furthermore, Dembowska *et al*[72] identified that HD patients have an elevated risk of developing oral mycosis, osteoporosis, rheumatoid arthritis, coronary heart disease, *etc*., which seriously affects their quality of life. Moreover, elderly HD patients are at higher risk of developing depression[73].

Comparison of quality of life between diabetic ESKD patients undergoing HD and PD: Studies have generally found that patients undergoing PD have a better quality of life than those undergoing HD. For instance, Mathew *et al*[74] showed that compared with HD, patients with PD had better work lives due to their flexible treatment time[75,76]. Moreover, there are fewer restrictions on diet and activities, which significantly reduces patient anxiety, allowing a better standard of life[77,78], consistent with multiple studies[79-81]. However, some research indicates that HD has advantages in physical function and sleep quality[82,83]. Additionally, the literature also reports that for elderly patients, the quality of life is similar for both PD and HD[84,85]. Current research generally indicates that patients undergoing PD have a better quality of life than those undergoing HD. However, investigations on the quality of life of diabetic patients are limited and require more evidence. PD is often preferred for diabetic ESKD patients due to its adaptability and convenience, allowing treatment at home while maintaining normal daily activities. The use of APD can further improve overall quality of life. For elderly patients, the effects of PD and HD are comparable. Therefore, PD is generally considered the more advisable treatment option.

Economic benefits

The ESKD imposes a huge burden on the country in terms of public health expenditure and medical costs[86]. PD is generally considered to have better economic benefits than HD. A retrospective study on 100 patients in the United States found that the hospitalization rate and total cost of treatment for patients undergoing PD were significantly lower than that of HD[87]. A study in Taiwan and China also confirmed that the total cost of PD treatment is lower than that of HD, and the opportunity cost savings are more obvious, especially for patients with fixed jobs[88]. Furthermore, Shukri *et al* [89] also reached a similar conclusion. Moreover, in a study in Hong Kong, China, the lifetime treatment cost of PD and HD was US$ 76915 (7.13 quality-adjusted life years) and US$ 142389 (6.58 QALYs), respectively. Therefore, PD is more cost-effective than HD, supporting the existing PD priority policy[90]. Overall, PD can reduce patients' economic burden, meet basic needs, and achieve better socio-economic benefits for both developed and developing countries[91].

Malnutrition

Malnutrition is a major complication in ESKD patients due to low nutritional intake, increased catabolism, and elevated protein loss caused by dialysis. Malnutrition significantly affects dialysis patients' quality of life and increases mortality [92]. Malnutrition is assessed using indicators such as serum albumin, subjective global assessment score, elderly nutritional risk index, and protein energy consumption[93,94]. Lowrie *et al*[95] reported that low albumin levels are closely related to death and that malnutrition is a significant factor in patient mortality, consistent with findings by Wu *et al*[96].

Nutritional status of diabetic ESKD patients undergoing PD: PD treatment can result in excessive protein loss through the peritoneum, reduced appetite from continuous glucose absorption, and a feeling of abdominal fullness due to excessive PD fluid, all contributing to malnutrition. A study by Prasad *et al*[97] found that most PD patients had protein and energy intakes lower than NKF-K/DOQI recommendations, with many already malnourished at the beginning of PD. Additionally, PD patients with comorbidities have lower nutritional intake[98]. Therefore, these patients face significant challenges related to malnutrition.

Nutritional status of diabetic ESKD patients undergoing HD: Malnutrition in diabetic HD patients is associated with infection, elevated blood sugar, increased muscle breakdown, gastroparesis, diarrhea, and inadequate dialysis. Silva *et al* [99] indicated that diabetic patients undergoing HD are at increased risk of malnutrition, which might be linked with insufficient nutritional intake, consistent with many studies[100,101]. Furthermore, HD treatment causes chronic inflammation, low nutrient intake, and increased catabolism, which decreases muscle and fat mass[102,103]. This may also be affected by factors such as anorexia[104], energy metabolism disorder, metabolic acidosis, *etc*. Therefore, regular nutritional monitoring of patients is essential.

Comparison of nutritional status between diabetic ESKD patients undergoing HD and PD: Many researchers currently believe that PD poses a higher risk of malnutrition than HD. Xu *et al*[105], in their retrospective study, revealed that the PD group had lower total protein and albumin levels than the HD group, possibly due to protein loss with the dialysate. A multicenter study of 487 patients found that those under 65 years old undergoing PD were more likely to be malnourished than those undergoing HD, while in those over 75 years old, HD increased the risk of malnourishment compared to PD[106]. Improving the nutritional status of ESKD patients is crucial for better patient prognosis. Studies suggest that PD poses a higher risk of malnutrition, particularly in younger patients. In contrast, HD may increase the risk of malnutrition in older patients. Individualized dialysis regimens should be tailored to the unique nutritional needs of each patient.

Fluid overload

Fluid overload is related to excessive fluid intake by the body and is a common complication in dialysis patients with ESKD. Furthermore, it is an independent risk factor for CVD and death in ESKD patients[107]. The patients' body volume load is primarily assessed *via* multifrequency electrical impedance analysis (BIA). Moreover, it has been inferred that PD is more prone to fluid overload than HD. According to a Chinese single-center cross-sectional study on 307 continuous ambulatory peritoneal dialysis patients, the incidence of fluid overload was 66.8[108]. Zoccali *et al*[109] also suggested

Table 2 Comparative summary of studies on peritoneal dialysis and hemodialysis in end-stage kidney disease patients with diabetes

Project	Randomized controlled study	Array research	
		Forward-looking	Retrospective
Survival rate	×	√	√
Glucose metabolism disorder	×	×	√
Infectious complications	×	×	×
Cardiovascular events	×	√	√
Residual renal function	×	×	√
Quality of life	×	√	√
Economic benefits	×	×	√
Malnutrition	×	×	√
Fluid overload	×	×	×

that over 50% of HD patients experience fluid overload. ESKD patients undergoing PD are more likely to experience fluid overload than those on HD, and it is not easy to detect, possibly due to increased dialysate intakes[110]. Eldehni *et al*[8] have also discovered that individuals with diabetes face an increased risk of fluid overload during PD treatment. This could be linked to the absorption of glucose, loss of protein, and malnutrition. Fluid overload is a common complication of PD and HD, requiring strict water and salt intake restrictions. HD may be a more favorable choice for diabetic ESKD patients to better control volume overload and reduce related complications. Strict management of fluid and salt intake is critical for patients undergoing both HD and PD.

CONCLUSION

In summary, diabetic ESKD patients face complex conditions and numerous complications. HD and PD each have advantages and disadvantages, making the selection of the first-choice dialysis method challenging. Dialysis methods should be selected based on the patient's condition, family economic status, peritoneal status, vascular access conditions, and regional medical insurance policies to achieve better survival rates and quality of life. A just and ethical approach to decision-making prioritizes patient autonomy and shared decision-making, ensuring each patient's individual needs are carefully considered. Furthermore, the survival rates of diabetic ESKD patients under different dialysis methods remain debated. Table 2 summarizes studies comparing diabetic ESKD patients undergoing PD and HD. There is currently a lack of prospective clinical research on glucose metabolism, infectious complications, RRF, malnutrition, and fluid overload. Therefore, further research on these factors is warranted. Future research should implement a weighted scoring system, allocating weights to critical aspects of dialysis options for diabetic patients based on clinical evidence and their impacts. Dialysis methods will then be evaluated and scored based on empirical data, with the highest-scoring method being prioritized for recommendation. This approach aims to facilitate personalized treatment plans, enhancing patients' quality of life and survival rates.

ACKNOWLEDGEMENTS

Thanks to the strong support of the research team that made this article possible.

FOOTNOTES

Author contributions: Hu YH wrote the main manuscript text; Liu YL and Zhang YX prepared tables 1-2; Meng LF participated in revising the manuscript; Cui WP designed this study and reviewed this manuscript.

Supported by Science and Technology Department of Jilin Province, No. YDZJ202201ZYTS110 and No. 20200201352JC.

Conflict-of-interest statement: All the authors have no conflict of interest related to the manuscript.

Country of origin: China

ORCID number: Yao-Hua Hu 0009-0000-0616-2228; Ling-Fei Meng 0000-0001-9253-4920; Yi-Xian Zhang 0000-0003-0602-070X; Wen-Peng Cui 0000-0001-6637-7255.

Corresponding Author's Membership in Professional Societies: Chinese Society of Nephrology, No. D01.

S-Editor: Qu XL
L-Editor: A
P-Editor: Yuan YY

REFERENCES

1 **Kalantar-Zadeh K**, Jafar TH, Nitsch D, Neuen BL, Perkovic V. Chronic kidney disease. *Lancet* 2021; **398**: 786-802 [PMID: 34175022 DOI: 10.1016/S0140-6736(21)00519-5]

2 **Li HL**, Tai PH, Hwang YT, Lin SW, Lan LC. Causes of Hospitalization among End-Stage Kidney Disease Cohort before and after Hemodialysis. *Int J Environ Res Public Health* 2022; **19** [PMID: 36011888 DOI: 10.3390/ijerph191610253]

3 **Kuehn BM**. End-stage Kidney Disease Doubles. *JAMA* 2022; **327**: 1540 [PMID: 35471504 DOI: 10.1001/jama.2022.5342]

4 **Kleinaki Z**, Kapnisi S, Theodorelou-Charitou SA, Nikas IP, Paschou SA. Type 2 diabetes mellitus management in patients with chronic kidney disease: an update. *Hormones (Athens)* 2020; **19**: 467-476 [PMID: 32500461 DOI: 10.1007/s42000-020-00212-y]

5 **Miyata Y**, Obata Y, Mochizuki Y, Kitamura M, Mitsunari K, Matsuo T, Ohba K, Mukae H, Nishino T, Yoshimura A, Sakai H. Periodontal Disease in Patients Receiving Dialysis. *Int J Mol Sci* 2019; **20** [PMID: 31382656 DOI: 10.3390/ijms20153805]

6 **Jin DC**, Yun SR, Lee SW, Han SW, Kim W, Park J, Kim YK. Lessons from 30 years' data of Korean end-stage renal disease registry, 1985-2015. *Kidney Res Clin Pract* 2015; **34**: 132-139 [PMID: 26484037 DOI: 10.1016/j.krcp.2015.08.004]

7 **Alalawi F**, Bashier A. Management of diabetes mellitus in dialysis patients: Obstacles and challenges. *Diabetes Metab Syndr* 2021; **15**: 1025-1036 [PMID: 34000713 DOI: 10.1016/j.dsx.2021.05.007]

8 **Eldehni MT**, Crowley LE, Selby NM. Challenges in Management of Diabetic Patient on Dialysis. *Kidney Dial* 2022; **2**: 553-564 [DOI: 10.3390/kidneydial2040050]

9 **Couchoud C**, Bolignano D, Nistor I, Jager KJ, Heaf J, Heimburger O, Van Biesen W; European Renal Best Practice (ERBP) Diabetes Guideline Development Group. Dialysis modality choice in diabetic patients with end-stage kidney disease: a systematic review of the available evidence. *Nephrol Dial Transplant* 2015; **30**: 310-320 [PMID: 25248364 DOI: 10.1093/ndt/gfu293]

10 **Liu H**, He Z, Hu X, Li S, Wang L, Zhao D, Lin Q, Liu X, Lu F, Zhang D. Propensity-matched comparison of mortality between peritoneal dialysis and hemodialysis in patients with type 2 diabetes. *Int Urol Nephrol* 2022; **54**: 1373-1381 [PMID: 34657242 DOI: 10.1007/s11255-021-03026-y]

11 **Xu F**, Yang Y, Wu M, Zhou W, Wang D, Cui W. Patients with end-stage renal disease and diabetes had similar survival rates whether they received hemodialysis or peritoneal dialysis. *Ther Apher Dial* 2023; **27**: 59-65 [PMID: 35614543 DOI: 10.1111/1744-9987.13890]

12 **Couchoud C**, Moranne O, Frimat L, Labeeuw M, Allot V, Stengel B. Associations between comorbidities, treatment choice and outcome in the elderly with end-stage renal disease. *Nephrol Dial Transplant* 2007; **22**: 3246-3254 [PMID: 17616533 DOI: 10.1093/ndt/gfm400]

13 **Waldum-Grevbo B**, Leivestad T, Reisæter AV, Os I. Impact of initial dialysis modality on mortality: a propensity-matched study. *BMC Nephrol* 2015; **16**: 179 [PMID: 26519164 DOI: 10.1186/s12882-015-0175-5]

14 **Elsayed ME**, Morris AD, Li X, Browne LD, Stack AG. Propensity score matched mortality comparisons of peritoneal and in-centre haemodialysis: systematic review and meta-analysis. *Nephrol Dial Transplant* 2020; **35**: 2172-2182 [PMID: 31981353 DOI: 10.1093/ndt/gfz278]

15 **Lee MJ**, Kwon YE, Park KS, Kee YK, Yoon CY, Han IM, Han SG, Oh HJ, Park JT, Han SH, Yoo TH, Kim YL, Kim YS, Yang CW, Kim NH, Kang SW. Glycemic Control Modifies Difference in Mortality Risk Between Hemodialysis and Peritoneal Dialysis in Incident Dialysis Patients With Diabetes: Results From a Nationwide Prospective Cohort in Korea. *Medicine (Baltimore)* 2016; **95**: e3118 [PMID: 26986162 DOI: 10.1097/MD.0000000000003118]

16 **Weinhandl ED**, Foley RN, Gilbertson DT, Arneson TJ, Snyder JJ, Collins AJ. Propensity-matched mortality comparison of incident hemodialysis and peritoneal dialysis patients. *J Am Soc Nephrol* 2010; **21**: 499-506 [PMID: 20133483 DOI: 10.1681/ASN.2009060635]

17 **Jin H**, Ni Z, Che X, Gu L, Zhu M, Yuan J, Huang J, Gu A, Jin Y, Yan H, Wang Q, Yu Z, Zhou W, Fang W. Peritoneal Dialysis as an Option for Unplanned Dialysis Initiation in Patients with End-Stage Renal Disease and Diabetes Mellitus. *Blood Purif* 2019; **47**: 52-57 [PMID: 30223256 DOI: 10.1159/000493176]

18 **Yeates K**, Zhu N, Vonesh E, Trpeski L, Blake P, Fenton S. Hemodialysis and peritoneal dialysis are associated with similar outcomes for end-stage renal disease treatment in Canada. *Nephrol Dial Transplant* 2012; **27**: 3568-3575 [PMID: 22391139 DOI: 10.1093/ndt/gfr674]

19 **Wang IK**, Liang WM, Lin CL, Liu YL, Chang CT, Yen TH, Huang CC, Sung FC. Impact of dialysis modality on the survival of patients with end-stage renal disease and prior stroke. *Int Urol Nephrol* 2016; **48**: 139-147 [PMID: 26560476 DOI: 10.1007/s11255-015-1157-z]

20 **Wang IK**, Lin CL, Yen TH, Lin SY, Sung FC. Comparison of survival between hemodialysis and peritoneal dialysis patients with end-stage renal disease in the era of icodextrin treatment. *Eur J Intern Med* 2018; **50**: 69-74 [PMID: 29208453 DOI: 10.1016/j.ejim.2017.11.017]

21 **Kim HJ**, Park JT, Han SH, Yoo TH, Park HC, Kang SW, Kim KH, Ryu DR, Kim H. The pattern of choosing dialysis modality and related mortality outcomes in Korea: a national population-based study. *Korean J Intern Med* 2017; **32**: 699-710 [PMID: 28651309 DOI: 10.3904/kjim.2017.141]

22 **Kearney J**, Gnudi L. The Pillars for Renal Disease Treatment in Patients with Type 2 Diabetes. *Pharmaceutics* 2023; **15** [PMID: 37242585 DOI: 10.3390/pharmaceutics15051343]

23 **Shubrook JH**, Neumiller JJ, Wright E. Management of chronic kidney disease in type 2 diabetes: screening, diagnosis and treatment goals, and recommendations. *Postgrad Med* 2022; **134**: 376-387 [PMID: 34817311 DOI: 10.1080/00325481.2021.2009726]

24 **Xue C**, Gu YY, Cui CJ, Zhou CC, Wang XD, Ruan MN, Huang LX, Chen SX, Yang B, Chen XJ, Qian YX, Wu J, Zhao XZ, Zhang YQ, Mei

CL, Zhang SL, Xu J, Mao ZG. New-onset glucose disorders in peritoneal dialysis patients: a meta-analysis and systematic review. *Nephrol Dial Transplant* 2020; **35**: 1412-1419 [PMID: 31236586 DOI: 10.1093/ndt/gfz116]
25 **Takatori Y**, Akagi S, Sugiyama H, Inoue J, Kojo S, Morinaga H, Nakao K, Wada J, Makino H. Icodextrin increases technique survival rate in peritoneal dialysis patients with diabetic nephropathy by improving body fluid management: a randomized controlled trial. *Clin J Am Soc Nephrol* 2011; **6**: 1337-1344 [PMID: 21493740 DOI: 10.2215/CJN.10041110]
26 **Jin YP**, Su XF, Yin GP, Xu XH, Lou JZ, Chen JJ, Zhou Y, Lan J, Jiang B, Li Z, Lee KO, Ye L, Ma JH. Blood glucose fluctuations in hemodialysis patients with end stage diabetic nephropathy. *J Diabetes Complications* 2015; **29**: 395-399 [PMID: 25681043 DOI: 10.1016/j.jdiacomp.2014.12.015]
27 **Li J**, Zhang R, Wu Z, Guo J, Wang Z, Li S, Li C, Yang G, Cheng X. Blood Glucose Fluctuation in Older Adults with Diabetes Mellitus and End-Stage Renal Disease on Maintenance Hemodialysis: An Observational Study. *Diabetes Ther* 2022; **13**: 1353-1365 [PMID: 35689733 DOI: 10.1007/s13300-022-01274-4]
28 **Jung HS**, Kim HI, Kim MJ, Yoon JW, Ahn HY, Cho YM, Oh KH, Joo KW, Lee JG, Kim SY, Park KS. Analysis of hemodialysis-associated hypoglycemia in patients with type 2 diabetes using a continuous glucose monitoring system. *Diabetes Technol Ther* 2010; **12**: 801-807 [PMID: 20809681 DOI: 10.1089/dia.2010.0067]
29 **Hayashi A**, Shimizu N, Suzuki A, Matoba K, Momozono A, Masaki T, Ogawa A, Moriguchi I, Takano K, Kobayashi N, Shichiri M. Hemodialysis-Related Glycemic Disarray Proven by Continuous Glucose Monitoring; Glycemic Markers and Hypoglycemia. *Diabetes Care* 2021; **44**: 1647-1656 [PMID: 34045240 DOI: 10.2337/dc21-0269]
30 **Burmeister JE**, Scapini A, da Rosa Miltersteiner D, da Costa MG, Campos BM. Glucose-added dialysis fluid prevents asymptomatic hypoglycaemia in regular haemodialysis. *Nephrol Dial Transplant* 2007; **22**: 1184-1189 [PMID: 17272314 DOI: 10.1093/ndt/gfl710]
31 **Chen XX**, Duan Y, Zhou Y. Effects of Hemodialysis and Peritoneal Dialysis on Glycometabolism in Patients with End-Stage Diabetic Nephropathy. *Blood Purif* 2021; **50**: 506-512 [PMID: 33302273 DOI: 10.1159/000511722]
32 **Guo Q**, Chen Y, Yang L, Zhu X, Zhang X, Zhao Q, Zhuang X, Wu Y, Luo P, Cui W. Influence of Early-Onset Peritonitis on Mortality and Clinical Outcomes in ESRD Patients with Diabetes Mellitus on Peritoneal Dialysis: A Retrospective Multicenter Study. *Blood Purif* 2022; **51**: 280-287 [PMID: 34638121 DOI: 10.1159/000514938]
33 **Meng LF**, Yang LM, Zhu XY, Zhang XX, Li XY, Zhao J, Liu SC, Zhuang XH, Luo P, Cui WP. Comparison of clinical features and outcomes in peritoneal dialysis-associated peritonitis patients with and without diabetes: A multicenter retrospective cohort study. *World J Diabetes* 2020; **11**: 435-446 [PMID: 33133391 DOI: 10.4239/wjd.v11.i10.435]
34 **Nessim SJ**, Bargman JM, Austin PC, Nisenbaum R, Jassal SV. Predictors of peritonitis in patients on peritoneal dialysis: results of a large, prospective Canadian database. *Clin J Am Soc Nephrol* 2009; **4**: 1195-1200 [PMID: 19406969 DOI: 10.2215/CJN.00910209]
35 **He F**, Wu X, Xia X, Peng F, Huang F, Yu X. Pneumonia and mortality risk in continuous ambulatory peritoneal dialysis patients with diabetic nephropathy. *PLoS One* 2013; **8**: e61497 [PMID: 23585903 DOI: 10.1371/journal.pone.0061497]
36 **Ueda R**, Nakao M, Maruyama Y, Nakashima A, Yamamoto I, Matsuo N, Tanno Y, Ohkido I, Ikeda M, Yamamoto H, Yokoyama K, Yokoo T. Effect of diabetes on incidence of peritoneal dialysis-associated peritonitis. *PLoS One* 2019; **14**: e0225316 [PMID: 31830041 DOI: 10.1371/journal.pone.0225316]
37 **Chang HH**, Chang CH, Hsiao CY, Kao SY, Chen JY, Chen TH, Tsai PJ. Diabetes Is the Most Critical Risk Factor of Adverse Complications After Peritoneal Dialysis Catheter Placement. *Front Med (Lausanne)* 2021; **8**: 719345 [PMID: 34778285 DOI: 10.3389/fmed.2021.719345]
38 **Lin J**, Ye H, Li J, Qiu Y, Wu H, Yi C, Lu S, Chen J, Mao H, Huang F, Yu X, Yang X. Prevalence and risk factors of exit-site infection in incident peritoneal dialysis patients. *Perit Dial Int* 2020; **40**: 164-170 [PMID: 32072873 DOI: 10.1177/0896860819886965]
39 **Lee SM**, Min YS, Son YK, Kim SE, An WS. Comparison of clinical outcome between incremental peritoneal dialysis and conventional peritoneal dialysis: a propensity score matching study. *Ren Fail* 2021; **43**: 1222-1228 [PMID: 34396922 DOI: 10.1080/0886022X.2021.1960564]
40 **Liu R**, Ye H, Peng Y, Yi C, Lin J, Wu H, Diao X, Mao H, Huang F, Yang X. Incremental peritoneal dialysis and survival outcomes: a propensity-matched cohort study. *J Nephrol* 2023; **36**: 1907-1919 [PMID: 37603146 DOI: 10.1007/s40620-023-01735-4]
41 **Sandrini M**, Vizzardi V, Valerio F, Ravera S, Manili L, Zubani R, Lucca BJ, Cancarini G. Incremental peritoneal dialysis: a 10 year single-centre experience. *J Nephrol* 2016; **29**: 871-879 [PMID: 27582136 DOI: 10.1007/s40620-016-0344-z]
42 **Yap HY**, Pang SC, Tan CS, Tan YL, Goh N, Achudan S, Lee KG, Tan RY, Choong LH, Chong TT. Catheter-related complications and survival among incident hemodialysis patients in Singapore. *J Vasc Access* 2018; **19**: 602-608 [PMID: 29582680 DOI: 10.1177/1129729818765055]
43 **Hasanoglu I**, Guner R, Sahin S, Yılmaz Karadag F, Parmaksiz E, Atalay HV, Alısır Ecder S, Arslan Gulen T, Atan Ucar Z, Karabay O, Sipahi S, Kaya Kılıc E, Duranay M, Yapar D, Dogan İ, Ersoz G, Turkmen G, Kıykım AA. Surveillance of hemodialysis related infections: a prospective multicenter study. *Sci Rep* 2022; **12**: 22240 [PMID: 36564392 DOI: 10.1038/s41598-022-24820-3]
44 **Shima H**, Okamoto T, Tashiro M, Inoue T, Masaki C, Tanaka Y, Tada H, Takamatsu N, Wariishi S, Kawahara K, Okada K, Nishiuchi T, Minakuchi J. Clinical Characteristics and Risk Factors for Mortality due to Bloodstream Infection of Unknown Origin in Hemodialysis Patients: A Single-Center, Retrospective Study. *Blood Purif* 2021; **50**: 238-245 [PMID: 32892202 DOI: 10.1159/000510291]
45 **Johansen KL**, Chertow GM, Gilbertson DT, Ishani A, Israni A, Ku E, Li S, Li S, Liu J, Obrador GT, Schulman I, Chan K, Abbott KC, O'Hare AM, Powe NR, Roetker NS, Scherer JS, St Peter W, Snyder J, Winkelmayer WC, Wong SPY, Wetmore JB. US Renal Data System 2022 Annual Data Report: Epidemiology of Kidney Disease in the United States. *Am J Kidney Dis* 2023; **81**: A8-A11 [PMID: 36822739 DOI: 10.1053/j.ajkd.2022.12.001]
46 **Chaudry MS**, Gislason GH, Kamper AL, Rix M, Larsen AR, Petersen A, Andersen PS, Skov RL, Fosbøl EL, Westh H, Schønheyder HC, Benfield TL, Fowler VG Jr, Torp-Pedersen C, Bruun NE. Increased risk of Staphylococcus aureus bacteremia in hemodialysis-A nationwide study. *Hemodial Int* 2019; **23**: 230-238 [PMID: 30779302 DOI: 10.1111/hdi.12728]
47 **Lee CC**, Sun CY, Wu MS. Long-term modality-related mortality analysis in incident dialysis patients. *Perit Dial Int* 2009; **29**: 182-190 [PMID: 19293356]
48 **Aslam N**, Bernardini J, Fried L, Burr R, Piraino B. Comparison of infectious complications between incident hemodialysis and peritoneal dialysis patients. *Clin J Am Soc Nephrol* 2006; **1**: 1226-1233 [PMID: 17699352 DOI: 10.2215/CJN.01230406]
49 **Iglesias P**, Bajo MA, Selgas R, Díez JJ. Thyroid dysfunction and kidney disease: An update. *Rev Endocr Metab Disord* 2017; **18**: 131-144 [PMID: 27864708 DOI: 10.1007/s11154-016-9395-7]
50 **McCullough PA**, Chan CT, Weinhandl ED, Burkart JM, Bakris GL. Intensive Hemodialysis, Left Ventricular Hypertrophy, and Cardiovascular Disease. *Am J Kidney Dis* 2016; **68**: S5-S14 [PMID: 27772643 DOI: 10.1053/j.ajkd.2016.05.025]

51 **Grzywacz A**, Lubas A, Niemczyk S. Inferior Nutritional Status Significantly Differentiates Dialysis Patients with Type 1 and Type 2 Diabetes. *Nutrients* 2023; **15** [PMID: 37049397 DOI: 10.3390/nu15071549]

52 **Lee SW**, Lee NR, Son SK, Kim J, Sul AR, Kim Y, Park JT, Lee JP, Ryu DR. Comparative study of peritoneal dialysis versus hemodialysis on the clinical outcomes in Korea: a population-based approach. *Sci Rep* 2019; **9**: 5905 [PMID: 30976069 DOI: 10.1038/s41598-019-42508-z]

53 **Khoo CY**, Gao F, Choong HL, Tan WXA, Koniman R, Fam JM, Yeo KK. Death and cardiovascular outcomes in end-stage renal failure patients on different modalities of dialysis. *Ann Acad Med Singap* 2022; **51**: 136-142 [PMID: 35373236 DOI: 10.47102/annals-acadmedsg.20219]

54 **Wang IK**, Lu CY, Lin CL, Liang CC, Yen TH, Liu YL, Sung FC. Comparison of the risk of de novo cardiovascular disease between hemodialysis and peritoneal dialysis in patients with end-stage renal disease. *Int J Cardiol* 2016; **218**: 219-224 [PMID: 27236118 DOI: 10.1016/j.ijcard.2016.05.036]

55 **Zou M**, Xie J, Lan L, Zhang Y, Tian L, Chen M, Yan Y. Safety and efficacy of hemodialysis and peritoneal dialysis in treating end-stage diabetic nephropathy: a meta-analysis of randomized controlled trials. *Int Urol Nephrol* 2022; **54**: 2901-2909 [PMID: 35426589 DOI: 10.1007/s11255-022-03194-5]

56 **Hu PJ**, Chen YW, Chen TT, Sung LC, Wu MY, Wu MS. Impact of dialysis modality on major adverse cardiovascular events and all-cause mortality: a national population-based study. *Nephrol Dial Transplant* 2021; **36**: 901-908 [PMID: 33313719 DOI: 10.1093/ndt/gfaa282]

57 **Zhang S**, Li H, Cai X, Zhao C, Cao J. The association between serum cystatin C and residual renal function in peritoneal dialysis patients. *Ther Apher Dial* 2022; **26**: 1241-1246 [PMID: 35253373 DOI: 10.1111/1744-9987.13832]

58 **Brener ZZ**, Thijssen S, Kotanko P, Kuhlmann MK, Bergman M, Winchester JF, Levin NW. The impact of residual renal function on hospitalization and mortality in incident hemodialysis patients. *Blood Purif* 2011; **31**: 243-251 [PMID: 21242677 DOI: 10.1159/000322252]

59 **Kendrick J**, Teitelbaum I. Strategies for improving long-term survival in peritoneal dialysis patients. *Clin J Am Soc Nephrol* 2010; **5**: 1123-1131 [PMID: 20430945 DOI: 10.2215/CJN.04300709]

60 **Horinek A**, Misra M. Does residual renal function decline more rapidly in hemodialysis than in peritoneal dialysis? *Adv Perit Dial* 2004; **20**: 137-140 [PMID: 15384814]

61 **Shen Q**, Fang X, Zhai Y, Rao J, Chen J, Miao Q, Gong Y, Yu M, Zhou Q, Xu H. Risk factors for loss of residual renal function in children with end-stage renal disease undergoing automatic peritoneal dialysis. *Perit Dial Int* 2020; **40**: 368-376 [PMID: 32063214 DOI: 10.1177/0896860819893818]

62 **Htay H**, Cho Y, Pascoe EM, Darssan D, Hawley C, Johnson DW; balANZ trial investigators. Predictors of Residual Renal Function Decline in Peritoneal Dialysis Patients: The balANZ Trial. *Perit Dial Int* 2017; **37**: 283-289 [PMID: 27935537 DOI: 10.3747/pdi.2016.00206]

63 **Justo P**, Sanz AB, Egido J, Ortiz A. 3,4-Dideoxyglucosone-3-ene induces apoptosis in renal tubular epithelial cells. *Diabetes* 2005; **54**: 2424-2429 [PMID: 16046310 DOI: 10.2337/diabetes.54.8.2424]

64 **Tanriover C**, Ucku D, Basile C, Tuttle KR, Kanbay M. On the importance of the interplay of residual renal function with clinical outcomes in end-stage kidney disease. *J Nephrol* 2022; **35**: 2191-2204 [PMID: 35819749 DOI: 10.1007/s40620-022-01388-9]

65 **Lee Y**, Chung SW, Park S, Ryu H, Lee H, Kim DK, Joo KW, Ahn C, Lee J, Oh KH. Incremental Peritoneal Dialysis May be Beneficial for Preserving Residual Renal Function Compared to Full-dose Peritoneal Dialysis. *Sci Rep* 2019; **9**: 10105 [PMID: 31300708 DOI: 10.1038/s41598-019-46654-2]

66 **Liu X**, Dai C. Advances in Understanding and Management of Residual Renal Function in Patients with Chronic Kidney Disease. *Kidney Dis (Basel)* 2017; **2**: 187-196 [PMID: 28232935 DOI: 10.1159/000449029]

67 **Tam P**. Peritoneal Dialysis and Preservation of Residual Renal Function. *Perit Dial Int* 2009; **29**: 108-110 [DOI: 10.1177/089686080902902s20]

68 **Floria I**, Kontele I, Grammatikopoulou MG, Sergentanis TN, Vassilakou T. Quality of Life of Hemodialysis Patients in Greece: Associations with Socio-Economic, Anthropometric and Nutritional Factors. *Int J Environ Res Public Health* 2022; **19** [PMID: 36430108 DOI: 10.3390/ijerph192215389]

69 **Brown EA**, Zhao J, McCullough K, Fuller DS, Figueiredo AE, Bieber B, Finkelstein FO, Shen J, Kanjanabuch T, Kawanishi H, Pisoni RL, Perl J; PDOPPS Patient Support Working Group. Burden of Kidney Disease, Health-Related Quality of Life, and Employment Among Patients Receiving Peritoneal Dialysis and In-Center Hemodialysis: Findings From the DOPPS Program. *Am J Kidney Dis* 2021; **78**: 489-500.e1 [PMID: 33872688 DOI: 10.1053/j.ajkd.2021.02.327]

70 **Sun H**, Zhuang Y, Gao L, Xu N, Xiong Y, Yuan M, Lu J, Ye J. Impact of dialysis modality conversion on the health-related quality of life of peritoneal dialysis patients: a retrospective cohort study in China. *PeerJ* 2022; **10**: e12793 [PMID: 35111408 DOI: 10.7717/peerj.12793]

71 **Cepeda Marte JL**, Javier A, Ruiz-Matuk C, Paulino-Ramirez R. Quality of Life and Nutritional Status in diabetic patients on hemodialysis. *Diabetes Metab Syndr* 2019; **13**: 576-580 [PMID: 30641769 DOI: 10.1016/j.dsx.2018.11.020]

72 **Dembowska E**, Jaroń A, Gabrysz-Trybek E, Bladowska J, Gacek S, Trybek G. Quality of Life in Patients with End-Stage Renal Disease Undergoing Hemodialysis. *J Clin Med* 2022; **11** [PMID: 35329910 DOI: 10.3390/jcm11061584]

73 **Alencar SBV**, de Lima FM, Dias LDA, Dias VDA, Lessa AC, Bezerra JM, Apolinário JF, de Petribu KC. Depression and quality of life in older adults on hemodialysis. *Braz J Psychiatry* 2020; **42**: 195-200 [PMID: 31389496 DOI: 10.1590/1516-4446-2018-0345]

74 **Mathew N**, Davies M, Kaldine F, Cassimjee Z. Comparison of quality of life in patients with advanced chronic kidney disease undergoing haemodialysis, peritoneal dialysis and conservative management in Johannesburg, South Africa: a cross-sectional, descriptive study. *BMC Psychol* 2023; **11**: 151 [PMID: 37158906 DOI: 10.1186/s40359-023-01196-1]

75 **Muehrer RJ**, Schatell D, Witten B, Gangnon R, Becker BN, Hofmann RM. Factors affecting employment at initiation of dialysis. *Clin J Am Soc Nephrol* 2011; **6**: 489-496 [PMID: 21393489 DOI: 10.2215/CJN.02550310]

76 **Iyasere O**, Brown EA, Johansson L, Davenport A, Farrington K, Maxwell AP, Collinson H, Fan S, Habib AM, Stoves J, Woodrow G. Quality of life with conservative care compared with assisted peritoneal dialysis and haemodialysis. *Clin Kidney J* 2019; **12**: 262-268 [PMID: 30976407 DOI: 10.1093/ckj/sfy059]

77 **Raoofi S**, Pashazadeh Kan F, Rafiei S, Hoseinipalangi Z, Rezaei S, Ahmadi S, Masoumi M, Noorani Mejareh Z, Roohravan Benis M, Sharifi A, Shabaninejad H, Kiaee ZM, Ghashghaee A. Hemodialysis and peritoneal dialysis-health-related quality of life: systematic review plus meta-analysis. *BMJ Support Palliat Care* 2023; **13**: 365-373 [PMID: 34301643 DOI: 10.1136/bmjspcare-2021-003182]

78 **Rayner HC**, Zepel L, Fuller DS, Morgenstern H, Karaboyas A, Culleton BF, Mapes DL, Lopes AA, Gillespie BW, Hasegawa T, Saran R, Tentori F, Hecking M, Pisoni RL, Robinson BM. Recovery time, quality of life, and mortality in hemodialysis patients: the Dialysis Outcomes and Practice Patterns Study (DOPPS). *Am J Kidney Dis* 2014; **64**: 86-94 [PMID: 24529994 DOI: 10.1053/j.ajkd.2014.01.014]

79 **Ong S**, Barker-Finkel J, Allon M. Long-term outcomes of arteriovenous thigh grafts in hemodialysis patients: a comparison with tunneled

dialysis catheters. *Clin J Am Soc Nephrol* 2013; **8**: 804-809 [PMID: 23371958 DOI: 10.2215/CJN.09240912]
80 **Surendra NK**, Abdul Manaf MR, Hooi LS, Bavanandan S, Mohamad Nor FS, Shah Firdaus Khan S, Ong LM, Abdul Gafor AH. Health related quality of life of dialysis patients in Malaysia: Haemodialysis versus continuous ambulatory peritoneal dialysis. *BMC Nephrol* 2019; **20**: 151 [PMID: 31039745 DOI: 10.1186/s12882-019-1326-x]
81 **Cameron JI**, Whiteside C, Katz J, Devins GM. Differences in quality of life across renal replacement therapies: a meta-analytic comparison. *Am J Kidney Dis* 2000; **35**: 629-637 [PMID: 10739783 DOI: 10.1016/s0272-6386(00)70009-6]
82 **Wu AW**, Fink NE, Marsh-Manzi JV, Meyer KB, Finkelstein FO, Chapman MM, Powe NR. Changes in quality of life during hemodialysis and peritoneal dialysis treatment: generic and disease specific measures. *J Am Soc Nephrol* 2004; **15**: 743-753 [PMID: 14978177 DOI: 10.1097/01.asn.0000113315.81448.ca]
83 **Zeng B**, Wang Q, Wu S, Lin S, Li Y, Jiang W, Guo R, Zhou F, Lin K. Cognitive Dysfunction and Health-Related Quality of Life in Patients with End-Stage Renal Disease Undergoing Hemodialysis in Comparison with Patients Undergoing Peritoneal Dialysis: A Cross-Sectional Study. *Med Sci Monit* 2022; **28**: e934282 [PMID: 35124688 DOI: 10.12659/MSM.934282]
84 **Bargman JM**, Girsberger M. Visions in a Crystal Ball: The Future of Peritoneal Dialysis. *Blood Purif* 2018; **45**: 218-223 [PMID: 29478058 DOI: 10.1159/000485158]
85 **Iyasere OU**, Brown EA, Johansson L, Huson L, Smee J, Maxwell AP, Farrington K, Davenport A. Quality of Life and Physical Function in Older Patients on Dialysis: A Comparison of Assisted Peritoneal Dialysis with Hemodialysis. *Clin J Am Soc Nephrol* 2016; **11**: 423-430 [PMID: 26712808 DOI: 10.2215/CJN.01050115]
86 **Roggeri A**, Roggeri DP, Zocchetti C, Bersani M, Conte F; ReNe (Renal Lombardy Network); Additional contributors from ReNe Network. Healthcare costs of the progression of chronic kidney disease and different dialysis techniques estimated through administrative database analysis. *J Nephrol* 2017; **30**: 263-269 [PMID: 27165160 DOI: 10.1007/s40620-016-0291-8]
87 **Berger A**, Edelsberg J, Inglese GW, Bhattacharyya SK, Oster G. Cost comparison of peritoneal dialysis versus hemodialysis in end-stage renal disease. *Am J Manag Care* 2009; **15**: 509-518 [PMID: 19670954]
88 **Chang YT**, Hwang JS, Hung SY, Tsai MS, Wu JL, Sung JM, Wang JD. Cost-effectiveness of hemodialysis and peritoneal dialysis: A national cohort study with 14 years follow-up and matched for comorbidities and propensity score. *Sci Rep* 2016; **6**: 30266 [PMID: 27461186 DOI: 10.1038/srep30266]
89 **Shukri A**, Mettang T, Scheckel B, Schellartz I, Simic D, Scholten N, Müller M, Stock S. Hemodialysis and Peritoneal Dialysis in Germany from a Health Economic View-A Propensity Score Matched Analysis. *Int J Environ Res Public Health* 2022; **19** [PMID: 36360885 DOI: 10.3390/ijerph192114007]
90 **Wong CKH**, Chen J, Fung SKS, Mok M, Cheng YL, Kong I, Lo WK, Lui SL, Chan TM, Lam CLK. Lifetime cost-effectiveness analysis of first-line dialysis modalities for patients with end-stage renal disease under peritoneal dialysis first policy. *BMC Nephrol* 2020; **21**: 42 [PMID: 32019528 DOI: 10.1186/s12882-020-1708-0]
91 **Kwong VW**, Li PK. Peritoneal Dialysis in Asia. *Kidney Dis (Basel)* 2015; **1**: 147-156 [PMID: 27536675 DOI: 10.1159/000439193]
92 **Schmicker R**. Nutritional treatment of hemodialysis and peritoneal dialysis patients. *Artif Organs* 1995; **19**: 837-841 [PMID: 8573005 DOI: 10.1111/j.1525-1594.1995.tb02437.x]
93 **Kang GH**, Kim YN, Shin HS. Relationship between geriatric nutritional risk index and subpopulation lymphocyte counts in patients undergoing hemodialysis and peritoneal dialysis. *Ren Fail* 2016; **38**: 1589-1593 [PMID: 27934551 DOI: 10.3109/0886022X.2015.1128234]
94 **Leinig CE**, Moraes T, Ribeiro S, Riella MC, Olandoski M, Martins C, Pecoits-Filho R. Predictive value of malnutrition markers for mortality in peritoneal dialysis patients. *J Ren Nutr* 2011; **21**: 176-183 [PMID: 21193323 DOI: 10.1053/j.jrn.2010.06.026]
95 **Lowrie EG**, Lew NL. Death risk in hemodialysis patients: the predictive value of commonly measured variables and an evaluation of death rate differences between facilities. *Am J Kidney Dis* 1990; **15**: 458-482 [PMID: 2333868 DOI: 10.1016/s0272-6386(12)70364-5]
96 **Wu X**, Meng J, Zhou L, Zhan X, Wen Y, Wang X, Feng X, Wang N, Peng F, Wu J. Albumin to Total Cholesterol Ratio and Mortality in Peritoneal Dialysis. *Front Med (Lausanne)* 2022; **9**: 896443 [PMID: 35755025 DOI: 10.3389/fmed.2022.896443]
97 **Prasad N**, Gupta A, Sinha A, Sharma RK, Kumar A, Kumar R. Changes in nutritional status on follow-up of an incident cohort of continuous ambulatory peritoneal dialysis patients. *J Ren Nutr* 2008; **18**: 195-201 [PMID: 18267212 DOI: 10.1053/j.jrn.2007.08.002]
98 **Prasad N**, Gupta A, Sinha A, Singh A, Sharma RK, Kaul A. Impact of stratification of comorbidities on nutrition indices and survival in patients on continuous ambulatory peritoneal dialysis. *Perit Dial Int* 2009; **29** Suppl 2: S153-S157 [PMID: 19270207]
99 **Silva LF**, Lopes GB, Matos CM, Brito KQ, Amoedo MK, Azevedo MF, Sá Araújo MJ, Martins MS, Lopes AA. Gastrointestinal symptoms and nutritional status in women and men on maintenance hemodialysis. *J Ren Nutr* 2012; **22**: 327-335 [PMID: 22071220 DOI: 10.1053/j.jrn.2011.07.007]
100 **Boaz M**, Azoulay O, Kaufman-Shriqui V, Weinstein T. Status of Nutrition In Hemodialysis Patients Survey (SNIPS): Malnutrition risk by diabetes status. *Diabet Med* 2021; **38**: e14543 [PMID: 33583032 DOI: 10.1111/dme.14543]
101 **Bataille S**, Landrier JF, Astier J, Cado S, Sallette J, Giaime P, Sampol J, Sichez H, Ollier J, Gugliotta J, Serveaux M, Cohen J, Darmon P. Haemodialysis patients with diabetes eat less than those without: A plea for a permissive diet. *Nephrology (Carlton)* 2017; **22**: 712-719 [PMID: 27287085 DOI: 10.1111/nep.12837]
102 **Sá Martins V**, Aguiar L, Dias C, Lourenço P, Pinheiro T, Velez B, Borges N, Adragão T, Calhau C, Macário F. Predictors of nutritional and inflammation risk in hemodialysis patients. *Clin Nutr* 2020; **39**: 1878-1884 [PMID: 31427179 DOI: 10.1016/j.clnu.2019.07.029]
103 **Kang SH**, Do JY, Kim JC. Association Between Alkaline Phosphatase and Muscle Mass, Strength, or Physical Performance in Patients on Maintenance Hemodialysis. *Front Med (Lausanne)* 2021; **8**: 657957 [PMID: 34079810 DOI: 10.3389/fmed.2021.657957]
104 **Salamon K**, Woods J, Paul E, Huggins C. Peritoneal dialysis patients have higher prevalence of gastrointestinal symptoms than hemodialysis patients. *J Ren Nutr* 2013; **23**: 114-118 [PMID: 22633989 DOI: 10.1053/j.jrn.2012.02.007]
105 **Xu XD**, Han X, Yang Y, Li X. Comparative study on the efficacy of peritoneal dialysis and hemodialysis in patients with end-stage diabetic nephropathy. *Pak J Med Sci* 2020; **36**: 1484-1489 [PMID: 33235561 DOI: 10.12669/pjms.36.7.2901]
106 **Cianciaruso B**, Brunori G, Kopple JD, Traverso G, Panarello G, Enia G, Strippoli P, De Vecchi A, Querques M, Viglino G. Cross-sectional comparison of malnutrition in continuous ambulatory peritoneal dialysis and hemodialysis patients. *Am J Kidney Dis* 1995; **26**: 475-486 [PMID: 7645556 DOI: 10.1016/0272-6386(95)90494-8]
107 **Lo WK**, Bargman JM, Burkart J, Krediet RT, Pollock C, Kawanishi H, Blake PG; ISPD Adequacy of Peritoneal Dialysis Working Group. Guideline on targets for solute and fluid removal in adult patients on chronic peritoneal dialysis. *Perit Dial Int* 2006; **26**: 520-522 [PMID: 16973505]

108 **Guo Q**, Yi C, Li J, Wu X, Yang X, Yu X. Prevalence and risk factors of fluid overload in Southern Chinese continuous ambulatory peritoneal dialysis patients. *PLoS One* 2013; **8**: e53294 [PMID: 23341936 DOI: 10.1371/journal.pone.0053294]

109 **Zoccali C**, Moissl U, Chazot C, Mallamaci F, Tripepi G, Arkossy O, Wabel P, Stuard S. Chronic Fluid Overload and Mortality in ESRD. *J Am Soc Nephrol* 2017; **28**: 2491-2497 [PMID: 28473637 DOI: 10.1681/ASN.2016121341]

110 **Jin Y**, Huang X, Zhang C, Xie J, Ren H. Impact of fluid overload on blood pressure variability in patients on peritoneal dialysis. *Ren Fail* 2022; **44**: 2066-2072 [PMID: 36415108 DOI: 10.1080/0886022X.2022.2148535]

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: office@baishideng.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com