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Determinants of Switching From Peritoneal to Hemodialysis in Preserving Residual Renal Function

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

There are more than 2 million end stage renal disease (ESRD) patients in the world. ESRD is becoming more manageable with the advent of competent therapies such as peritoneal dialysis (PD) and hemodialysis (HD). While recent evidence suggests that switching from PD to HD may preserve residual renal function longer than either PD or HD alone as an alternative approach, little is known about the optimal timing and the long-term efficacy of switching dialysis modes. The purpose of this quantitative retrospective study, based on the bio-psychosocial model, was to investigate the optimal timing and determinants of the effectiveness of switching dialysis modes from PD to HD. Data were extracted from a national database of ESRD dialysis patients. The Kaplan-Meier survival curve and the log-rank test were used to determine the effect of optimal dialysis time for switching from PD to HD on ESRD patient's survival and mortality. The results showed the optimal duration for switching dialysis modalities was 9 months where patients had a 90% survival rate after switching. ESRD patients taking more than 24 months to switch modes had the highest loss of renal function. Also, patients between 40 and 80 years of age were at a significantly higher hazard of renal function loss than patients younger than 40 years of age. It was concluded that timely switching of dialysis mode from PD to HD increases survival in ESRD patients. Younger patients have better survival rates in peritoneal dialysis modality than older patients. Moreover, females switching from PD to HD have better survival rates than males. The positive social change implications of this study may help raise awareness to the importance of optimal timing when switching dialysis modalities for improved survival and quality of life.

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Dedication

"To succeed in life, it is not important to reach the first." "To succeed, you just have to keep trying until you get there; getting up each time you fall on the road."

I dedicate this work first of all to God, for always blessing me with wonderful projects and with great strength to fulfill them.

To my mother Lutfie Katerji, who always accompanies me and gives me strength to continue; even when she was not with us physically.

I dedicate this dissertation, mainly, to my wife Amaiza Katerji. God put on my path many years ago and today I appreciate that you continue in my life. You have been my rock; always giving me strength, and been supportive when I needed the most. My wife is the person who has been there, during the difficult and trying times.

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Chapter 1: Introduction to the Study

Introduction

End stage renal disease (ESRD) is the permanent failure of the kidneys either slowly over time or suddenly (Santoro et al., 2013). The sole treatment of ESRD is renal replacement therapy (RRT) which includes transplantation, peritoneal dialysis (PD) or hemodialysis (HD) (Stephen et al., 2014). Most ESRD patients prefer having a kidney transplant but this is greatly hindered by an insufficient supply of donor organs (Stephen et al., 2014). The National Kidney Foundation (2016) estimated that the prevalence of ESRD in the world is on rise with USA having 660, 000 cases in 2015 from 173,000 cases in 2013. The United States Renal System (2013) made a global comparison of ESRD prevalence. In the survey, more than 70% of the sampled countries reported to have at least 80% of ESRD patients on HD while 17% were on PD and the 3% on other treatment modes (The United States Renal System, 2013).

This study used data from National Dialysis Center that has the relevant information needed in the study. The data from National Dialysis Center (2011) database showed that the population of people living with ESRD had increased from 2 million in 2010 to 2.1 million in 2011 and will continue to increase steadily with a 6% to 7% yearly increase projected in the future with more than 75% of the patients undergoing dialysis.

Technique failure has been defined in several ways in the literature. It is the discontinuation of dialysis mode (Quinn, Ravani, & Hochman, 2010). Technique failure is any change from PD to HD for at least 30 days (Shen, Mitani, Saxena, Goldstein, & Winkelmayer, 2012) or a permanent change to HD (Descœudres et al., 2008). These varied definitions can lead to differences in the reported risk of technique failure as well as inconsistencies between countries or programs (Quinn et al., 2010). In this study, technique failure is defined as switching from PD to HD within a period of 6 months.

There are factors playing a role in the success or failure of ESRD treatment such as socio-demographic factors and financial and social support, which should be taken into consideration in maintaining PD (Shen et al., 2012). In a similar study, Weinhandl et al. (2010) found that diabetes, cardiovascular disease, and age, all play a role in survival rates and determination of the technique to be adopted. However, Weinhandl et al. only explored HD and PD.

Switching of dialysis modes can increase success rates when treating ESRD patients. Suzuki, Hoshi, Inoue, Kikuta, and Takane, (2013) sought to establish the effects of patient transfer from either mode of dialysis or a combination of both HD and PD. Patients were monitored monthly during the study. At each, visit complete blood count and electrolyte concentrations were measured. The findings of the study indicated that the sequence of beginning treatment with PD followed by a switch to HD is a valuable way of treating ESRD patients (Suzuki et al., 2012). The researchers suggested that patients who need dialysis therapy should consider the new dialysis approach of PD first and transfer to home HD (Suzuki et al., 2012). Similarly, Stanley (2010) and Shen et al. (2012) explored the efficacies of PD and HD and concluded that a well-timed transfer from PD to HD may enhance the survival of a patient. The researchers also added that technique failure is associated with socio-demographic factors (Stanley, 2010; Shen et al., 2012). In their study, Shen et al. (2012) used a nationally representative sample of 1,587

US patients who had begun dialysis on PD. In this study, I utilized a larger national database of over 100,000 dialysis patients to evaluate the effectiveness of PD and switching from PD to HD. In addition, I will also seek to establish the determinants associated with the occurrence of dialysis technique failure.

Background of the Study

During dialysis, there is a possibility of loss in renal function and after loss of renal function PD may lead to a worse outcome than HD, whereas, a timely transfer may increase the long-term survival (Stanley, 2010). Pajek et al. (2014) examined if the timing of the switch from PD to HD affected mortality rate of patients with renal disease. They concluded that the timing of the switch had no significant effect on the mortality rate of patients. However, the limitation of their study was that they could only examine the effect of the timing of the switch for 4years as a result of patient mortality.

Theofilou (2012) noted that the advantages associated with PD include preserving RRF (Residual Renal Function) and long, gradual, progressive ultrafiltration. The current study used GFR measures provided at the National Dialysis Center database for all the patients because GFR are routinely monitored to determine the renal function of patients. Data for survival times was also collected from the National Dialysis Center database. RRF is independently associated with endothelial dysfunction in ESRD patients on PD, suggesting that RRF may contribute to endothelial protection in these patients (Han et al., 2012). The GFR at the medical database are already standards as per the guidelines provided by the National Kidney Foundation. Medical conditions such as diabetes and cardiovascular diseases are significant risk factors that contribute to the deaths of ESRD patients (Pajek et al., 2014; Sud, Tangri, Pintilie, Levey, & Naimark, 2014), whereas demographic factors such as age and gender and presence of other health conditions play a role in the success of dialysis (Theofilou, 2012; Weinhandl et al., 2010). I included patients who began on PD first and then switched to HD in different time periods to examine if the timing of the switch had any impact in renal function and survival times of ESRD patients (Pajek et al., 2014).

There should be increased focus to identify patients at higher risk for peritonitis besides evaluating the care processes and implementation of preventive strategies for patients switching from PD to HD (Pulliam et al., 2014). Pajek et al. (2014) found that peritonitis is a cause of technique failure followed by ultrafiltration failure and that when the successful switch to HD, which was surviving at least 60 days after technique failure, and timing were evaluated, no adverse effect on survival in adjusted analysis was revealed.

The approach of starting PD and then switching to HD was also proposed by Suzuki et al. (2013) who attributed the advantages to improved preservation of RRF, longer survival times, and a lower occurrence of hospitalizations. Suzuki et al. (2013) noted that the outcomes of a dialysis approach should be evaluated against the specified standards provided by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI). The KDOQI outlines what should be carried out by medical practitioners, caregivers, and patients themselves to ensure that those with ESRD lead the best possible quality of life as they undergo treatment (Inker et al., 2014). The NKF KDOQI provides definition and stages of ESRD, evaluation, and treatment, individuals at increased risk of ESRD. In addition it also offers evaluation of laboratory measurements for ESRD and estimation of GFR.

Problem Statement

ESRD is an economic, social, as well as medical burden. With the advent of PD and HD therapies, ESRD is becoming manageable (Finnegan-John & Thomas, 2012). Whereas both PD and HD have shown great promise (Mehrotra, Chiu, Kalantar-Zadeh, Bargman, & Vonesh, 2011; Yeates et al., 2012), both techniques are prone to loss of RRF over time, which is also impacted by co-morbidities particularly for patients on PD (Hoshi et al., 2006; Weinhandl et al., 2010). Recent studies by Stanley (2010), Shen et al. (2012), and Suzuki et al. (2012) have shown that switching from PD to HD can improve the renal functions of patients, but whether this translates to longer survival times has not yet been demonstrated. There is little data in the United States addressing the outcomes and factors associated with switching modalities from PD to HD (Jaar et al., 2009). A PD First approach not only has benefits for patients but also physicians, and healthcare systems (Ghaffari et al., 2013). However, the researchers did not conduct an empirical study; a gap which will be filled by this study by using data available in a national database. Pajek et al.'s (2014) findings that switching from PD to HD can improve the survival times of patients was inconclusive, partly because of the small sample size used. The study by Jaar et al. (2009) only used a sample size of 262 patients and Pulliam et al. (2014) used a sample size of 1,167 patients. In this study, the sample size limitations of previous studies were addressed by using a larger sample size to determine the optimal time for switching from PD to HD and whether or not the timing influences the survival times of patients.

This study utilized a sample of patient records from a national registry database of over 128,000 dialysis patients to examine the optimal dialysis time for switching from PD to HD on renal function and survival times for ESRD patients and the impact of patient demographic and comorbidity factors as possible modifiers.

Purpose of the Study

The purpose of this quantitative retrospective study was to examine whether the timing of the switch from PD to HD is more effective on maintaining renal function and survival times for ESRD patients than those on PD or HD alone. Although several studies have been conducted to examine the efficacy of PD and HD alone and switching from PD to HD, they have utilized small sample sizes which limit the generalizability of the findings (Creswell, 2003). Examples include studies by Suzuki et al. (2012) and Moriishi, Kawanishi, and Tsuchiya (2010) using data from the Australia and New Zealand dialysis and transplants registry involving 2,715 patients with ESRD treated with PD, HD, and switch to HD who used considerably smaller samples who were home based. The current study utilized a sample of patient records from a national registry database of over 128,000 dialysis patients undergoing dialysis at National Dialysis Center, a dialysis specialized hospital dealing with hospital based patients, to examine if switching from PD to HD improves renal function and survival times. The researcher also explored the effect of independent and multivariate demographic (age and gender) and comorbidities (diabetes and cardiovascular (CVD)) determinants on the dependent variables.

Research Questions

This study focused on examining whether the timing of the switch from PD to HD impacts renal function and survival times including if demographic factors such as age and gender, and comorbidities such as diabetes and cardiovascular disease, also impact both renal function and survival times for ESRD patients. The renal function was assessed using the GFR and the data for survival times was collected from the National Dialysis Center database. The Chi-square test of independence was utilized to show the link between cardiovascular disease, diabetes, and demographic factors (age and gender) and optimal dialysis time for switching from PD to HD. The study was guided by the following research questions:

RQ1: Is the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic and comorbidity patient factors?

RQ2: Do comorbidities modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic patient factors?

RQ3: Do demographic patient factors modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for comorbidity patient factors?

Research Hypotheses

Hypotheses

$H_0$1: The timing of the switch from PD to HD does not impact renal function and survival times when controlling for demographic and patient factors.

H_a1: The timing of the switch from PD to HD impacts renal function and survival times.

$H_0$2: Comorbidities do not impact the dialysis time of switching from PD to HD when controlling for demographic patient factors.

H_a2: Comorbidities impact the dialysis time of switching from PD to HD when controlling for demographic patient factors

$H_0$3: Demographic factors do not impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors.

H_a3: Demographic factors impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors?

Theoretical Framework

This study utilized the bio-psychosocial model. The model helps to explain the interplay between social, physical, and environmental factors (Janowski, 2009). In this study, the use of the bio-psychosocial model enabled me to study the interplay between social factors such as sex, age, and comorbidities of ESRD patients and the influence of these factors on the various modalities used in treatment. The model allowed me to study the interplay between the treatment modalities of HD, PD, the switching from PD to HD, and any changes in renal function and survival times of ESRD patients.

Social factors affecting the interplay between the treatment modalities of HD, PD, or the transition from PD to HD and renal function of ESRD patients in the methodology were examined through quantitative methods of research. These factors included sex, age, and comorbidities of ESRD patients. Determining the optimal time to switch from PD to HD helped to guide best practices for ESRD dialysis protocols, guide on the effectiveness of the dialysis technique, and improve the patient outcomes.

Nature of the Study

The study used a quantitative retrospective research design and used a sample of available cases in the database to allow for data collection process. A quantitative research method is the collection and manipulation of numerical data with an aim of meaningfully describing the phenomenon that the data represent (Creswell, 2009). I used case control in order to be consistent with the research questions and how the study was conceptualized, as it determined whether the timing of the switching from PD to HD significantly improved renal function and survival times for ESRD patients compared to either PD or HD alone.

The study sought to evaluate if the timing of switching from PD to HD significantly improves renal function and survival times in ESRD patients. By using case control, I was able to compare changes in renal function from one group of patients (PD/HD with and without diabetes and cardiovascular diseases) with another group of patients who switched from PD to HD. Renal function was measured by use of the glomerular filtration rate (GFR). An estimated GFR (eGFR) calculated from serum creatinine (Scr) using the IDMS-traceable Modification of Diet in Renal Disease

(MDRD) formula GFR (mL/min/1.73 m2) = 175 x (Scr)-1.154 x (Age)-0.203 x (0.742 if female) x (1.212 if African American) (conventional units) (National Kidney Foundation, 2014). It is worth noting that this IDMS-traceable MDRD study equation calculator is for use with Scr reported in mg/dL. The equation does not require weight because the results are reported normalized to 1.73 m2 body surface area, which is an accepted average adult surface area. The study used the calculated GFR measure stored in the National Dialysis Center database for all the patients which is a standardized measure per the guidelines provided by the National Kidney foundation (National Kidney Foundation, 2014). The RRF is calculated using 24-h urine collections by determining the mean of creatinine and urea clearance. The clearance rate is then normalized to a body surface area of 1.73 m2 (Nongnuch, Assanatham, Panorchan, & Davenport, 2015).

To analyze Research Question 1, the patients were grouped into clusters of the same timing for switchers switching from PD to HD, same gender, those with diabetes, same age, and cardiovascular diseases. I used a sample of the available data in the database of National Dialysis Center where the data was categorized into patients on PD, HD, and PD to HD and assessed whether the factors stated above had significant relationships or differences among themselves. The inclusion criteria of the sample was ESRD patients who are on PD, HD, and PD to HD, 20 years old and above, with comorbidities of diabetes and/or cardiovascular disease (CVD). The samples not matching these criteria were excluded from the study. The optimal dialysis time was determined by assessing the average number of months taken by ESRD patients to switch from PD to HD after having undergone dialysis for at least 6 months under PD dialysis modality. To explore the effect of comorbidities on patient's survival and renal function after undergoing switch from PD to HD, Cox-proportional hazards regressions were used. In the model, a positive regression coefficient for an explanatory variable implies that the hazard is higher, and thus the diagnosis worse (Zhao et al., 2014). Alternatively, a negative regression coefficient shows that there is a better diagnosis for patients with higher tenets of that variable.

To assess the Research Questions 2 and 3, patients were grouped into clusters based on the timing of the switch from PD to HD. The Cox model (Schoenfeld residuals) was used in order to isolate the effect of timing of the switch from PD to HD on renal functioning (Pajek et al., 2014). This was achieved by having different strata with different baseline hazard functions that denote how the risk of event per time unit varies over time at baseline levels of covariate and the effect variables denoting how the hazard changes in response to explanatory covariates. Also, there was a group of patients with diabetes and without diabetes, and another group with cardiovascular diseases and without cardiovascular diseases for PD, HD alone, and those who started on PD then switched to HD after 6 months. The exact number of patients was not known until when the researcher started using the database but each group was assigned at least 1,200 patients to ensure that the population sample size was appropriate and representative. I ensured the patients to be sampled were selected and spread across age groups below 20, 20-30, 31-40, 41-50, 51-60, 61-70, and above 70.

To address Research Questions 2 and 3, I analyzed whether the dialysis time of switching from PD to HD changed due to comorbidities such as cardiovascular disease and diabetes and demographic factors such as age and gender. Multiple linear regressions and the biologically consistent Cochran Maentel Haenzsel test which is relevant and accurate with regard to the topic was used to assess the association between different factors and the switch from PD to HD across the different groups of patients (Schmidt & Kohlman, 2008). The multiple linear regression analysis was used to determine the impact of the independent variables of comorbidities such as cardiovascular disease and diabetes, and demographic factors such as age and gender to the dialysis time of switching from PD to HD. The effects of the different independent variables to the dependent variable were analyzed in a single regression model in order to compare the effects of the different independent variables. A level of significance value of 0.05 was used in order to determine the statistical significance of relationships in the regression analysis (Ziliak & McCloskey, 2013). A statistically significant impact by the independent variables to dependent variables was determined if the *p*-value of the regression was less than or equal to the level of significance value. If the *p*-value of the parameter estimate was significant at the 0.05 significance level, the null hypothesis was rejected, which implied that there would be a statistically significant impact by the independent variable to the dependent variable Then, the beta coefficient of the regression was investigated to determine how strongly the independent variable impacts with the dependent variable. A positive regression coefficient means a positive relationship indicating that the dependent variable increases as the independent variable increases (Chvostekova, 2013). A negative regression coefficient means a negative relationship indicating that the dependent variable decreases as the independent variable increases (Chvostekova, 2013). The study based on the quantitave retrospective methodology focused on assessing the effectiveness of switching from PD to HD on patient's survival and improving the residual renal function. The residual renal function was measured by glomerular filtration rate and assessed among group of patients in PD/HD and patients switching from PD to HD. Three research questions were developed to help evaluate the effectiveness of switching dialysis modalities. The Kaplan Meir tests, cox proportional hazard regression models and the Cochran Mantel Haesnzel models were used to test the hypotheses.

Ethical Considerations

The information retrieved from the data source, the Frenious Medical Care Facility database, was treated with high level of secrecy and confidentiality and was not divulged to any party or used for any other purpose apart for this research. The research was conducted in manner that upholds ethics of participants by ensuring their integrity, confidentiality, privacy, and seeking of consent (Check, Wolf, Dame, & Beskow, 2014).

Definition of Terms

A Peritoneal Equilibrium Test (PET). This is a test that was developed by Twardowski et al (1987) and is the commonly adopted test for determining peritoneal transport in PD patients. Glucose 2.27%/2.5% dialysate and a 4-h dwell are adopted during the test (citation). The test involves sampling and measuring protein, dialysate, serum, and low-molecular-weight solutes such as glucose, creatinine, and sodium among others (Struijk, 2008).

Encapsulating Peritoneal Sclerosis (EPS). This is a serious complication in PD patients and is characterized with symptoms such as obstructive ileus and varying levels of systemic inflammatory reaction, peritoneal thickening and encapsulation, cocooning, and obstruction of the intestines (Kawanishi & Moriishi, 2007).

End Stage Renal Disease (ESRD). ESRD is a progressive permanent failure in renal function which affects' the body's capability to maintain fluid, metabolic and electrolyte balance resulting in retention of toxic wastes in the body (Santoro et al., 2013). The most common reasons for failure are high blood pressure (hypertension) and diabetes which affect blood vessels over time and damage the kidney filters (American Nephrology Nurses Association, 2011). ESRD can also be caused by birth defects which affect blockages of urine flow, nephron infection, and trauma due to accidents (American Nephrology Nurses Association, 2011).

Hemodialysis. This is one of the ESRD treating modes where toxins are removed and excess fluid through extracorporeal circulation of blood via artificial kidney or a dialyzer (Carolinas health care system, n.d). Toxins and other waste product pass through the membrane and are washed away but the filtering holes do not allow blood cells to pass due to their size (Carolinas health care system, n.d). The treatment is performed in 3 to 4 hour sessions thrice weekly predominantly as center hemodialysis in hospitals or freestanding dialysis units (Carolinas health care system, n.d). In this case, the dialyzers are reprocessed and patient may re-use them several times (Carolinas health care system, n.d). If the patient and an assistant undergo training, the treatment may be performed at home (Carolinas health care system, n.d).

Peritoneal dialysis (PD). Peritoneal dialysis is a treatment for ESRD that uses the peritoneal membrane as an alternative to the dialyzer or artificial kidney (Carolinas health care system, n.d). The process requires the insertion of a catheter into the abdominal wall and recurring and installation and removal of sterile dialysate (Carolinas health care system, n.d). Toxins move from the plasma to the dialysate because of concentration gradients (Carolinas health care system, n.d). Toxins, having a slightly different concentration than dialysate, are removed as the dialysate is drained (Carolinas health care system, n.d). Fluid removal is through osmotic ultrafiltration by means of hypertonic dialysate solutions (Carolinas health care system, n.d). The two commonly variations of PD available are continuous ambulatory peritoneal dialysis (CAPD) and continuous cycling peritoneal dialysis (CCPD) (Carolinas health care system, n.d).

Renal function. This is how efficient kidneys filter blood (National Kidney Foundation, 2014). This efficiency can be indicated by use GFR (National Kidney Foundation, 2014). Residual renal function is the urinary clearance of urea and creatinine (National Kidney Foundation, 2014). Marron, Remon, Perez-Fontan, Quiros, and Ortis (2008) defined RRF as the residual GFR among individuals suffering from ESRD. GFR is the generally accepted index for determining kidney function (Thomas & Thomas, 2009).

Assumptions of the Study

During this study, I assumed that the data collected was accurate in both storage and recording by medical practitioners. Further, it was assumed that the equipment used and the efficiency of the nurses or physicians did not affect the data on efficacy of the two treatment modalities of PD and switching from PD to HD. Any errors from the medical team could cause death of a patient and thus, affect the results of the study. Psychological effects play a part in one's healing and I assumed that this did not affect the success of the dialysis. Health lifestyles, like diet, also influenced the success rate of remedy but this was assumed to play no significant role in this study. I also assumed that innate traits of patients did not have an effect in dialysis outcome. Arguably, health literacy has an effect in using prescribed treatment and adhering to medical instructions. I assumed health literacy did not play a role in dialysis outcome.

Scope and Delimitation of the Study

The research problem was to establish the effectiveness of PD alone, switching from PD to HD (after six to 12 months) as well as establish whether social factors (age and gender) and medical conditions (diabetes and cardiovascular disease) play a role in improved renal function. The efficacy of switching from PD to HD can only be established by comparing with the GFR scores of PD and after switching to HD. This objective was achieved by use of the discussed research design and consequent data collection and analysis.

In line with the study objectives, the efficiency of HD, PD, and switching from PD to HD affects a patient's life, which could result in mortality (Suzuki et al., 2012). Further, the success of the methods is affected by social factors (such as age and gender) and the presence of diseases (diabetes and cardiovascular disease). This shows that there is a causal effect relationship between method used and mortality, social factors, and other diseases. The scope for this study was to establish causal effect relationships. The analysis of efficacy of separate methods facilitated the comparison with the effect of switching from PD to HD to answer the research questions. The capture of social economic data helped the researcher to determine their role in the technique failure.

The population target of the study was ESRD patients whose data has been captured by National Dialysis Center database. The data included ESRD patients with diabetes and cardiovascular disease. I believe that the characteristics of this ESRD patients captured represented the big picture of other ESRD patients and enabled the researcher to draw a generalized conclusion.

Limitations of the Study

The use of secondary method of data collection poses challenges and eventually affects validity of the research outcomes. In many cases, it becomes difficult to trace data from databases (Vartanian, 2010). I used key search terms to locate data from the National Dialysis Center database. The main limitation of secondary data is that the data may be general and vague according to what the researcher needs (Vartanian, 2010). The researcher is forced to make decisions based on assumptions and unsupported evidence which may lead to incorrect conclusions (Vartanian, 2010). The general sources of information in a research may dilute the whole research process unnecessarily as the decisions made from that specific research might lead to affecting wrong information.

To add on the limitations of secondary data, Whiteside, Mills, and Mccalman (2012) argued that available data may be too little to generate all the information required to come up with a concrete stand on the decision to make. To correct these limitations of secondary data, I employed key search terms to locate data from the National Dialysis

Center database. These facilities have large amounts of information which is well researched on and accurate besides being most current.

Significance of the Study

The objective of this study was to examine whether the timing of the switch from PD to HD is more effective on maintaining renal function than PD or HD alone, having accounted for demographic factors such as age, gender and co-morbidities such as diabetes, cardiovascular disease (CVD). Diabetes and CVD are the most diseases present among dialysis patients that contribute to the highest cases of mortalities (Pajek et al., 2014; Palmore et al., 2014; Sud et al., 2014).

The social change implication of this study is that the findings could help patients and medical practitioners make an evidence-based decision on the optimal course of dialysis with the greatest likelihood of success. In addition, the timing of the switch from PD to HD has not been well studied and could help raise awareness to the importance of considering the temporal relationship when patients should switch dialysis techniques for optimal survival and quality of life.

The finding of this study could aid in the decision-making process of patients and medical practitioners when evaluating for the best treatment. Moreover, it could also fill in a gap in the literature about the effectiveness of the switch from PD to HD.

Summary

ESRD patients receive treatment of PD, HD or the switching from PD to HD (Suzuki et al., 2012). PD and HD have different success rates across a cohort of patients with notably age, gender, and other conditions such as diabetes and CVD (Weinhandl et al., 2010; Shen et al., 2012; Suzuki et al., 2012). Most researchers believe that patients on PD are more likely to have cognitive dysfunction than patients on HD with same characteristics (Hoshi et al., 2006). On the same issue, elderly patients receiving HD have greater probability of intradialysis hypotension (Stefánsson et al. 2014). Research findings indicated that beginning treatment with PD then followed by combining HD and PD is a varied way of treating patients with ESRD (Suzuki et al., 2013; Pajek et al., 2014). However, these studies are limited in given the small sample size used. As such, I used a national database of 128,000 dialysis patients from National Dialysis Center to evaluate the effectiveness of each dialysis mode independently. I also examined effectiveness of switching from PD to HD as well as identified determinants associated with the level of dialysis technique failure

To cater for the knowledge gaps among patients, this study provided more insight to the effectiveness of switching from PD to HD and in managing patients with ESRD. The study also sought whether social factors and medical conditions influence technique failure and any changes in renal function of patients with ESRD. Through my research, I discovered the importance of first gaining knowledge when making decisions regarding optimal renal replacement therapy.

The study used a quantitative research design. The main aim of the study was to discover factors affecting an outcome, understanding the higher contributors in the outcome, discovering any interventions, and making predictions. Secondary data was used in this study. It has an advantage of cost effectiveness but posed limitations such as it was general data without detail, most of the data sources were outdated, and the data accuracy could not be confirmed. The data limitations were minimized by employing key search terms to locate data from the National Dialysis Center database. These source databases are very popular due to their accuracy, up-to-date and large cohort size. The study, with regard to the increase and projected future increase of patients with ESRD worldwide, will have significance as its findings added to the literature available on the PD, HD, and switching from PD to HD modes of dialysis and further effects of social effects such as age and sex in its success.

This chapter has developed the problem statement, scope, and purpose of the study which will be built on in chapter two wherein the literature review, theoretical foundation, and literature of the rationale of the conceptual model covered was provided. Moreover, the literature review related to key variables and concepts developed in this chapter are discussed in more detail in Chapter two.

Chapter 2: Literature Review

Introduction

There are more than 2 million ESRD patients in the world with 660,000 being in USA (National Kidney Foundation, 2016). With the advent of PD and HD therapies, ESRD is becoming manageable. Regardless of the dialysis modality used, preservation of RRF is associated with an increased survival in dialysis patients whereas technique failure leads to a rapid loss of RRF (Hoshi et al., 2006; Shen et al., 2012). Recent evidence by Stanley (2010), Shen et al. (2012), and Suzuki et al. (2012) suggested that switching from PD to HD may preserve RRF longer than either modality alone. Several studies have tried to identify predictors of technique failure and switching technique success but the results have been limited by the size and scope of available dialysis patients (Shen et al., 2012; Suzuki et al., 2012). In this study, I used a national database of over 128,000 dialysis patients to evaluate whether the timing of the switch from PD to HD is more effective on maintaining renal function than PD or HD alone. Additional variables of interest such as demographic factors (age, gender) and comorbidities (diabetes, cardiovascular disease) significantly improve renal function and survival times for ESRD patients compared to either PD or HD alone. Comorbidities in ESRD patients have been discussed to comprise of diabetes, hypertension, cardiovascular diseases, and anemia, among others (Zha & Qian, 2017). However, the comorbidities of interest in my study were diabetes and hypertension.

According to the National Kidney Foundation (2014), RRF is an indication how efficiently kidneys filter blood. This efficiency can be indicated by a number of ways, such as use of GFR. The GFR is measured in mL/min and is usually standardized to a body surface area of 1.73 m2 (National Kidney Foundation 2014). For an adult aged 20-29 the normal GFR is 116 and it decreases as age increases to normal GFR of 75 for those aged 75 and above (National Kidney Foundation, 2014). A number of factors such as age, gender, height weight, and race affect GFR given the differences in mass muscle (National Kidney Foundation, 2014). As such, there are different measures that are based on the named factors.

PD and HD are the most common modes of intervention in treatment of ESRD patients. Both modes of treatment have different advantages and disadvantages and impact on a patient's physical, psychological and social health differently (Sam, Kovacic, Radic, Ljutic, & Jelicic, 2012). Well-nourished and medically stable patients on PD are more likely to have cognitive dysfunction than patients on HD with same characteristics (Sam et al., 2012). Elderly patients receiving HD have a higher probability of intradialysis hypotension (Sam et al., 2012). The choice of dialysis mode is influenced by a number of factors including financial capability of patient and the opinion of physician (Abraham et al., 2012). Recent studies have indicated that socio-demographic factors and presence of other diseases play a role in the success of dialysis. Age, for instance, is a major contributor to the success of dialysis (de Melo et al., 2016; Franco & Fernandes, 2013). Theofilou (2012) noted that there are different score systems for kidney disease quality of life (KDQOL) based on age, occupation, gender, marital status, and educational level. McDonald, Marshall, Johnson, and Polkinghorne (2009) revealed that HD increases survival rates in older patients while PD increases survival rates in younger patients. A similar study was conducted by Weinhandl et al. (2010), who demonstrated that PD plays a critical role in enhancing the survival rate of patients less than 65 years. New patients suffering from ESRD who select PD as their initial intervention strategy, are likely to be younger when compared with those starting with HD (Weinhandl et al., 2010). There are similar findings by Shen et al. (2012) who noted that socio-demographic such as age, gender, and presence of other diseases such as diabetes and CVD play a role in the success of dialysis treatment of patients.

Studies have been conducted to examine the influence of chronic diseases on technique failure. Shahab, Khana, and Nolph (2006) found out that ESRD patients with coronary artery disease have a higher mortality rate irrespective of their diabetic status in PD and HD. In another study, there was no difference in survival rate of ESRD patients with CVD in both PD and HD (Shahab et al., 2006). Considering the advantages and differences in efficacies, PD and HD can be used in an integrated mode, whereas PD is usually followed by a timely change to HD once complications arise (Shahab et al. 2006). The researchers concluded that management of conventional and uremia-related cardiovascular risk factors are essential in patients with ESRD regardless of the dialysis mode used (Shahab et al. 2006).

Past studies have only explored technique failure without focusing on switching. Stanley (2010) conducted a study to investigate the contribution of geographic factors, pre-ESRD, social, medical, and demographic factors to modality assignment of new patients suffering from ESRD. Information for Stanley's study was gathered from morbidity and mortality Wave 2 studies. The findings of this study demonstrated that the selection of PD as opposed to HD was linked with lower serum albumin, fewer comorbidity conditions, white race, as well as young age (Stanley, 2010). Additionally, the study found out that patients living with someone, married, employed, and more highly educated were more likely to use PD as opposed to HD (Stanley, 2010).

Balafa et al. (2011) conducted an albumin test to examine whether protein and peritoneal albumin losses play an integral role in technique failure. Individuals undergoing PD took part in their study. Their findings indicated that protein and peritoneal albumin losses does not influence technique failure (Balafa et al., 2011). Yu, Chen, and Li (2013) conducted a study to test whether or not hypoalbuminemia play an integral role in PD and HD technique failure. The findings of their study indicated that hypoalbuminemia increases complication in patients undergoing both PD and HD (Yu et al., 2013). Among ESRD patients, my study provides insight into the importance of switching from PD to HD dialysis on hospital based patients. I also intend to expand the knowledge on how social-demographic factors (age and gender) and medical conditions (diabetes and CVD) influence technique failure and renal function of ESRD patients.

One of the central objectives of my study was to examine whether the timing of the switch from PD to HD is more effective on maintaining renal function than PD or HD alone. The purpose of this chapter is to provide a review of related literature that would serve as the basis for a framework for subsequent data collection and data analysis. In order to develop a framework that incorporates the relevant studies necessary to understand the existing literature about PD and HD of ESRD patients, the review is divided into different sections, with subsections. The chapter begins by describing the literature search strategy used. The theoretical framework guiding the study and the conceptual framework is then detailed This is followed by review of extant studies with regard to ESRD including the history of ESRD, causes of ESRD such as diabetes and hypertension, and treatment of ESRD including transplant, HD, PD and shift from PD to HD. The chapter also includes information on technique failure, the choice between different modalities, a comparison of HD and PD in adults, and the outcome of dialysis. The chapter concludes with a summary.

Literature Search Strategy

The chapter presents an in-depth review of literature pertinent to the research problem. The literature review was conducted by reviewing scholarly and peer-reviewed journal articles, dissertations, and seminal literature. They were obtained from PubMed, Ebscohost, Proquest general Google search, and Google Scholar. I used key terms, namely, *end of stage renal disease (ESRD), peritoneal dialysis, hemodialysis, "renal function , causes of ESRD, technique failure, clinical outcomes of patients on dialysis, switching from hemodialysis to peritoneal dialysis, preservation of renal function, factors affecting dialysis outcome, mortality rate of ESRD patients on dialysis* and *clinical outcomes of patients on dialysis*. The literature review yielded 182 related articles, but upon further scrutiny only 112 were relevant to the study hence used and cited. The study has 92 articles including in the literature review, published within the last 5 years.

Theoretical and Conceptual Framework

Biopsychosocial Model

The biopsychosocial model details the importance of understanding human health and illness in their fullest contexts (Frankel, Quill, & McDaniel, 2003). According to Frankel et al. (2003), the biopsychosocial model intends to systematically consider biological, psychological, and social factors and their complex interactions in understanding the illness, health, and health care delivery. In the biopsychosocial approach, humanistic qualities are highly valued involving the application of the scientific method to diverse biological, psychological, and social phenomena as related to human health (Frankel et al., 2003). To apply the biopsychosocial approach effectively in a clinical practice such as treatment, one has to recognize that relationships are central to providing health care, use self-awareness as a diagnostic and therapeutic tool, elicit the patients' history in the context of life circumstances, and provide multidimensional treatment (Janowski, 2009). Lastly, those applying this approach must also decide on the aspects of biological, psychological, and social domains which are most important in understanding and promoting the patients' health (Janowski, 2009).

Several studies were found that used the biopsychosocial model. Maribo, Melchiorsen, Rubak, Jespersen, and Nielsen (2014) described the core themes in modern rehabilitation and how the psychosocial model can be used to improve the practice. The psychosocial model can be used to highlight barriers connected to rehabilitation such as practical barriers, economic barriers, social barriers, and lack of resources (Maribo et al., 2014). Maes and Twisk (2010) reviewed the model proposed by Havey and Wessely

(2009) about the biopsychosocial explanatory model for myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS). However, the conclusion of the authors was that a bio psychosocial model based upon IO and NS abnormalities is likely more appropriate to treat the complex disorder (Maes & Twisk, 2010). Some authors also stated that the biophysical model also has disadvantages (Ghaemi, 2009; Benning, 2015). Harding, Campbell, Parsons, Rahman, and Underwood (2010) also stated that pain clinics using a biopsychosocial model of pain management may not be achieving their maximum potential.

The section provides an overview of literature in regards to the purpose of the study which focuses on determinants of switching from PD to HD and determining whether timing of switch improves renal function among ESRD patients. The literature search strategy yielded 115 studies that were cited in the literature section including those within the last 5 years. Literature showed that factors determining switch from PD to HD were age, gender, marital status, diabetes and CVD. Age was considered a significant factor in determining the switch where younger patients perform better in PD while elderly in HD. Diabetes and CVD greatly contributed to switch from PD to HD. My study was guided by the use of bio-psychosocial model that aided in operational definition of study variables.

Conceptual Framework

The conceptual framework illustrates the hypothesized relationships among patient’s characteristics, the health status, the patients with ESRD experiences, and the social economic factors associated with patient’s satisfaction and health status. These constructs were used to relate how ESRD patient's characteristics and modalities for treatment (PD, HD, or transition from PD to HD) influence the outcomes. I investigated the impact of determinants such as demographic, socio-economic, and health status factors on treatment technique failure. According to Harding et al. (2010), the socioeconomic and other conditions on the body of the patients with the ESRD disease are identified as cofounders of the association between health status and patient recovery. Figure 1 illustrates the bio-psychosocial model.

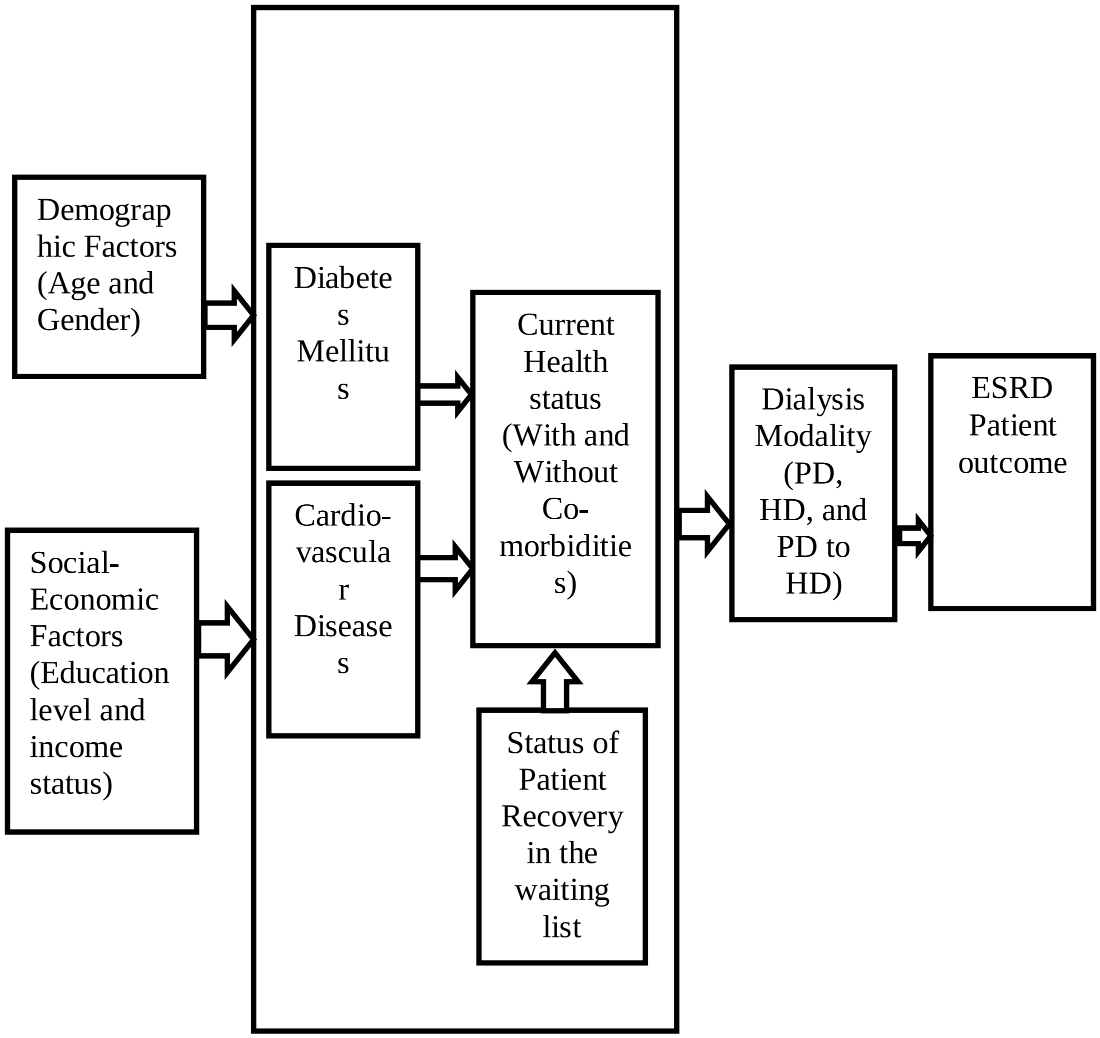

Figure 1. Conceptual framework.

The biopsychosocial model holds that a patient's clinical outcome is influenced by social context and biological factors (Frankel et al., 2003). The biological facets include infections, physical trauma, nutrition, and hormones, which are tied to gender and genetics (Frankel et al., 2003). According to the biopsychosocial model, it is the interaction between an individual's genetic makeup, their biology, and socio-cultural environment which contributes to illness or health. (Frank et al., 2003) The biopsychosocial model demonstrates that each one of these factors is not adequate to bring about health, but the interaction between them defines the progression of one's health development (Lane, 2014). In this study, the outcome of ESRD patients on dialysis is influenced by patients' biological and demographic factors, as well as the presence of other diseases.

The social-economic factors in the conceptual framework, such as educational background, are significant in the ESRD patient health outcome, which is an important predictor of treatment success (Hampton, 2011). ERSD patients with more education have a greater likelihood to possess better health literacy, helping them to gain social skills needed to gain access, understand and use health information as prescribed (Hampton, 2011). Connected to the conceptual framework, Secker (n.d) argued that low health literacy correlates directly to the poor health status. Limited knowledge on medical conditions leads to decreased comprehension of medical information, poor compliance rates to the set guidelines, poor self-reported health, and increased health related costs (Secker n.d). Health literacy is important in the dialysis population due to educational disparities between PD and HD patients and the transfer from HD to PD diagnosis. Individuals with a high education level may be placed on the PD, which requires more knowledge in order to understand the complexities of the procedures involved (Sinnakirouchenan & Holley, 2011). Patients undergoing PD may be more assertive and autonomous in the decision-making process compared to those receiving HD (Sinnakirouchenan & Holley, 2011), emphasizing the point that health literacy is an important variable in determining technique failure .

CVD is one of the health status factors determining the outcomes of dialysis in ESRD patients (Buvanendran, Leong, & Deer, 2013). The significance of CVD in ESRD patients is increased by the accelerated atherogenesis, endothelial dysfunction and inflammation, and lipid derangements (Buvanendran et al., 2013). According to Zyga and Kolovos (2013), patients with ESRD suffering from cardiovascular conditions such as arrhythmias, CVD, coronary artery disease, and peripheral vascular disease, have a worse outcome after dialysis when compared to patients with ESRD without CVD. Cardiovascular conditions in treating ESRD patients affect the outcomes after using PD, HD, or PD to HD dialysis. HD has been identified to result to better outcomes in cardiovascular patients compared to PD dialysis (Zyga & Kolovos, 2013).

Theoretically, as PD results in good outcomes, it should be presented to patients with cardiovascular conditions to improve blood pressure control and avoidance of uremic peaks and less hemodynamic stress (Zyga & Kolovos, 2013). This statement has invited some criticism as some researchers have suggested that PD promotes a proatherogenic environment (Van Biesen, Verbeke, & Vanholder, 2007; Bhowmik & Tiwari, 2012; Li, Ng, & Mcintyre, 2017). To add to this, ultrafiltration failure and the development of high transport membrane permeability in the process of treatment contributes to hypertension, cardiomyopathy, and fluid overload among the PD treated patients (Zyga & Kolovos, 2013).

Diabetes has been highlighted in the conceptual framework as one of the determinants of the outcomes of patients with ESRD after dialysis. The outcomes of PD in patients with diabetes changes according to the treatment modality as well as other factors such as the age and gender of the patient (Wang et al., 2013). According to the majority of studies and researches done, diabetic patients using PD have more encouraging outcomes compared to diabetic patients using HD (Wang et al., 2013). Treatment of ESRD under PD and HD have thus, been attributed to more positive outcomes than HD. Patients under PD have better outcomes than HD. CVDs are among the causative factors for mortality in patients with ESRD. The traditional risk factors of ESRD include diabetes, hypertension, and dyslipidemia (Liu et al., 2014). The most causative factors for chronic kidney disease and ERSD are hypertension and diabetes (Abu-Odah, Abed, El-Khateeb, Salah, & El-Nems, 2016; Ghaderian, Hayati, Shayanpour, & Mousavi, 2015; Liu et al., 2014). CVDs account for 50% of the deaths for patients undergoing dialysis due to chronic kidney disease (Kumar, Bogle, & Banerjee, 2014). Moreover, the prevalence of mortality of ESRD patients in the United States was 20% higher for patients with CVD as compared to patients without CVD (Liu et al., 2014). Hypertension was observed to be the most common cause of death with approximate 2.33 million of total cardiovascular deaths and 1.27 million premature cardiovascular deaths were associated with hypertension among patients in China (Liu et al., 2014). The CVD are more prevalent in men than in women (Liu et al., 2014). Hypertension, in this study have been considered as major risk factor for ESRD and its prevalence continues to cause mortalities among the affected patients. CVDs cases are thus, high in US.

In addition, diabetes D accounts for 45% of the known cases of ESRDin the United States (Ghaderian et al., 2015). Similarly, for Germany and Austria, diabetes accounts for 34% and 30% for ESRD, respectively (Ghaderian et al., 2015). Diabetes is a leading cause of ESRD cases in Middle Eastern countries whereby approximately 35% cases of patients aged 40 years and older were observed in Iran, 26.6% in Saudi Arabia, 21.2% in Kuwait, 35% in Egypt, and 48.6% in Lebanon (Ghaderian et al., 2015; Abu-Odah et al., 2016). The survival rate of diabetic patients is lower than nondiabetic patients regardless of dialysis modality (Ghaderian et al., 2015). Diabetes and age have thus, been pointed out as the major factors leading to ESRD. Diabetes is prevalent in developed countries which reflect an increased percentage of ESRD patients.

The conceptual framework also indicates gender as a significant factor contributing to the outcomes of PD, HD, or PD to HD treatments to patients with ESRD. Female patients with ESRD exhibit the biggest difference in life expectancy compared to their counterparts without the disease. According to Yeates et al. (2012), dialysis therapy reduces greatly the survival advantage that women in the general population experience. In addition, Yeates et al. (2012) indicated that diabetic women experience poorer out comes in dialysis compared to diabetic men exposed to the same conditions and treatment modalities.

Age is a determinant in the outcome of dialysis among patients with ESRD. According to Yeates et al. (2012), PD results in better health outcomes in young patients with ESRD while HD results to better outcomes in the elderly and this is reflected in diabetic patients. The consideration for age differences is of significance as individuals receiving PD tend to be younger than their counterparts receiving HD. Wang et al. (2013) argued that when comparing PD, HD and PD to HD, it is important for adjustment of age where PD patients should be less than 65 years. Thereby, patients with ESRD choosing

PD as their initial treatment then moving to HD tend to be younger resulting to better outcomes and increased survival rates.

Age is considered a significant factor during the dialysis of ESRD patients. Additionally, age is a contributor and risk factor of diseases such as diabetes mellitus and hypertension (de Melo et al., 2016; Franco & Fernandes, 2013). The demand for renal replacement therapy is on the rise among the elderly people who are prone to cardiovascular diseases which are the lead causes of chronic kidney disease. An increased demand for elderly people to be offered dialysis and improvement of patient's survival among the aging group is required (Franco & Fernandes, 2013). It is estimated that one in four patients who starts renal replacement therapy in the USA is a patient aged 75 years or older. A similar scenario prevails in France whereby the mean age of patients engaging in dialysis is 70.2 years and in the United Kingdom is approximately 65 years. The glomerular filtrate rate decreases with increase in age where the percentage is lower for the elderly people (Franco & Fernandes, 2013).

The dialysis of elderly people using hemodialysis has unique features. The elderly population as compared to the younger population has more co-morbidities, hospitalizations, drug use, and usage health services (de Melo et al., 2016). Conducting research for the elderly people with chronic kidney disease is important as it improves their quality of life. The metabolic functions, as well as psychological functions of body organs, decrease as the age of a person increases. Moreover, the elderly people are less likely to engage in physical exercises which also increase chances of chronic diseases (de Melo et al., 2016). The elderly as well have lower life expectancies which lead to the decision to engage in dialysis for the treatment of renal replacement therapy (Segall et al., 2015).

Residual Renal Function

The Residual Renal Function for patients with End Stage Renal Disease is the capability of native kidneys to emanate water and uremic toxins (Roszkowska-Blaim & Skrzypczyk, 2013). The renal residual function is associated with parameters such as Glomerular Filtration Rate. The Residual Renal Function does not have a common method of measurement but it is based on daily dieresis which is a scale for body mass or body surface area in children. The patients with ESRD receive the renal replacement therapy. The residual renal function is important to children because it does not only help preserve adequacy of renal replacement therapy but also lower the risk of adverse myocardial changes, fasten the growth rate, enhance treatment of anemia and calcium-phosphorus balance abnormalities as well as improve nutrition and blood pressure control (Roszkowska-Blaim & Skrzypczyk, 2013).

Residual renal function in PD and HD. Studies indicate that engagement in HD mode results in the increased rate of loss of residual renal function compared to patients engaging in peritoneal dialysis. In addition, a study indicated that patients observed a greater loss of residual renal function on the onset of initiating treatment with HD than those who had not (Curran & Bargman, 2011). The loss of residual renal function in PD is associated with malnutrition whereas the maintenance results in better nutrition statuses. The preservation of residual renal function for ESRD patients in PD dialysis in overall enhances patient’s survival rates (Curran & Bargman, 2011). The residual renal function is also an important aspect in patients under hemodialysis mode. The residual renal function contributes to the total solute clearance which specifically aids in removing middle as well as small solute proteins (Xydakis et al., 2013). Residual Renal Function aids by maintaining balance in residual homeostasis mechanism for calcium and phosphorus balance, optimal control of fluid balance, reduction in cardiovascular diseases as well as the reduction in left ventricular hypertrophy. The residual renal function improves the quality of life by increasing the hemoglobin status in blood and better phosphate control. The PD dialysis preserves residual renal function better than HD dialysis does (Xydakis et al., 2013). The measurement of residual renal function is the glomerular filtrate rate which exhibits a causal relationship with mortality of end-stage renal disease of patients. A study conducted by Wal et al. (2011) indicated there was no difference observed for end-stage renal disease patients starting dialysis on either PD or HD. However, the study concluded that the decline of RRF is slower in patients who receive PD as compared to HD. Hence, PD is preferred in preserving residual renal function than HD in end stage renal disease patients.

Benefits of maintaining residual renal function. There are many benefits associated with maintaining residual renal functions in patients with ESRDs. The residual renal function helps patients maintain dialysis by improving survival and quality of life. The improvement in quality of life for ESRD patients undergoing dialysis is enhanced due to the constant clearance of solute as well as managing volume control (Mathew, Fishbane, Obi, & Kalantar-Zadeh, 2016). There are few studies examining the effect of residual renal function on the outcomes of patients undergoing Hemodialysis. One of the main rationales for the paucity of studies examining the effect of residual renal function on the outcomes in patients undergoing hemodialysis is that there are challenges of accurate interdialytic urine collection from patients using hemodialysis. Moreover, research has shown that residual renal function declines rapidly in hemodialysis patients as compared to peritoneal dialysis (Mathew et al., 2016). The use of hemodialysis preserves residual renal function longer as compared to patients under peritoneal dialysis.

The residual renal function is important as it leads to control volume, balancing of minerals and electrolytes, leads to less inflammation as well as enhances effective clearance of protein-bound solutes and middle molecules (Mathew et al., 2016; Patel & Hu, 2015). The preservation of residual renal function lowers mortality rates for dialysis patients. A study conducted by Canada USA Peritoneal Dialysis (CANUSA) indicated that a 12% lower risk of death was observed for every incremental rise of estimated glomerular filtrate rate (eGFR) of 5 1/week/1.73 m2. Moreover, a 36% reduction in mortality was associated with the daily urine volume >250 ml alone (Patel & Hu, 2015). The rate of residual renal function decline is observed to decline faster among hemodialysis patients compared to patients on peritoneal dialysis. The decline in glomerular filtrate rates among the patients under peritoneal dialysis ranges widely from 1% to 8% per month while in hemodialysis patients, the rate ranges between 6% and 11% per month. In addition, the preservation of residual renal function is observed among the patients who start dialysis early. The patient’s survival under HD dialysis with residual renal function is higher as compared to those without residual renal function (Patel & Hu, 2015). Cadnapaphornchai and Teitelbaum (2014) indicated that preserving residual renal function has a positive effect on morbidity and mortality. The preservation of residual renal function is associated with improved control of complications related to chronic kidney disease as well as decreasing mortality rates.

Predictors for changes in residual renal function. The residual renal function among peritoneal dialysis patients increases to higher volume removal while the renal function decreases due to the onset of diseases such as hypertension. The presence of hypertension diseases leads to volume overload that contributes to increased residual renal function (Tian et al., 2016). Moreover, the fluid overload among PD patients is attributed to old age, increased percentage of diabetes, increased co-morbidities, blood pressure as well as malnutrition. The fluid variation is an important factor in determining the decline of residual renal function (Tian et al., 2016). Mathew et al. (2016) also indicated that demographic characteristics, co-morbid diseases, and the characteristics of dialysis patients are among the factors contributing to the decline in residual renal function. Cadnapaphornchai and Teitelbaum (2014) indicated that the decreased left ventricular hypertrophy and hypertension among the end stage renal disease patients contributes to a reduction in residual renal function. The adequate and satisfactory control of hypertension that is associated with creatinine and urine clearance leads to the decline of residual renal function. The decreased intake of protein is considered as a risk factor for morbidity and mortality among end-stage renal disease adults. Thus, the residual renal function also affects the nutrition status of the patients undergoing dialysis. Moreover, preserved residual renal function controls anemia in ESRD patients (Cadnapaphornchai & Teitelbaum, 2014).

Strategies for improving long-term survival in peritoneal dialysis patients. Prevalence of the end stage renal disease (ESRD) will continue to rise in most countries even with the advent of new treatment methods of kidney problems. The mortality rates of patients with the conditions have fallen over the years, but long-term survival of patients with the disease has been a challenge. Cardiovascular diseases account for most deaths in ESRD patients. Lowering of risk factors such as the co-morbidity does not account for reduced mortality in patients. Kendrick and Teitelbaum (2010) indicated that strategies such as preservation of residual renal function, reducing the rate of infections, and maintaining peritoneal integrity can help to maintain the long-term survival in peritoneal dialysis patients. The preservation of RRF and Peritoneal Membrane integrity have resulted in longer survival terms of ESRD patients since factors such as age and cardiovascular diseases in ESRD patients cannot be controlled. In addition, integration of Angiotensin-Converting Enzyme (ACE) inhibitors and Angiotensin Receptor Blockers (ARBs) with hypertensive patients will lead to the preservation of RRF in diabetic and chronic patients (Kendrick & Teitelbaum, 2010). Hence, reduced cases of infections that contributes to longer survival of ESRD patients.

Chaudhary (2011) indicated that survival rates of ESRD patients on peritoneal dialysis can be increased by educating patients and medical staffs, maintaining and managing peritonitis, the ultrafiltration failure and managing catheter-related complications as well as improving the adequacy of dialysis. The constant intake of glucose concentration which acts like an osmotic agent causes changes in the membrane over time and thus leads to membrane failure. The use of newer biocompatible solutions without dextrose have led to less membrane damage and hence, preservation of peritoneal membrane. In addition, use of biocompatible solutions lowers levels of glucose degradation products which preserve the RRF longer. The preservation of RRF has a positive impact on PD patients' survival rate (Chaudhary, 2011). The clearance of mediated molecules and protein bound substances by use of renal replacement therapy increases the survival rates of end stage renal disease patients. The renal replacement therapy is effective for most patients engaging in peritoneal dialysis mode. The regulation of blood pressure in patients with cardiovascular diseases by maintaining fluid pressure through control of Left Ventricular Hypertrophy regulates the renal function which assures for prolonged survival rate (Curran & Bargman, 2011).

Peritoneal dialysis is associated with the advantages of higher quality life, preserved residual renal functional as well as increased in cost saving. In addition, patients are expected to survive longer in PD than in HD. Patients are expected to survive longer under the treatment of peritoneal dialysis through the adoption of better family support, stronger receptivity to dialysis, and higher cognition of dialysis (Chiang et al., 2016). The patients faced with chronic kidney diseases are expected to gain improved survival rate once they receive early nephrology referral and multi-disciplinary pre-dialysis education. In addition, Nongnuch et al. (2015) emphasized that preservation of residual renal function for the patients with chronic kidney disease positively affects their survival rates. The urine collections in most centers enable the treatment of patients in the peritoneal dialysis which is common as compared to hemodialysis. Similarly, patients under the peritoneal dialysis are at risk of attracting a variety of hypertonic dialysate and episodes of peritonitis. Regulating the rate of loss of residual renal function by use of modality prescriptions, over ultrafiltration of fluids and use of bio-incompatible fluid dialysis will prolong the survival rates of peritoneal dialysis patients (Nongnuch et al., 2015).

End Stage Renal Disease

End stage renal disease (ESRD) is the gradual onset of sudden or permanent failure of the kidney (American Nephrology Nurses Association, 2011). The human kidney is responsible for cleaning body wastes and maintains balance of electrolytes and fluids by coordinating effects on the heart and blood vessels (Smith, 2013). Currently there are 1.9 million people worldwide who are undergoing ESRD treatment (Anand, Bitton, & Gaziano, 2013).

Kidney disease causes damage to the nephrons through stressors such as hypertension and diabetes. Passing urine less than often normal or more often than normal, vomiting, nausea, loss of appetite, feeling tired , increased difficulty in breathing, swelling in the face, feet and hands and itchy skin are some of the symptoms that the kidneys are not functioning properly (National Institute for Health and Clinical Excellence, 2009).

Kidney failure is categorized into two depending on how fast the failure occurs. Acute renal failure is sudden failure that can be caused by poison or drug that can make the kidney to fail, accident, abrupt loss of blood or very low blood pressure (Carolina Health Care System, n.d). If the kidney failure is gradual then it is called chronic renal failure, which can be caused by unattended high blood pressure or unsuccessfully controlled diabetes. Chronic kidney failure develops into ESRD. Renal function panel, biopsy, and 24- hour creatinine clearance are some of the clinical tests that can be done to ascertain functionality of the kidney (National Kidney Foundation, 2015). The main causes of kidney failure are diabetes and hypertension but infections that affect the nephrons, trauma, and birth defects are other causes though they are rare (Carolina Health Care System, n.d). The causes of ESRD vary with social factors such as race, ethnicity, and age (American Nephrology Nurses Association, 2011).

There are two modes of treating kidney failure namely; kidney transplant and dialysis. Dialysis is the cleaning of blood either inside or outside the body by use of machine while transplant is the receiving of live kidney from a donor (National Kidney Foundation, n.d). These methods will be discussed in detail in other parts of the literature review. The choice of treatment, mode depends on lifestyle, personal preference, and medical condition of patient.

Diabetes as a Cause of ESRD. Diabetes is the leading cause of ESRD as per data provided by the American Nephrology Nurses Association (2011). In the US, there were 25.8 million diabetic Americans where diabetes accounted for 44% of the kidney failures. Diabetes is the shortcoming of the body to utilize glucose (Redmon et al., 2014). Passing urine often, having dry itch skin, having blurry eyesight, feeling very tired and hungry often, losing weight unintentionally, and slow healing of wounds are some of the symptoms of diabetes (National Kidney Foundation, 2013). They are two types of diabetes namely; diabetes type 1 and diabetes type 2. In type 1 diabetes, the cells of the pancreas fail to secrete insulin as that have been destroyed due to the failure in the immune system of the body (Center for Disease Control, n.d). Diabetes type 1 is treated by getting insulin injections, nutrition, physically activeness and controlling cholesterol consumed and blood pressure. Diabetes type 2 is the failure of the body to properly utilize the insulin generated by the pancreas. Obesity and lack of physical activity increases the chances of diabetes.

There are almost equal rates of kidney failure in both types of diabetes (American Nephrology Nurses Association, 2011). However, some groups are at a higher risk of kidney failure if they also have diabetes. Those with high blood pressure, more than 65 years old, are Hispanic Americans, African-Americans, Asians, American Indians, or Pacific Islanders and have a family member who has kidney disease, have higher chances of having kidney failure (National Kidney Foundation, 2013).

Fox et al. (2012) conducted a meta-analysis of studies selected according to Chronic Kidney Disease Prognosis Consortium criteria. The authors used Cox proportional hazards models to approximate the hazard rations (HR) of mortality and end-stage renal disease associated with albuminuria and eGFR in individuals with and without diabetes. The authors analyzed data of 1, 024, 977 participants (128, 505 with diabetes). The authors concluded that kidney disease is an important predictor of clinical outcomes.

There are high or low glucose levels in the blood for diabetic patients due to the low insulin levels or lack of utilization of the insulin produced by the pancreas. With high glucose levels, the kidneys are forced to work harder in the filtration process to maintain the necessary glucose levels. The extra effort required may cause the vessels in the kidneys to give way consequently allowing loses of protein in the urine. This continuous strain of the kidney eventually results in loss of ability to function effective and lead to development of end stage renal disease (ESRD).

The damage caused to the nervous system by diabetes also causes or accelerates kidney failure. Nerves transmit messages to all other body parts and the brain including the kidney and its parts like the bladder letting one know when it is full. If the nerves are damaged one cannot know when the bladder is full and the pressure accumulated from full bladder can damage the kidney (National Kidney Foundation, 2013). If urine stays for long in the bladder there are chances the urinary tract will be infected due to the bacteria in the urine. With high sugar level, bacteria will grow rapidly and can cause infections to the bladder which will spread to the kidney (National Kidney Foundation, 2013).

Despite being the lead cause of kidney failure, the progression of kidney failure can be slowed in diabetic patients. As per the guidelines of the National Kidney Foundation (2012) this can be achieved by treating hyperglycemia which is the defining failure in diabetes that causes organ complication such as kidney failure. Thorough treatment of hyperglycemia averts elevated albuminuria and slows down the progress. The downside of this remedy is that patients are at an increased risk of severe hypoglycemia.

Based on the glomerular filtration rate and assessments of urine albumin, the development of kidney disease that results in ESRD has been categorized into five stages (American Association of Diabetic Educators, 2013). In the first stage, there is evidence of kidney ineffectiveness but with a normal glomerular filtration rate whereas in the second stage, kidney ineffectiveness increases accompanied by a decrease in levels of glomerular filtration rate to 60- 90 milliliters in a minute. In both stage one and two, there are not many symptoms however, there may be protein or blood on the urine, high blood pressure, and more than normal levels of End stage renal disease. In stage three, glomerular filtration rates further reduces to 30 to 59 milliliters per minute with a further dip in glomerular filtration rate to 15 to 29 ml/ml, which is severe. At this stage, there will be fatigue, reduction in ability to concentrate, difficulty sleeping especially at night, and loss of sexual drive. In the fifth stage, there is obvious evidence from very low glomerular filtration rate of 15ml/min accompanied by nausea, continuous illness, itching, inverted sleeping pattern, fat and muscle loss, and skin coloration (American Association of Diabetic Educators, 2013).

Hypertension as a Cause of ESRD. Hypertension is the second common cause of kidney failure (Carolina Health Care System, n.d). By 2011, sixty-six percent of ESRD patients had hypertension (American Nephrology Nurses Association, 2011). Hypertension is a condition with blood pressure of more than 140/90 mmHG (University of Cambridge, 2009). Hypertension can be controlled by changes in lifestyle which include, reduced sodium intake, losing weight, alcohol moderation, being physically active, reduction of intake of saturated fat and smoking cessation. If lifestyle modification fails, antihypertensive drugs are used. The risk of getting ESRD in hypertension patients varies with age, body weight, and ethnicity where older persons, over weight are at a higher risk and there are those with family history.

The cause of kidney failure by hypertension is increased blood pressure that damages the nephrons and the association of hypertension to diabetes and vascular diseases, extracellular volume changes, chronic inflammation, and adjustment of cardiovascular dynamics. Smith (2013) noticed that there is a greater effect on kidney disease due to higher systolic pressure, than for pulse blood pressure, or diastolic blood pressure. Mahmoodi et al. (2012) conducted a meta-analysis of 45 cohorts (25 general population, seven high-risk, and 13 chronic kidney disease) with 1,127,656 participants, 364,344 of whom had hypertension. The authors contended that chronic kidney disease should be considered as at least an equally relevant risk factor for mortality and ESRD in individuals with or without hypertension.

For hypertensive patients with kidney failure, multiple antihypertensive agents are used to attain require blood pressure of below 130/80 mmHg. RAAS inhibitors are one of the most used antihypertensive agents (Smith, 2013). Medical guidelines propose (ARBs) angiotensin receptor blockers or ACEi (Angiotensin Converting Enzyme inhibitors) to be the first preferred treatment in slowing down the progression of kidney disease in persons with hypertension (Mount, 2012). Aldosterone 91012 has been associated with renal injury development of chronic kidney disease due to high aldosteroine escape as a result of high blood pressure, increased vascular inflammation, fibrosis, oxidative stress, sympathetic nervous system and apoptosis (Maron & Leopold, 2010; Smith, 2013). There is need to use aldosteroine antagonist as a remedy to inhibit enjoining of aldosterone with the mineral corticoids receptor. However, there are concerns of using agents in slowing progression of kidney failure as they have been found to be associated with increases in chances of hyperkalemia.

There are factors that contribute the progression of simple kidney malfunction to ESRD in patients with hypertension. Visceral obesity activates a series of maladaptive renal, cardiovascular, prothrombotic, inflammatory and metabolic responses; a number of which form the cardio-metabolic syndrome (Saito et al., 2013). These responses including dysglycemia, hyper-insulin resistance, dyslipidemia, hypercortisolemia and an altered vascular function enhance the progression of kidney disease to ESRD. In hypertensive patients, insulin resistance in these patients with visceral obesity is associated with the characteristic of the fat in the para-intestinal and mental regions (Saito et al., 2013).

Treatment of ESRD

Transplantation, peritoneal dialysis, and hemodialysis are the available modalities for renal replacement therapy for the treatment of ESRD. HD is subdivided into two; center HD which is the most commonly used and home HD. Peritoneal dialysis (PD) encompasses of both continuous cycling PD (CCPD) and ambulatory PD (CAPD), along with other forms of PD in a small sub-group (Lewis & Noble, 2012). Renal transplantation is always from a living donor (either emotionally related donor or a blood relative) or even a cadaveric donor. During the process of being treated for ESRD, it is possible for the patients to severally switch between the different renal replacement therapy modalities. For instance, a certain patient might switch from CAPD to transplantation, from transplantation to HD and perhaps to another transplant.

A Brief History

In the 1960's, peritoneal, renal transplantation, and hemodialysis started to be commonly used to treat ESRD patients. Earlier before 1960, dialytic modalities were helpful to some patients who were suffering from acute renal failure. Living donor transplants were successfully performed to a few identical twins, but there was no other treatment available except dietary modification for patients with ESRD. In the early 1960's, some few patients for chronic renal failure were treated with hemodialysis using the Belding Scribner's work. This was followed by the use of peritoneal in the 1960s followed by renal transplantation from twins who are not identical in the same period. The renal transplantation from non-identical twins was made a reality through improved understanding of immunology and by the use of immunosuppressive therapies (Bomback & Bakris, 2011). However, Medicare coverage was not enacted by this time.

Medicare coverage for end-stage renal disease was enacted by the congress as part of social security amendments that eventually became effective in 1973. The reduction in treatment costs have been encouraged by several legislative changes made in the Medicare's ESRD program through changes in modality to home dialysis and payment methods (Bomback & Bakris, 2011). Other changes have taken place ever since 1960s, remarkably outpatient erythropoietin therapy for dialysis patients and an emergence of immunosuppressive drugs after transplantation.

Transplant as Treatment of ESRD. Kidney transplant is a treatment of ESRD where a kidney is taken out of donor and surgically placed into a recipient (Carolina Health Care System, n.d). A successful kidney transplant enables a patient to terminate dialysis. Kidney transplant is affected by factors such a number of willing donors, medical condition of the recipient and the suitability of the donors (American Nephrology Nurses Association, 2011). A recipient must undergo evaluation to ascertain their suitability to undertake a transplant (Carolina Health Care System, n.d). The evaluation process entails meeting with a social worker, financial specialist, dietician, transplant nephrologists, and surgeon. The purpose of the meeting is to educate the recipient on the transplant process by highlighting probability of success, risk and benefits, expected lifestyle, diet and the financial obligation. Besides educating the recipient, lab tests and x-rays are conducted to establish the health status of recipient.

Once the evaluation process is completed, the transplant team reviews the information and makes a decision if the transplant is viable and a safe option. In the review, a patient with other diseases like cardiovascular diseases, cancer, or other serious infections has reduced chances of having a successful transplant. The transplant team will want to ascertain if the patient will be able to follow the schedule after the transplant especially in the first year, which requires regular visits to the physician (National Institute of Health, 2008).

If recommended, the recipient gets an opportunity to undergo either of the two types of transplant. In the first option, the recipient will get a kidney donated from a live donor (National Institute of Health, 2008). The donor might be someone known to the recipient mostly family member or friend. The option of a living donor has high chances of success and transplant can be planned at convenient time. However, not all who need a transplant can get a living donor and as such can only receive kidney from a deceased donor. Throughout the life of the new kidney, one must take antirejection medication daily in order to maintain the new kidney (National Kidney Foundation, 2012). During the first year after kidney transplant, the patients are monitored closely by a physician, after that, the frequency drops to monthly lab visits. Transplant is considered as the best strategy of treating End Stage Renal Disease but due to limited number of donors, several strategies such as hemodialysis are being considered (Naalweh et al., 2017).

There are various advantages of undergoing a transplant chief among them being the ability to live a near normal life again with reduced restrictions such as those in diet. There are increased energy levels as new functioning kidney promotes production of red blood cells. Kidney transplant increases quality of life than dialysis and has better chances of survival where in the first five years there are seventy percent as compared to thirty percent in patients who have undergone dialysis. For successful kidney transplant, ESRD associated comorbidities like cardiomyopathy, may be resolved completely, or made insignificant. However, the disadvantage of transplantation is the risk of the body rejecting the new kidney, the increased chances of cancer; follow up especially in the first year and the increase risk of infections. It is observed that the success of transplant is affected by the time the patient spent on dialysis prior to transplant. There are increased chances of success with an early transplant but this depends in the chances of getting a live donor.

With the increasing occurrence of ESRD and the success rate associated with transplant, there is bound to be regulations that govern the process and the code of ethics. Both the recipient and the donor have the right to receive and donate the organ (Award, 2013). However, commercially inspired transplant is unethical and unacceptable practice. The living donor is obliged to give informed consent duly signed without any undue influence such as finance or coercion. This happens after understanding the risks and benefits involved and medical evaluation of the psychological preparedness. The patient should not be used as a means but an end and as such there is respect for integrity, dignity, and authenticity (Award, 2013). The autonomy of donors should be respected with regards to the ability to understand information and make a decision which gives them a decision-making capacity which should be respected. When making the final decision on transplant, balance between saving life in a cost effective manner (clinical utility demand) and the upholding of right to donate a kidney both after death and in life is made (Award, 2013).

Hemodialysis. Through the process of hemodialysis, toxins and excess fluid are removed via extracorporeal circulation of blood. This is done through a dialyzer or what is commonly referred to as “artificial kidney”. The treatments are usually scheduled for three times in a week and last for 3 to 4 hours (Cabral & Santos, 2012). Arterio-venous (AV) fistula, indwelling vascular catheter or vascular graft is used to access the vascular. The treatment is usually performed as “center hemodialysis” in a freestanding or hospital-based dialysis unit. In this environment, patients’ dialyzers are often reprocessed and therefore a given patient may reuse the dialyzer multiple times (Cabral & Santos, 2012). However, this modality can be used at different locations. This process of hemodialysis may be performed at home (home dialysis) after the patient and the assistant undergo several weeks of training. The advantages associated with home hemodialysis include patient independence and the dialysis scheduled meets the patient convenience (Cabral and Santos, 2012). Patients treated with home hemodialysis appear to enjoy a better quality of life and are reported to survive better compared to center hemodialysis. In the near past, home hemodialysis has been practiced as a daily treatment given as either slow nighttime dialysis (Pierratos) or short daytime (Buoncristiani). Patients under hemodialysis are partially responsible for the success of the success of their treatment, medical prescription, as well as adherence to HD sessions. The patients ensure that they maintain their diet in order to increase their chance of survival (Nalweeh et al., 2017).

Peritoneal dialysis. This process uses the peritoneal membrane as a substitute surface dialysis. It entails placement of a catheter into abdominal cavity, and repeated drainage and instillation of sterile dialysate (Ronco, Rosner, Crepaldi, & International Course on Peritoneal Dialysis, 2012). The movement of toxins from the plasma to the dialysate is caused by the concentration gradients during the dwell time. The dwell times vary form few hours in CAPD, to up to 1 hour in other forms of cyclic PD. Toxins which are equilibrated with the dialysate are drained together with the toxins. The fluid is removed via osmotic ultrafiltration through the use hypertonic dialysate solutions. There are various options that can be used in PD.

The most commonly used peritoneal dialysis option is the continuous ambulatory PD (CAPD). Four or five exchanges are performed daily to the patient with a dialysate of 2-3 liters. Continuous cycling PD (CCPD) is a home treatment that utilizes a certain number of exchanges through a machine (cycler), every night, with a long dwell time during the day (Ronco et al., 2012). The combinations of both CAPD and CCPD have been utilized predominantly in patients without renal function (Diaz-Buxo). Intermittent PD (IPD) has 3 to 7 times exchanges of dialysate weekly for 8 to 12 hours and is performed through the cycler (also an automated PD) Nonetheless, these options are used in different situations.

The use of various options of PD favors different patients at different situations. CAPD and CCPD are frequently used for patients who choose the independence of self-care and those who have difficulty with other aspects of hemodialysis or vascular access (Ronco et al., 2012). PD therefore has two extreme groups that are preferred for the procedure; the ones who are stable and independent and the ones who are unstable and poorly tolerant to hemodialysis. However, there is need to compare the outcomes of different modalities across different demographic factors.

Choice dialysis modality. The choice of dialysis modes for ESRD patients is determined by geographical considerations, patient's preferences, and medical and social contexts. The factors dictate the type of peritoneal dialysis mode to be used (Franco & Fernandes, 2013). The peritoneal dialysis mode has been used due to the factors such as financial constraints, cultural issues, and lack of informed consent in treating elderly patients. A lot of elderly patients engaging the treatment of the end stage renal disease prefer use of the peritoneal dialysis which are the elderly. The peritoneal dialysis has helped the elderly conduct physical processes to manage ESRD prevalence (Cupisti et al., 2017). The majority of patients with chronic kidney disease prefer to start dialysis using peritoneal as compared to hemodialysis (Franco & Fernandes, 2013). Patients with end-stage renal diseases are required to engage in renal replacement therapies. Different medical options are available such as transplant, dialysis as well as conservative treatment. A significant number of the patients choose transplants and dialysis (Erlang, Nielsen, Hansen, & Finderup, 2015). In addition, patients intending to engage in renal replacement therapy through dialysis are required to engage in a timely preparation and education on the dialysis mode to adopt (Segall et al., 2015). Most patients opt to start dialysis immediately after choosing the mode of dialysis. Many nephrologists suggest that home-based dialysis therapies should be used among patients with Renal Replacement Therapies as the larger population is for elderly. In addition, many elderly patients have lots of co-morbid functions than the younger patients. Consequently, doctors and caregivers strongly suggest hemodialysis for such patients (Segall et al., 2016).

In addition, the choice of dialysis modality is influenced by factors such as the resource availability, timing of referral, unavailability of teamwork experience with certain dialysis modes as well as physician bias (Chiang et al., 2016). However, patients are more likely to choose peritoneal dialysis over hemodialysis due to its association with improved quality of life, reduced dialysis costs, and its relevance in preserved residual renal function (Chiang et al., 2016; Keating, Walsh, Ribic, & Brimble, 2014). On the other hand, patients do not choose peritoneal dialysis due to late referral, unplanned dialysis, medical factors, and time spent on modality education. Patients are likely to choose one dialysis modality over the other due to education on the different structures of the modalities (Chiang et al., 2016). Decision-making in medication among the patients is a tough task especially among patients with chronic kidney diseases. The decisions of choosing the right path of medication are dependent on the existence of real and imaginary knowledge (Jayanti et al., 2015). The illness burden is as well likely to determine the choice of dialysis modality to be used. Moreover, clinical condition determines patients' decisions to engage either in peritoneal dialysis or hemodialysis (Jayanti et al., 2015).

Shift from PD to HD. Malnutrition is common in PD patients. Karen, Julie, Eldho, and Catherine (2011), illustrated that PD patients are attributed to decreased food intake and chronic inflammation linked to dialysis related comorbidities and complications. These phenomena advocate for a shift from PD to HD to reduce the prevalence of gastrointestinal symptoms in dialysis patients. The selection of PD or HD is usually based on the patient motivation, desire, and geographical distance from HD unit, physician, and the level of patient education. According to Ramapriya and Jean (2011), many patients are not educated on PD or HD before beginning dialysis. The study shows that the relative risk of technique failure in patients in PD verses HD changes over time with a lower technique failure risk in PD in the initial stages of dialysis. This technique shows continuous success in PD for up to one and a half to two years which decreases suddenly favoring the HD technique. Thus PD technique is best at the beginning of the dialysis up to about two years where the patient should shift to HD technique depending on the patient factors (Pike, Hamidi, Ringerike, Wisloff, & Klemp, 2017).

Ramapriya and Jean (2011) indicated that ESRD patients' satisfaction may be high with PD as the PD technique costs are relatively lower compared to the HD technique but a shift from PD to HD would reduce mortality rates of the patients. The PD technique is more advocated for than HD technique. According to Sens et al. (2011), mortality rate is higher in PD technique than in HD technique. Sens et al. (2011), through a study, compared mortality risks in patients by dialysis modality by including all patients who started planned chronic dialysis with associated congestive Cardiovascular Disease in 933 PD patients and 3468 HD patients. There was a significant difference in the favor of HD technique with a survival time of thirty six months compared to survival time of twenty months in PD. This study concluded that there is high survival rates in HD patients compared to PD patients.

TST (tuberculin skin test) response is lower in PD patients. According to a study conducted by Altunoren et al. (2012), which was aimed at investigating TST positive rates in HD and PD patients and the factors influencing TST positivity. HD patients indicated higher results than the PD patients. In this specific condition, the study found that TST is lower in PD patients especially in tuberculosis cases.

A wide range of factors affect the uptake of PD compared to HD. According to Oliver et al. (2012), PD is cheaper than HD and has many potential advantages compared to HD technique which is more costly and contradicted. The study examined the differences in patient PD technique advantages compared to the benefits associated with HD technique. HD technique was rendered to be more contradicted besides being costly compared to PD technique illustrated as cheap and having a lot of potential benefits.

Oliver et al. (2013) conducted a study with an objective to compare the risks of access interventions between the two modalities in a sample of 369 incidents of chronic dialysis patients. The study emphasized the fact that PD patients have more benefits attached to the technique by concluding that patients under PD technique require fewer interventions to maintain the dialysis access than the patients under HD technique. Basing argument from the different studies, this study advocates for an integrated model technique. Initially PD technique should be advocated for the first two to three years and shifted to HD depending on the patient's conditions.

Chaudhary, Sangha, and Khanna (2011) and Dalal, Sangha, and Chaudhary (2011) conducted similar studies to establish if there is sufficient evidence to make PD the first therapy before switching to HD. The researchers noted that the lower cost of therapy, a flexible schedule, increased freedom from the patient's viewpoint, and convenience of home therapy are some factors that support the an ESRD patient staring dialysis on PD then switching to HD. Moreover, the risk of Ultrafiltration failure in PD and increased preservation of RRF when one has switched to HD also support the switching technique. However, the researchers did not conduct an empirical studies hence their findings are limited.

Jaar et al. (2009) noted that technique failure is more associated with PD than HD and that there is little data in the United States addressing the outcomes and factors associated with switching modalities from PD to HD. The researchers also found that PD patients of black race were approximately 3 times more probable than white PD patients to switch from PD to HD while patients living at least 30 miles from the dialysis clinic were 58% less likely to switch from PD to HD likened to patients living less than 30 miles from the dialysis clinic. Ghaffari et al. (2013) conducted a study to explore why PD should be the initial choice before switching to HD. The researchers noted that A "PD

First" approach not only has benefits for patients but also physicians, and healthcare systems. Patients starting dialysis for the first time often have noteworthy residual kidney function. The maintenance of RRF is associated with enhanced survival. Pajet et al., (2014) established that Peritonitis is a cause of technique failure followed by ultrafiltration failure. It is cost effective to start on PD then switching to HD (Chui et al., 2013). The researchers found that patients who transitioned from PD to HD had lower health care costs than those who used PD or HD alone.

The reason for switching from PD to HD can also be attributed to rising cases of peritonitis as well as catheter-related infections. The peritonitis infections cause the occurrence of ultrafiltration failure and the membrane related problems that often results in technique failure. The ultrafiltration failure and volume overload caused by excessive salt and water intake has led to the inability of maintaining adequate filtrate which leads to the failure of PD (Chaudhary, 2011). The prolonged exposure to hypotonic glucose concentrations affects the transport characteristic of the peritoneal membrane. The peritoneal membrane faces dysfunction due to excessive fluid and sodium intake which leads to loss of residual renal function and eventually peritoneal dialysis is abandoned.

The effects of HD on ESRD patients. Peritoneal dialysis has been common over the past few years to the most patients undergoing treatment for End Stage Renal Disease, but the prevalence has decreased compared to hemodialysis. A vast number of ESRD patients are transferring from PD to HD where the risk of transferring to HD after PD initiation is highest for the first few months (Chaudhary, 2011). The transfer to HD affects the quality of life of patients as the transfer affects their living habits. The transfer affects the lifestyles of the patients, physical health and functional status, personal relationships as well as social economic status (Gerogianni & Babatsikou, 2014). The shift to HD has been accompanied by many stressing factors such as uncertainness of their future, regular hospital admission, restriction of leisure time and financial constraints among others. The patients undergoing hemodialysis are often faced with the stress of low self-esteem, depression and personality disorders such as neuroticism, alexithymia, introversion and psychoticism (Gerogianni & Babatsikou, 2014).

Patients on Hemodialysis find the dialysis mode stressful as it involves getting dialysis three times a day. The freedom of patients is undermined due to the constant use of machines as well as the high dependence of healthcare personnel (Nasiri et al., 2013). The patients on hemodialysis mode are always faced with emotional challenges. The patients on hemodialysis are constantly faced with physiological and psychological challenges due to the constant use of machines. The patients are restricted from mobility and face challenges in maintaining their diets. The patients are always fatigued, angered, and have poor adherence to treatment (Ahmad & Al Nazly, 2014).

The patients also cope with the challenges faced during the process of obtaining dialysis using hemodialysis. The patients use the emotion-oriented and problem-oriented solving methods. The problem-oriented solving methods entails the use of planning and following up of active programs while emotion-oriented method involves controlling of emotions and adapting to the current situation (Nasiri et al., 2013). The patients as well cope with the challenges of undergoing hemodialysis by accepting responsibility, seeking social support as well as self-controlling. In addition, the patients constantly engage avoidance, idealism and positive re-evaluation (Ahmad & Al Nazly, 2014).

Technique Failure

In some cases dialysis does not result in expected clinical outcome of managing ESRD. Betty et al. (2013) study design illustrated a dialysis where patients were categorized by initial and subsequent modality changes during the first year of dialysis and tracked for inpatient and out-patient costs, physical claims, and medication costs for at least three years using a merged administrative data set. The design determined unadjusted and adjusted cumulative costs for each modality group using multivariable linear regression models. PD technique was associated with lower costs in the period of one year only; however, the costs were similar to HD technique in three years. Using Betty et al. (2013) study one can illustrate that costs drivers in PD technique failure arise primarily from costs of dialysis provision, hospitalization, medications, and physician fees.

Comparing the patients receiving different ESRD treatment modalities, those receiving HD, PD and those who transited from HD to PD therapy, all have significant lower total health care costs at one to three years. Patients experiencing PD technique failure have similar costs which might increase in the case of supporting economic rationale for first policy program.

The primary technique failure in PD technique remains high. Matthew et al. (n.d), in his study illustrated that PD provides a safe and effective renal replacement therapy for regional pediatric centers that serve a rural setting where the study was conducted but illustrated the technique failure rates as high as 24.6%. This was conducted from a population of 88 children between the ages of two days to twenty years receiving PD catheters for the management of acute and chronic renal failure. This study illustrates that though PD technique is significant in ESRD patients treatments there is still a gap to be filled in determination of its high technique failure rate.

Dual incision laparoscopic surgery in PD (DILS-PD) with fixation technique is a simple and safe procedure. According to Yeh et al. (2013), DILS-PD procedure minimizes or eliminates the possibilities of migration without additional costs. Yeh et al. (2013) conducted a study where they performed open surgery for PD catheter implantation (OS-PD) and DILS-PD and then compared the information on demographic data, medical, operative, and postoperative findings and complication information between the groups. From the study there was no tube migration in the DILS-PD group but on the other hand there were 25.7 percent of the patients with OS-PD group with tube migration indicating that DILS-PD technique reduces the technique failure rate in the treatment for ESRD patients. From the study one can recommend for the DILS-PD as compared to OS-PD technique.

Early recognition of medical deterioration and early medical intervention are necessary for a better outcome for elderly PD patients. According to Cheng et al. (2013), self-care patients experience a high percentage in the technique failure in PD technique compared to assisted care patients. From a study of 138 elderly ESRD patients where seventy were assisted care patients, it was recognized that technique survival was high among the care assisted patients due to the fact that early medical deterioration was detected fast and the necessary measures put in place to correct the situation. These phenomena improved the technique survival rate. On the other hand self-care patients exhibited a high rate of technique failure which is associated with late recognition of medical deterioration circumstances reporting the incidence when it is too late. When the medical deterioration has already heightened to levels that cannot be corrected it leads to PD technique failure in the ESRD patient. The type of assisted care did not determine the level of technique failure indicating that the main determinant of the technique failure incidence was early recognition of deteriorating medical situations which were corrected at the appropriate time.

On site availability of PD, case mix, funding, patient location, and reimbursement do not determine the technique failure in PD. According to Hingwala et al. (2013), if the PD attempt was maximized, a significant amount of resources can be saved or even directed to a much larger population of ESRD patients. Hingwala et al. (2013) conducted a study to examine the differences in patient PD attempt rates between nephrologists using technique survival and mortality as the outcomes. The highest attempt rate was compared with the lowest where all the results were significant. In the study while comparing the largest attempt and the lowest attempt it was found that the factors limiting PD utilization did not include case mix, funding, availability of PD and the location of the patient. This illustrates that PD technique failure is not facilitated by location of the funding which should encourage many ESRD patients to have high PD attempts to reduce the technique failure.

PD and HD are simple, safe, and efficient therapy methods. According to Burdmann and Chakravarthi (2011), it is possible to correct acute kidney injury and volume overload both in and out of the intensive care unit settings through the use of high volume PD and HD. Burdmann and Chakravarthi (2011) in their study advocate the use of PD and HD to children patients with refractory Cardiovascular Disease or hemodynamic ally instable conditions to reduce technique failure.

Causes of technique failure. The technique failure results from the switching from one modality to another. The most common switching method in most patients is the switch from PD to HD where patients switch to HD due to some reasons. The major cause of technique failure in ESRD patients is peritonitis which occurs majorly within the first 1 to 2 years after initiating from PD (Chaudhary, 2011). Peritonitis causes of technique failure have increased from studies conducted in major dialysis centers. A study conducted on 292 PD patients that involved 28 dialysis centers indicated that 24.8% of PD patients switched from PD to HD where 40% of the patients switched within the first one year and 70% switched within two years (Chaudhary, 2011). In addition, ultrafiltration, as well as volume overload, is also a major cause of technique failure. Patients are characterized to engage in taking large volumes of salts and water. The patients are therefore faced with inadequate solute clearance (Quinn et al., 2010).

The cause of technique failure can also be attributed to the mechanical failure of the equipment used in performing the dialysis. The failure of the equipment is attributed to catheter failure which may malfunction or block. In addition, patients may have technique failure due to psychosocial factors accompanying the patient. Similarly, death may also be a cause of technique failure where patients die due to complications accrued with an individual modality (Quinn et al., 2010). The early detection of the factors that contribute to technique failure can lead to technique survival. Patients under dialysis mode are often advised to monitor their infection rates, loss of renal replacement therapy and changes in the peritoneal membrane that help in early detection of technique failure. The early detection of technique failure help patients to overcome the causes of PD cessations, psychosocial factors as well as the reduction of mortality rates (Bechade et al., 2014).

The Choice between Different Modalities and the Dialysis Center

There are two commonly used modalities of dialysis for treating patients with the ESRD. PD and HD are the two commonly used modalities of treatment and they differ in terms of techniques (Barone et al., 2014). A large number of patients suffering from ESRD have been on either of these two modalities of treatment. The choice of either of the treatment modalities depends on a number of factors. Studies conducted about the difference between these modalities have shown some significance difference. These differences are well manifested in the quality of life, social and emotional well-being (McDonald et al., 2009). The choice of modality treatment affects the quality of life of the patient. Historically, the survival of patients under HD was considered greater than those on PD.

Initially, it was believed that patients who started with HD had survival advantage as compared to those who were on HD. Until the 1990's some studies reported survival advantage of the patients who start with HD as compared to PD (Ronco, Dell'Aquila, &

Rodighiero, 2006). However, there was no enough literature to support this claim and therefore it called for enough research to be done on this field. Nevertheless, there were some external factors that influenced the application of HD instead of PD.

Elderly patients who were suffering from concomitant diseases were subjected to PD. This was also driven by the shortage of HD units. It was also influenced by clinical and social contraindications that could not allow the patient to undergo HD (McDonald et al., 2009). However, some recent studies have indicated that there is no significant difference in any of the modalities.

In the early 2000's the patients were directed towards the treatment which was most beneficial to them. According to Sisca and Pizzareli (2002), there lacked a significant disparity in the expected survival rates between the different treatment methods. Both PD and HD were considered similar in terms of the expected survival for patients in all the ages, genders and other demographic factors. Even though HD is the most common modality of dialysis, it has another variant known as HDF.

In HDF, more fluid is removed by the dialysis machine in the process of treatment. This implies that the blood is cleansed better. Nevertheless, the removed fluid has to be replaced and this calls for another session that last as long as the session of HD (Ronco, Canaud, & Aljama, 2007). This modality involves the use of sophisticated instruments and therefore it is not commonly used due to the financial constraints (Ronco et al., 2007). The choice between the public and private dialysis centers in United States is also influenced by some factors.

Most people who want to seek dialysis services prefer the public units. The public units are said to be more equipped than the private units (Barone et al., 2014). The National Health Service finances the purchase of the equipment. The patients therefore believe that any complication that arises from the procedures would be well dealt with when the patient is at the public unit. The choice of the modality and center is, therefore, said to be influenced by the preferences of the patients and the clinical advice of the physicians. The preference of the modality might be influenced by the patient's knowledge of dialysis modalities. Foley et al. (2014) noted that a patient's commitments such as work and family influence the choice of dialysis center. Hence, the patient plays a great role in determination of the dialysis modality and the center.

The urgent start of dialysis using PD for ESRD patients is feasible as compared to the use of hemodialysis. .As the number of patients with end-stage renal disease is on the rise, there is a need to adopt a strategy of minimizing the prevalence which is enhanced through dialysis. .According to the United States Renal Data System 2014 annual report data, it is estimated that there is 0.14% prevalence of patients with end-stage renal disease (Jin et al., 2016). Patients with ESRD do not have a distinct plan for starting dialysis which calls for urgent dialysis. The urgent start of dialysis using peritoneal dialysis has been considered by most nephrologists since it does not require functional pre-established vascular access. Hemodialysis used in most healthcare centers requires the high use of central venous catheter at the time of initiating dialysis (Jin et al., 2016). The urgent start of dialysis using PD can serve patients well. The urgent start of dialysis by use of hemodialysis is associated with a probability of bacteremia infections as compared to patients starting dialysis under PD mode.

Peritoneal Dialysis versus Hemodialysis in Adults

Single center

Improvement of survival rates because of timely shift of PD to HD. Studies have been conducted to investigate the improvements of survival rates as a result of timely shift of PD to HD. Panagoutsos et al. (2008) focused on patients from Greece who were on dialysis for 10 years in a single Division of Nephrology. The researchers determined five-year survival rates for 299 patients and considered factors such as gender, age, serum albumin, and common diseases. The researchers compared three categories of patients including those who were starting PD, those who were starting HD, and those who were changing from PD to HD. The researchers also evaluated use of serum albumin and dialysis dose between the groups and established that there was no significant variance. The study established two survival curve phases; PD is boosted by RRF in the initial phase while the second phase is characterized by a loss of RRF. The study also established an increase in the mortality risk among PD patients resulting from a decline in Kt/V (Panagoutsos et al., 2008).

The use of PD has been well established all over the world as a therapy of renal replacement in ESRD patients. Nevertheless, there is need for timely shift from PD to HD for variety of reasons. These reasons include repeated infections and peritoneal membrane function. The shift should be timed when the patient has mature AVF (Panagoutsos et al., 2008).

There are various benefits accrued to timely shift from PD to HD. Improved mortality rate is the main aim for the shift to HD. Panagoutsos et al. (2008) carried out a research which involved patients who started their treatment during the last 10 years. There were 33 PD patients who ranged from 40 years to 70 years of age who transferred to HD, another 134 PD patients who were aged between 53 years and 75 years used only PD. The study also involved 132 patients aged between 32 years and 64 years of age who started and remained in HD. The main reasons why the patients transferred to HD were loss of ultrafiltration and relapsed peritonitis. The results indicated that 3-year survival rates for those who changed dialyses were 97%, those who started and remained in PD were 54%, and those who started and remained in HD were 92%. For 5-year survival rate, those who shifted indicated a rate of 81%, those who remained in PD indicated 28%, and those who remained in HD indicated a rate of 83%. These results indicated that 3-year survival rate was significantly higher for the patients who shifted from PD to HD than those who remained in PD or HD. It was also evident that the 5-year survival rate was higher in the patients who shifted than those who remained in PD. However, there was no significant difference in the HD patients. It was therefore evident that the transfer of patients from PD to HD improved their survival after they develop PD related complications. However the study did not determine the optimal switching time. This study will aim to fill this gap.

In addition, studies have shown that although peritoneal dialysis has many advantages compared to hemodialysis, the dialysis modality remains underutilized as the initial modality of the end-stage renal disease patients (Contreras et al., 2014). A majority of patients in the United States (93%) starts dialysis through the use of HD modality (Ghaffari et al., 2013). A majority of ESRD patients starts dialysis using HD due to the ease of initiating HD, physician experience and training, lack of PD infrastructure to enhance successful dialysis by use of PD as well as inadequate pre-ESRD patient education. The PD dialysis modality has been observed to have a high survival advantage in the early years of dialysis initiation. The early survival advantage is independent of patient's characteristics such as age as well as co-morbidities such as diabetes and cardiovascular diseases. The PD has shown significant improvement of mortality rates in the first year of dialysis whereas the HD has not shown the significant improvement since the 1990s (Ghaffari et al., 2013). The PD modality is associated with improved quality of life as well as reduced costs. Patients who switch from PD to HD have the same cost of dialysis as patients under HD dialysis modality only. In addition, initial dialysis through the use of PD is associated with management and improvement of residual renal function. Managed residual renal function improves patient's survival rates (Ghaffari et al., 2013). Moreover, Beladi et al. (2015) indicated that there is increased patients' survival advantage of PD patients during the first year of initiating dialysis. Pajek et al. (2014) indicated that timely switching from PD to HD due to technique failure improves patients' outcomes and survival. The mortality rates of patients are decreased.

Comparison of clinical outcomes of PD and HD in elderly patients. There is an increasing growth of elderly patients seeking dialysis treatment in the U.S.A. It is therefore important to determine the most efficient modality and the best way to implement either of the modalities. The dialysis, PD and HD differ in terms of quality of life and particularly to the elderly who are more exposed than the younger patients (Aghakhani, Samadzadeh, Mafi, & Rahbar, 2012). In United States, PD is less frequently used in elderly patients as compared to younger patients, different studies have defined elderly patients differently with some of the defining it as those aged 65 and above while other defining it as those aged 75 and above. In 2009, the USRDS data depicted that 12% of the dialysis patients aged 20 to 55 were on PD while only 4% of the patients aged 75 and above were on PD. But this different when compared with other countries like France where PD is dominant in elderly patients. In France more than half of the PD patients are aged 70 years and above. In Hong Kong, of all the patients who are on dialysis, 80% are on PD. In United Kingdom, 17% of the elderly patients are on PD, while in Canada; only 12% of the elderly patients are on PD. This is a clear indication that the modality choice varies from one country to the other.

The cost of the modality treatments does not seem to affect the choice of mode of treatment. In United States, the cost of HD is relatively higher than that of PD. The choice of HD against PD by the elderly patients has some financial implications. The wide use of HD by the elderly patients is enhanced by the resource availability and cultural issues (Wright, 2009). This implies that there is no significant difference in the outcomes of the modalities and the choice might be affected by other factors such as cultural issues. However, there are other factors that may be considered in choosing either PD or HD.

There are challenges that are evident in using either PD or HD for elderly patients. Quality of life is predominantly important for the elderly patients on dialysis.

One factor is travel time to and from the dialysis center which can have a negative impact on patient's quality of life as well as the patient's caregiver (Joshi, 2014). The patients are also required to have a peritoneum that is not disrupted by prior surgeries and ability to perform daily medical technique. It is, therefore, important to assist the patient who cannot be able to perform these tasks. The main advantage of PD is that it is physiologically gentle and it can be performed at home. However, in comparison of clinical outcomes of these two modalities, it is good to consider the effect on infection rate.

Younger patients have portrayed better quality of life when subjected to PD as compared to HD (Barone et al., 2014). For elderly patients, they portray the same quality of life across PD and HD. PD is appropriate for any patient who would like to dialyze at night and those who place a lot of value on independence (Barone, et al., 2014). Elderly patients therefore consider other factors except quality of life in choosing the modality treatment. Those who would like to dialyze at night can use PD. However, younger patients portray better quality of life on PD. Nutrition is another clinical outcome that should be considered across all the modalities in elderly patients.

Multicenter

Mortality between HD and PD dialysis patients. Multicenter has demonstrated different results as compared to single-center in respect to mortality rate of HD and PD. A study by Chiu et al. (2011) analyzed the mortality data from 822 consecutive patients starting the dialysis process in 11 centers. The study involved extensive collection of comorbidity data before the patient started the dialysis process with an average follow up of 24 months. There was a significant difference with respect to HD and PD patient's hemoglobin (Hb), age, comorbidity and albumin score. It was observed that the HD group had significantly higher scores. Data was also collected in relation to severity of disease and acuity of onset of the renal failure.

A comparison of mortality data from both groups indicated that no disparities between the survival rates of the two groups. The researchers deduced that the apparent initial survival advantage of PD patients in previous studies could be as a result of lower incidence of important start in PD cohorts and lower comorbidity (Chiu et al., 2011). This study affirmed that the survival advantage in any of the two treatment modes was lost due to adjustment of comorbidities and acute start in the final phase.

Research has indicated differences in mortality and survival rates of ESRD patients under PD and HD dialysis modalities. The differences are observed due to the different causes of ESRD, differences in age, co-morbid diseases, and the time of initiation of dialysis (Beladi Mousavi, Hayati, Valavi, Rekabi, & Mousavi, 2015). The mortality of ESRD patients varies with the presence and absence of diabetes mellitus, where survival is worst for patients with diabetic nephropathy. In addition, Yang et al. (2015) observed that mortality of ESRD patients is higher for patients undergoing dialysis through PD as compared to patients under HD modality.

Effect of duration of dialysis on mortality in HD and PD dialysis. The duration period under which the patient undergoes the treatment affects the mortality rate of the patients. Yamagata et al. (2012) conducted a study involving 1222 new patients starting a dialysis process for over a period of four years in Japan. The study was a large, prospective, observational, multicenter cohort study. The collected data focused on primary renal disease, RRF comorbidities, albumin, and efficacy of dialysis, the patients' nourishment status, and Hb at the start of the dialysis process and at various stages during the 4 years study period. Subgroups were analyzed according to variables such as gender, diabetes, age, and cardiovascular disease (CVD). Averagely, the HD cohort had more comorbid conditions, was older, had poorer RRF, and lower Hb. There was no noteworthy disparity in serum albumin. The researchers also noted that the unadjusted mortality rates were considerably higher in the HD group, mainly in the initial 12 months after start of the dialysis process and remained comparatively static until the fourth year. The findings also indicated that the mortality rates among the PD group increased over the four years observation period. There were unsubstantial differences in the intent as treated or to-treat analyses. After the adjustment, the relative risk (RR) of death for HD was not statistically significant as compared with PD patients until one year, but showed a significant PD advantage. Nevertheless, an RR disadvantage was discovered with PD up until two years for patients with varying ages.

For patients aged less than 60 years with no diabetes, there was no statistical significant discrepancy in the survival rates between HD and PD during the course of the study. For the younger group of patients suffering from diabetes, a significantly higher mortality rate among the HD patients in the period of up to two years was noted (Yamagata et al., 2012). Irrespective of diabetic status, gender or CVD status, the two to four year analysis portrayed a survival benefit in favor of HD patients for all patients older than 60 years. It was, therefore, concluded that the use of PD for a long-term, particularly among the elderly, is related to an increment in mortality. Further studies were also recommended to investigate the probable survival advantage among PD patients who timely shift to the HD treatment modality.

Comparison between PD and HD in relation to mortality risk in patients with chronic kidney disease. Chronic kidney disease affected the mortality rate of the patients on PD and HD. Maier et al. (2009) conducted a research study among 1,041 patients on PD and HD from 81 dialysis clinics. This prospective study took place for a period of seven (7) years. Data were gathered on disease severity and coexisting diseases along with sex, age, racial or ethnic background, Hb, C-reactive protein, serum albumin, BMI, and residual urine output. Following the calculations, there were no significant disparities in the mortality risk between PD and HD patients who were receiving treatment for the first one year. Conversely, after being on treatment for two years, the risk of mortality was notably greater among PD patients. Although an increased death risk with PD use for elderly or diabetic patients was not detected, a slightly higher risk of death among certain groups on PD particularly the patients who had a history of CVD.

Registry data analysis. This section highlights some of the published registry data analysis done in various countries such as Netherlands, USA, Italy, Denmark, and Canada.

Adjusted mortality rates between HD and PD dialysis. A register data analysis of the Taiwan Organ Replacement was conducted by Huang, Cheng, and Wu (2008). The study was done on 11,970 patients who were suffering from stage five kidney disease and involved a follow up of up to five years. Where deaths occurred, they were associated with the treatment modalities that the patients were receiving before death (Huang et al., 2008). Compiled data from the study and calculated for primary renal disease, age, pre-dialysis comorbidities, and center size. The study findings indicated that the risk of mortality for patients starting the PD treatment was 73% compared to that of the patients who were commencing with HD when considering certain predictive factors; but, this became less evident when certain subgroups were removed from the data (particularly for those over the age of 65 years and with diabetes). The death rate for patients on PD increased over a period of time while the survival rate among HD patients formed a U shape.

Mortality in end-stage renal disease. Registry data was used to analyze survival rate in ESRD in Canada. The data involved 204,000 incident and prevalent patients for a period of over 7 years. There were noteworthy disparities in the rates of mortality based on different aspects including age, gender, and diabetes. However, there lacked significant disparities in the death rates for non-diabetic HD and PD patients with regards to race, gender, or age. On the other hand, patients aged 50 years and above and who suffered from diabetes portrayed significant increase in the risk of mortality on PD and HD (Yeates et al., 2012). The risk was higher among females rather than males. This was apparently the primary noteworthy interaction of gender-by-treatment that was identified. A significantly lower mortality rate was recorded among patients below the age of 50 years when the ESRD patient was treated with PD compared to HD.

The number of patients receiving treatment as a result of end-stage renal disease is increasing. Patients observed to have chronic kidney disease are at high risks of dying due to cardiovascular sources. The patients are faced with sudden cardiac deaths due to arrhythmias (Chen et al., 2014). The mortality of ESRD patients with cardiovascular diseases has been reduced by the use of implantable cardioverter defibrillators (ICDs). The ICDs also serve the role of reducing the risk of getting heart attacks. The patients with chronic kidney disease for both men and women have been found to have lower life expectancy. The life expectancy has been observed to decline for the patients with kidney failure (Turin et al., 2012). People with diabetes have been observed to have greatly reduced life expectancies. A study conducted indicated that patients with diabetes have eight years life expectancy less than patients that are non-diabetic (Turin et al., 2012). The mortality rates for patients with ESRD are thus on the rise such that the survival rate of patients is less than the patients with AIDs. The survival rate decreases as the patients ages (O’Connor & Corcoran, 2012).

Comparison of initial survival advantage of PD against HD. The use of PD in United States has increased due to its low cost, convenience and simplicity. The survival rate and quality of life has also improved in this modality due to antibiotic prophylaxis, advances in technique, and the newer solutions that are available. The rate of complications that are associated with PD has also reduced due to these advances (Pranav, Harbaksh, & Kunal 2011). The achievement of adequate clearance associated with PD and the perception by nephrologists on better survival rates on HD has really influenced the choice of modality globally. Nevertheless, studies have shown that initiating the treatments on PD is advantageous as compared to initiating the treatment on HD.

All ESRD patients have the goal of improving the survival rate, reduce morbidity, preserving residual renal function and improving the quality of life. It happens that most of the ESRD patients will receive HD, PD and renal transplantation at a particular point in their lifetime. The rate of survival for the first 2 years is higher in PD than in HD .Other factors that compel the use of PD first are convenience of home therapy, increased freedom for the patient. Preservation of residual renal function is another factor that compels the ESRD patients to start with PD.

Residual renal function (RRF) is a very important factor clinically because it contributes to quality of life, adequacy of dialysis, and mortality in dialysis patients. The reduction in RRF reduces middle and small molecular weight toxin clearance increase phosphorous, sodium and water retention and decreases erythropoietin synthesis (Wang & Lai, 2006). The loss consequently leads to malnutrition, anemia, cardiac hypertrophy, congestive Cardiovascular Disease atherosclerosis, valvular calcification, vascular and increase in cardiovascular mortality and morbidity. Another factor that compels the ESRD patients to start with PD is lower infection and hospitalization rates. Infection is the other major cause of death for dialysis patients. According to Aslam, Bernardini, Fried, Burr, and Piraino (2006), the rate of admission for septicemia/bacteremia is 1.5 to 2.3 times higher for the HD patients as compared to PD patients. The introduction of Y set systems and twin bags has reduced the rate of PD peritonitis in the recent past. Therefore, there is reduction of the rate of infection for the PD patients as compared to HD patients and this compels the ESRD patients to start with PD instead of HD. Patient satisfaction is another factor that compels the ESRD patients to start with PD.

One can receive home based therapy through PD. This eliminates the need for going to the dialysis unit for three times a week. The PD patients commonly visit their physician once in every month. Due to the flexibility of PD, ESRD patients can travel and participate in various different activities (Wasserfallen et al., 2006). Patients on PD give excellent ratings of dialysis as compared to HD patients. This level of satisfaction is also observed across all the demographic factors such as age gender, race, education, marital status, distance from the center, employment factors, and time since the start of dialysis (Lukowsky et al., 2013). It therefore follows that the level of satisfaction for the PD patients is higher that of HD patients. Nevertheless, the advantage of starting with PD is also affected by other demographic factors such as age, gender, and sex.

Initial response of the treatment differs along the demographic factors. According to the study conducted by Sens et al. (2011), the factors taken into consideration were sex, age, and primary renal disease. The results portrayed a substantial advantage of PD as compared to HD for up to 2 years of dialysis after which the results were substantially similar. The difference was not significant for older patients as well as those with diabetes, but there was no subgroup where the use of PD in treatment had a statistically substantial detrimental effect. When the patients were first subjected to PD, the survival rate was better as compared to HD. However, older patients never showed any significant difference.

Comparison of survival outcomes for ESRD patients in PD and HD modalities. Peritoneal dialysis and Hemodialysis are widely recognized renal replacement therapies for end-stage renal disease patients (Liu et al., 2013). Observational studies have attempted to establish the mortality rates of ESRD patients using hemodialysis and peritoneal dialysis. However, it is not yet clear as to which modality prolongs the survival rates of ESRD patients (Yang et al., 2015). Moreover, the survival rates of patients with cardiovascular diseases between peritoneal dialysis and hemodialysis have not yet been established (Liu et al., 2013). Similarly, there exist conflicting results about the mortality rates of ESRD patients in different studies. The conflicting findings arise due to differences in methodology of the studies as well as the period of follow-up (Liu et al., 2013). However, a study conducted by Yang et al. (2015) revealed that survival outcome for ESRD patients for the year of treatment is not significantly different for patients under hemodialysis and peritoneal dialysis. In the long term, patients initiating treatment using peritoneal dialysis had higher mortality rates compared to patients under hemodialysis (Heaf & Wehberg, 2014). Moreover, young patients without cardiovascular diseases and diabetes mellitus perform better while under peritoneal dialysis than in hemodialysis (Yang et al., 2015).

Comparison of HD and PD dialysis survival in the Netherlands. A study was carried out based on data from the Dutch End-Stage Renal Disease Registry (RENINE). The study involved 16,643 patients and was carried out for a period of 15 years. Of interest to the study while computing was gender, age, year of start of dialysis, center of dialysis, and the primary renal disease. The results verified an early survival benefit for PD compared with HD therapy (Liem, Wong, Hunink, Charro, & Winkelmayer, 2010). Nevertheless, the survival benefit diminished with age and the presence of diabetes as a result of renal failure.

Registry data studies on specific patient subgroups

Development of cardiovascular disease through modality of treatment in patients suffering from end-stage kidney disease. Depending on the modality treatment, the development of cardiovascular disease varies. A study that involved 4,191 patients for a period of three years was conducted. Their aim was to look at both the risk of developing CVD and mortality depending on the choice of modality. Germane endpoints for the study included death, chronic Cardiovascular Disease or the development of ischemic heart disease. CVD was determined by conditions such as; myocardial infarction, congestive cardiac failure, and coronary artery disease. The results, when computed for age, established CVD, and gender, failed to indicate any significant disparities in the survival rates of patients undertaking PD and those on HD (Zyga & Kolovos, 2013). Similarly, no significant difference was witnessed in the patient number in either modality group that developed CVD.

To further explore the differences on modality groups, Zyga and Kolovos (2013) utilized prevalence data for 107, 922 new patients for a period of two years to determine whether PD enhanced survival rates among patients suffering from congestive Cardiovascular Disease (CHF) compared to HD. CHF was determined from the patients' medical evidence records and the data was combined with the USRDS transplant and mortality data. The researchers also computed the data different comorbidities such as gender, age, peripheral vascular disease, glomerular filtration rate, body mass index, and cancer. The study established that the comorbidities were minimized when patients switched modalities. On average, follow up on patients was conducted for a period of 12 months. The computed data of the total patient group portrayed a minimized risk of death among PD in comparison to HD for the initial 12 months. The study findings indicated no difference in survival rates between the periods of 12 to 18 months, but indicated a considerably increased risk of death after the 18 months period. When the data analysis for subgroup was performed, a substantially lower survival rate for diabetic and non-diabetic patients with CHF was determined after six (6) months if they started with PD treatment modality compared to when they started with HD therapy. There was a 10% lower mortality risk for non-diabetic patients without CHF if they commenced with PD compared with HD.

Mortality differences by dialysis modality without and with coronary artery disease. Mortality of patients with coronary artery disease (CAD) differs with respect to dialysis modality. Patients with CAD tend to have a higher risk of death. According to a study conducted by Wang et al. (2003) using data from US Medicare and Medicaid services which was merged with data from United States Renal Data System (USRDS), there were some significant differences in the risk of death on patients who were under HD or PD modality. The study revealed that patients with CAD and who commenced with PD had a higher relative risk of death by 23%. The patients with CAD demonstrated a higher risk of mortality when the mode of treatment that they were subjected to first was PD. However, the question of whether those patients without CAD showed any significant difference in mortality with respect to the modality used arises.

Patients without CAD also demonstrated different mortality when subjected to different modalities. The patients demonstrated an initial survival advantage when they commenced on PD for the initial six months and later an advantage in survival when on HD (Wang et al., 2013). It was, therefore, evident that patients with CAD had a higher a risk of death when commenced on PD as compared to when on HD. It was also evident that patients without CAD had a higher survival in long run when under HD.

Mortality differences by dialysis modality with and without diabetes disease. The mortality rates of ESRD patients with diabetes are high due to poor and strict glycemic control of diabetes mellitus. The patients with diabetes are at high risk of dying while undergoing the hemodialysis mode. The chances of survival for people aged 60 years and below with diabetes are poor as compared to the people aged 65 years and above (Park et al., 2015). The number of patients with diabetes is alarming where survival rates of the patients are a major concern due to lack of kidney donors. In turn, the dialysis modality is aiding in reducing the incidences of the death outcomes. The survival rates for diabetic patients with ESRD are much worse than non-diabetic patients. The survival rates of diabetic patients with ESRD are high for patients under peritoneal dialysis than patients on hemodialysis (Cotovio, Rocha, & Rodrigues, 2011). The peritoneal dialysis has been observed to be effective in helping diabetic ESRD patients to lower their levels of ultra-filtration. The diabetic patients under peritoneal dialysis also benefit from the abandonment of creating an arteriovenous fistula that fastens cardiac load thus, accelerating heart failure (Cotovio et al., 2011).

Despite the wide acceptance of peritoneal dialysis in increasing survival rates for diabetic patients, few of the patients adopt the dialysis mode. The choice on the type of dialysis mode on adopting HD or PD for diabetic patients should be made on the basis of medical grounds, clinical complications accrued as well as wishes of the patient. However, high mortality rates are accounted for ESRD patients under hemodialysis mode. The leading cause of mortality rate is accounted by the increase in cardiovascular diseases especially diabetes (Koeda, Ogawa, Ito, Tsutsui & Nitta, 2014). The diabetes causes the emergence of diseases such as atherosclerosis and left ventricle diastolic dysfunction that reduces survival rates of ESRD patients. Therefore, incidences of diabetes in ESRD patients under hemodialysis are high which causes an increase in mortality rates (Koeda et al., 2014).

Summary of the evidence. Some studies have shown that PD mode of treatment is generally as equal to treatment through HD but when sub-groups such as gender, age, and diabetes are considered, a difference in the survival rate of the patients is observed. As previously indicated, (Zyga & Kolovos, 2013; Wang et al., 2013) demonstrated that commencement with PD is better when dealing with younger patients. The survival advantage however disappears after two to five years during which the patient should consider switching to HD. For the older patients with cardiac comorbidities or diabetes, there is low probability of survival when started with PD therapy (Sens et al., 2011). The influence of modality choice in respect to the patient characteristic is should therefore be considered.

Utilization of ESRD Modalities by Patient Characteristics

There are factors that influence the choice of treatment modality with respect to age, sex cause of ESRD and race. Younger patients had a higher chance of functioning transplants that the older counterparts (Allen et al., 2001). The results for this study were as follows; 68.1% of patients under the age of 20 had functioning transplant, 48.8% of the ones in the age bracket of 20-44 had a functioning transplant, 31.6% of those in the 45-64 age group had a functioning transplant and 6.8% of those aged 65 and above had a successful renal transplant. These results indicated a trend in functioning transplant in accordance to the age. Nevertheless, sex is another factor that influences the choice of modality for patients with ESRD.

Sex affects the modality choice for patients with ESRD. Males have shown a higher possibility of having a functioning transplant as compared to females. According to Allen et al. (2011), males demonstrated 30.8% higher chance of having a successful and functioning transplant as compared to 24.8% in females. This is a clear indication that for the patients with ESRD, males had a better chance of having a successful transplant. Another cause of influence that is of interest is the cause of ESRD.

The cause of ESRD also showed some differences in the choice of modality. Allen et al. (2011) confirmed that patients with cystic kidney and glomerulonephritis had a higher chance of having a successful and functional transplant as compared to prevalent patients with diabetes or hypertension. Allen et al. (2011) also pointed that these variations across disease categories in the choice of modality may also be influenced by the age or gender. With patients showing some significant difference across age, sex, and cause of ESRD, it is important to have in mind these effects before choosing the treatment modality. Hallan et al. (2012) evaluated the possible effect modification (interaction) by age of the association of eGFR and albuminuria with clinical risk. The meta-analysis included 2, 051, 244 participants from 33 general population or high-risk (of vascular disease) cohorts and 13 CKD cohorts from Asia, Australasia, Europe, and North/South America, conducted in 1972-2011 with a mean follow-up time of 5.8 years (range, 0-31 years). The conclusion was that both low eGFR and high albuminuria were independently associated with mortality and ESRD regardless of age across a wide range of populations.

Impact of Combining PD and HD Therapy on Peritoneal Function

There are various effects of combining PD and HD on Peritoneal Function. The main advantages of peritoneal dialysis (PD) are continuous correction of acid–base equilibrium and retention of residual renal function (RRF). However, after RRF is lost, increase in the PD dose is limited; this results in possible inducement of uremic state and insufficient solute clearance. For such cases, the addition of hemodialysis (HD) to PD increases the ultrafiltration volume and dialysis dose, thereby optimizing dialysis. Agarwal, Clinard, and Burkart (2003) reported that the combination of HD and PD improved an ultrafiltration failure and insufficient dialysis dose. According to Moriishi et al. (2010), switching to PD 5 to 6 days per week, from PD 7 days per week combined with HD once per week, improves nutrition status, and increases the dialysis dose. Moriishi et al. (2010) reported that a combination of both PD and HD is a simple and reliable method for increasing the dose of dialysis after RRF loss. Nevertheless, the combination procedure should be keenly followed in terms of the number of times that it should be administered per week.

In combination therapy of PD and HD, HD is performed 1 to 2 times per week, which implies there is a period through which no dialysis solution is reserved in the abdominal cavity. On top of that, the ultrafiltration volume is mainly controlled by HD, which in turn reduces the need to use the solution for high-glucose dialysis thus lowering the glucose load. These advantages have been suggested to influence peritoneal function. RRF is a vital prognostic factor in PD patients. However, RRF is lost in duration of several years, the solute clearance becomes inadequate, and extra body fluid mounts up in such patients. Matsuo et al.(2010) showed that an increase in the clearance of low molecular weight solutes failed to improve prognosis. Frequent use of hypertonic solution and increase in the volume of dialysis solution did not improve survival; instead, these techniques enhanced the impairment of peritoneal function and accelerated the occurrence of encapsulating peritoneal sclerosis (EPS).

A study that involved 76 patients for a period of 12 years was carried out to investigate the effect of the combination. A peritoneal equilibrium test (PET) was performed at the beginning of a combination of PD and HD therapy and this test was used to group patients into four, based on the dialysate to plasma ratio of creatinine (D/P Cr). The groups were;

- High (H=5)
- High average (HA=29)
- Low average (LA=26)
- Low (L=16)

The D/P remained high in the H group but declined significantly in the HA group and appeared to decline in the LA and L groups. The eFDP level decreased noticeably after initiation of a combination of PD and HD therapy in H group, although the change was not significant. According to Moriishi et al. (2010), therapy with PD and HD led to retention of peritoneal function in patients who had lost RRF and aided continuation of PD. Nevertheless, peritoneal function failed to improve in patients with already deteriorated function. A therapeutic method change should thus be considered for such patients.

National Dialysis Center

National Dialysis Center is an international health care group that operates more than 3,250 dialysis centers around the world and bases its dialysis treatment on high quality standards (National Dialysis Center, 2015a).Hemodialysis, acute dialysis, peritoneal dialysis, dialysis care, spectra laboratories, liver support therapy, and therapeutical apheresis among other services. Most patients undergo hemodialysis out-patient treatment at one of approximately 28,000 dialysis centers around the world. The organization uses clinical databases to improve integrated quality management which also support nephrologists while taking care of patients. The corporation collects treatment information from dialysis patients in databases, allowing comparisons of treatment quality between dialysis centers.

Summary and Conclusions

The literature review shows that dialysis modes HD and PD have varied outcome that is affected by socio demographic factors such as age, gender and education level and presence of other diseases. One of these outcomes is technique failure which can be indicated by loss of renal function in PD patients necessitating a switch to HD. It is known that outcome is affected by other factors but knowledge in of the role of factors in preserving renal function and technique success and failure is limited. The studies in this aspect used a small sample size of not more than 1300 but this study will fill this gap by using a large sample size drawn from a national population. This chapter has showed what is known and the gap that this study will seek to fill. The following chapter (chapter three) gives an in depth description of how the researcher will conduct the research in order to fill the gap identified. The research methodology and design will be discussed. The population and sample will also be included in the discussion. Moreover, the data collection procedure and data analysis will be presented.

Chapter 3: Research Method

Introduction

The main objective of the study was to examine the optimal timing of the switch from PD to HD in maintaining renal function and the impact of demographic factors (age, gender) and comorbidities (diabetes, CVD). In this study, optimal timing was defined as the period within the first 6 months when switching from PD to HD improves ESRD patient outcomes as demonstrated by an improvement in the patients' RRF, indicated by GFR. The optimal switching time was calculated as an average of the time taken for patients who switched to demonstrate an improvement in RRF as indicated by the GFR. The research methodology chapter highlights the actions that were taken in order to test the study hypotheses and answer the research questions. The chapter highlights the study population, the sampling criteria, and data collection method that were adopted after application of power analysis to address the research questions and the hypotheses. This is followed by the data analysis plan which includes descriptive statistics to give meaningful summaries and inferential statistics to explore the relationships between the variables. I have identified and outlined the threats to validity taking into consideration the threats to internal and external validity. The last section of the chapter outlines the ethical considerations that were observed during the study.

Research Design and Rationale

In line with the study objectives and hypotheses, renal function and optimal dialysis for switching are the dependent variables while PD, HD, switching from PD to HD, social demographic factors (age, gender), and diseases (diabetes and CVD) are independent variables. The diseases are assessed based on their presence or absence in ESRD patients. Creswell (2003) advised researchers to adopt research designs that enable them to collect and analyze data and clearly answer their research questions. In this regard, the best research design is one that most easily facilitates the collection of appropriate data and aligns with the research questions. The other factors that should be taken into consideration when determining the research design to adopt include time and accessibility of resources (Creswell, 2003; Johnson & Christensen, 2008).

A quantitative research design is the collection and manipulation of numerical data with an aim of meaningfully describing the phenomenon that the data represented (Creswell, 2003). A quantitative research design is appropriate when the researcher intends to extract summaries from the data (Johnson & Christensen, 2008). I chose a quantitative design in order to support the research hypotheses and the preconceived relationship between the variables in the study. This aligns with a study by Johnson and Christensen (2008) who observed that if a researcher intends to statistically test hypotheses that explore relationship between two or more variables, a quantitative design is most appropriate. The three dialysis modes, social factors, and other diseases exhibit relationships which were best explored by a quantitative design. Specifically, I adopted a cohort study design which allowed for evaluation of the ESRD patient clinical indices based on the data from the records of National Dialysis Center. National Dialysis Center was selected since it is known worldwide for providing dialysis services for persons with chronic kidney failure (National Dialysis Center, 2015a). The National Dialysis Center database holds large amount of kidney dialysis records with over 290, 250 patients receiving 43 million treatments to date.

Methodology

Population

A study population refers to the total number of the study subjects (Lu & Gatua, 2014). The population in this study consisted of over 128, 000 ESRD patients across the U.S. who received treatment from National Dialysis Center. This included patients from all ethnicities, ages, and gender from 2005 to 2015. Only ESRD patients with CVD and diabetes were part of the target population.

Sampling and sampling procedures

Sampling technique. It is not possible for researchers to study entire populations due to time and resource constraints. This leads to selection of samples from the population. Researchers use two key sampling techniques probability and nonprobability sampling (Onwuegbuzie, Slate, Leech, & Collins, 2009). Probability sampling creates a likelihood of every subject in the population being selected to be part of the study sample (Grafstrom & Lundstrom, 2013). This study adopted probability sampling; the study captured data of patients who have undergone three dialyses modes with other factors like diabetes and cardiovascular diseases.

When a researcher is interested in studying the characteristics of subpopulations, the stratified random sampling should be used as a sampling technique to ensure all the subpopulations are captured in the final dataset (Khan, Ali, Raghav, & Bari, 2012). Stratified random sampling is applicable when clusters of population members exhibit variation but have very similar traits within the clusters (Khan et al., 2012). Patients within the three dialysis modes are bound to exhibit unique characteristics of the dialysis mode. Stratified random sampling involves dividing the population into different homogenous strata then randomly selecting the desired sample size (Diaz-García & Ramos-Quiroga, 2014). In applying stratified random sampling in this study, the population was divided into homogenous strata of the three dialysis modes (PD, HD, and PD to HD) and then the required sample size was randomly drawn from each stratum.

Sampling frame. How well a population is represented by a sample depends on the sample size, selection procedures, and the sample frame (Diaz-García & Ramos-Quiroga, 2014). A sample frame is the proportion of the population who has the probability of being included in the sample by possessing the desired attributes (Diaz-García & Ramos-Quiroga, 2014). The sampling frame must include traits that are in the population (Diaz-García & Ramos-Quiroga, 2014). In line with the research objectives, my study sampled included ESRD patients who began treatment in the USA. Only patients who had undergone dialysis with the treatment methods of HD, PD, and a switch from HD to PD were included. In line with the objective of testing the effect of presence of other diseases, the study sample included patients with CVD and those with diabetes. In addition, in order to meet the selection criteria the dialysis patients had to be 20 years of age or older. The selection criteria were developed to help identify as precise sample size and minimize possible sampling error. Table 1 demonstrates the sampling frame.

Table 1

Sampling frame

PD	HD	PD and HD
List of patients aged 20 years and above	List of patients aged 20 years and above	List of patients aged 20 years and above
List of patients who have undergone dialysis	List of patients who have undergone dialysis	List of patients who have undergone dialysis
List of ESRD patients	List of ESRD patients	List of ESRD patients
List of patients who began treatment in USA	List of patients who began treatment in USA	List of patients who began treatment in USA
List of patients with cardiovascular and diabetes disease	List of patients with cardiovascular and diabetes disease	List of patients with cardiovascular and diabetes disease

Sample size. The sample size adopted for any study should enable the researcher to collect sufficient data that can answer the research questions (Lu & Gatua, 2014). The alpha level, effect size, and power of the test affect the sample size (Park, 2008). Additionally, the adopted sample size is influenced by constraints in time and resources. The power level is the probability of rejecting the null hypothesis when the alternative hypothesis is true (Park, 2008). A higher power level increases the probability of making the correct conclusion and as such in this study (Park, 2008); the power level was 0.9 in hypothesis testing for my study. A large power of the test indicates a higher probability of rejecting the null hypothesis (Park, 2008). In quantitative design it is essential to outline the hypothesis testing procedure which includes rejection-acceptance standards by setting the alpha level (Figueiredo Filho et al., 2013). This is achieved by setting the alpha level. A smaller alpha level increases the chances of detecting any significance, but a very small alpha level will be stringent and require a large sample size to detect an effect (Figueiredo Filho et al., 2013). Effect size is a measure of the magnitude of a treatment effect which is established by quantifying the sizes of differences or the sizes of associations (Figueiredo Filho et al., 2013). The study utilized an alpha level of 0.05. Hagen, Lafranca, IJzermans, and Frank (2014) used an effect size of 0.04 for cohort and experimental studies while Ferguson (2009) recommended a small effect size for studies seeking to evaluate the effectiveness of an intervention. I chose an effect size of 0.038 for my study. Cunningham and McCrum-Gardner (2007) indicated that there is no set criterion for choosing the effect size and thus, it is influenced by researcher's decision. In power analysis, the sample size is determined as a function of the three variables: the power, alpha level, and the effect size (Gelman & Carlin, 2014). G*Power was used to obtain the minimum sample to be used (McCrum-Gardner, 2014). With an alpha level of 0.05, power of 0.9, and effect size of 0.038, the total sample size of my study was30,000, which were distributed in the three dialysis modes. I used a database with 128,000 patients. The number of cases with renal failure was achieved through employing keyword *renal failure* within the search engine of medical databases following the sampling frame criterion and within the specified time frame since the National Dialysis Center has treated over 290,250 patients with kidney failure. The National Dialysis

Center is a worldwide center for addressing chronic kidney diseases such as kidney failure or renal failure (National Dialysis Center, 2015). I sought to use at least 30,000 records but opted to use as many patient records as retrieved. This increased validity of the findings.

Procedure for Data Collection

Data collection entails assembling the data that are used to answer the research questions. There are two types of data: primary and secondary (Cresswell, 2009). Primary data is first-hand information that is sourced from the study subjects while secondary data is sourced from printed materials (Cresswell, 2009). This study was based on secondary data that was sourced from the records of National Dialysis Center. Permission was obtained from the management of National Dialysis Center in order to allow the researcher access the patients' records. The permission was requested through the use of permission letter. A memorandum of understanding and data use agreement was obtained from the authorities from the medical center regarding the intended outcomes, study subjects, and the aim for which data was and was not be used. The Institution Review Board in my university assessed the validity of the memorandum of understanding and data use agreement documents.

Data cleaning and screening. Data cleaning entails checking for inconsistencies, errors, omissions, and the presence of outliers while taking the necessary steps to standardize the data (Maccio, Chiang, & Down, 2014). Testing for normality followed data cleaning (Mickey, Dunn, & Clark, 2004). Data cleaning also involved validation checks in order to ensure that ethical considerations for data privacy were maintained during the data analysis.

Data cleaning starts by outlining the possible inaccuracies, the methods to determine the errors, and how to correct the errors (Taneja, Ashri, Gupta, & Sharma, 2014). In this study, I paid attention to different types of errors such as improperly spelled names of variables, null characters, outliers, inaccurate figures, and missing variables. Determining the erroneous values involved verifying the transposition of key values and checking for typographical mistakes and incorrectly entered data. The fields with more than one variable were also corrected accordingly. Verification of inconsistencies in the data were rectified by using descriptive statistics by determining the minimum, maximum, sum, and frequencies for the variables. I also utilized measures of central tendency such as standard deviation, mean, range, and mode. In the case of continuous variables, like age, scatter plots were used to check of outliers.

Data Analysis Plan

This section highlights in detail how the data was analyzed to obtain answers to the research questions. The section begins by outlining the research questions and hypotheses to be used in analysis. Statistical tests that were performed to analyze the data in line with the study questions and hypotheses are clearly outlined. Statistical Package for Social Scientists (SPSS) version 21 was used to analyze the data. The procedure for data collection and the procedure for data screening and cleaning which give credibility to the results are also listed in the section.

Research questions. This study focused on examining whether the timing of the switch from PD to HD impacts renal functions and survival times, including if demographic factors such as age and gender and co-morbidities such as diabetes and cardiovascular disease also impact both renal function and survival times for ESRD patients. The renal function was assessed using the GFR and RRF, whereas data for survival times was collected from the National Dialysis Center.

This study was guided by the following research questions:

RQ1: Is the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic and comorbidity patient factors?

RQ2: Do comorbidities modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic patient factors?

RQ3: Do demographic patient factors modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for comorbidity patient factors?

Research Hypotheses

Hypotheses

$H_0$1: The timing of the switch from PD to HD does not impact renal function and survival times when controlling for demographic and patient factors.

H_a1: The timing of the switch from PD to HD impacts renal function and survival times.

$H_0$2: Comorbidities do not impact the dialysis time of switching from PD to HD when controlling for demographic patient factors.

H_a2: Comorbidities impact the dialysis time of switching from PD to HD when controlling for demographic patient factors

$H_0$3: Demographic factors do not impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors.

H_a3: Demographic factors impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors?

Statistical Tests

Descriptive statistics. Descriptive statistics is the meaningful description of data by use of a few indices (Shang, 2015). If the indices are of the entire population then they are called parameters whereas if they are of a sample they are called statistics. In this line, the researcher used statistics. Measures of central tendency and the measures of variability are the descriptive statistics the researcher utilized. The researcher summarized the data by use of measures of central tendency such as mean, mode, maximum, minimum and range (Shang, 2015). Measures of variability such as variance showed how the data was spread. Further, the researcher graphed the data.

Chi square test of independence. The study hypotheses are aimed at detecting the existence of relationship between the variables. Chi-square test is used to determine the association between two categorical variables (Agnese et al., 2012). Chi-square tests the hypothesis of no association between two or more factors or criterion. The decision criterion of establishing existence of a relationship was comparing the P value corresponding to the chi-square statistic and the level of significance for the study. If the P value is less than the level of significance the null hypothesis of association is rejected and alternate hypothesis accepted but if the P value is less than the level of significance, the null hypothesis fails to be rejected (Bacciu, Etchells, Lisboa, & Whittaker, 2013).

The Chi-square test was used to answer research questions two and three. In this study, the researcher explored the relationship between social factors (age and gender) and co-morbidities (diabetes and CVD) with the optimal dialysis time for switching from PD to HD for ESRD patients. The researcher expects to find that social demographic factors and medical conditions are associated with the optimal dialysis time for switching from PD to HD for ESRD Patients.

Kaplan-Meier Survival Curves and the Log-Rank Test. The Kaplan-Meier Survival Curves is used to analyze time taken before the occurrence of an event and the number of research objects or participants who are involved in the event (Jelkic, Opacak, Horvat, & Safner, 2013). In medical research, the Kaplan–Meier Survival Curves are used to measure the fraction of patients living for a certain amount of time after treatment (Foerster et al., 2014). The Kaplan–Meier estimator was used to evaluate the number of patients who survived after switching from PD to HD compared to those with and without diabetes and cardiovascular diseases and those in different age brackets as well as gender.

The different groups of patients produced varied Kaplan–Meier estimators. It is informative to compare the estimators to establish any variations or similarities across the groups after switching from PD to HD. This was achieved by using the Log-Rank Test which is used to compare the survival distributions of two or more groups (Wu, 2014). As such, the survival rate across patients with and without diabetes and those with and without CVD were compared to establish the modifying effect of the variables on a patient's survival.

Cochran Mantel Haenszel. The study hypotheses seek to establish the existence of relationships between dialysis modes and improved renal function and the effect of social factors and existence of other diseases on technique failure. The relationship might depend on another factor. It was the interest to me to establish the nature of the relationship upon including a third factor. For instance, I explored if the effect of diabetes and cardio vascular diseases on improved RRF was similar across gender or age. Hagen, et al. (2014) and Kathleen et al. (2006) used Cochran Mantel Haenszel to explore relationships in their dialysis studies. The Cochran Mantel Haenszel is the test of conditional dependence with a null hypothesis that two variables are independent over a third factor (Yu & Gastwirth, 2008). If the *P* value corresponding to the chi-square statistic of Cochran Mantel Haenszel is less than the α-level of significance, then the null hypothesis is rejected but if the *P* value of the chi-square statistic of Cochran Mantel Haenszel is greater than the α-level of significance then the null hypothesis is accepted (Yu & Gastwirth, 2008).

As a result, the Cochran Mantel Haenszel was used to test the hypotheses 3 and 4 in this study. I explored the nature of association between cardiovascular diseases and diabetes, and improved renal function and survival rate across gender and age as well as the optimal dialysis time for switching from PD to HD for ESRD patients. The analysis helped to establish if the relationship is uniform for the male and female gender and its nature across different age groups. I expected to find that the relationship varies across gender and age.

Cox-proportional hazards regressions. To explore the effect of co-morbidities on patient's survival and wellbeing after undergoing switch from PD to HD, Cox-proportional hazards regressions were used. A Cox model is a statistical technique for analyzing the association between the survival of a patient and a number of explanatory variables (Jackson et al., 2014). The regression approach evaluates the time one began a medical procedure and a following event such as measure of GFR and death. The model also offers an approximation of the treatment effect on survival after adjusting for other explanatory variables (Borucka, 2014). The explanatory variables to be adjusted for were co-morbidities and demographic factors.

The final model from a Cox regression analysis yields an equation for the hazard as a model of the explanatory variables. In the model, a positive regression coefficient for an explanatory variable implies that the hazard is higher, and thus, the diagnosis worse (Zhao et al., 2014). On the contrary, a negative regression coefficient shows that there is a better diagnosis for patients with higher tenets of that variable.

Threats to Validity

Validity refers to the truthfulness of research findings. Researchers are urged to ensure internal and external validity (Creswell, 2009). Threats to internal validity influence the ability to establish causal relationships between the study variables (Morgan & Gliner, 2009). One of the possible threats to internal validity in this study is maturation

(Krauth, 2011). However, the study groups have the same maturity rate. The accuracy in measuring the dependent variable may also influence internal validity by introducing skewness towards the mean (Hyett, Kenny, & Dickson-Swift, 2014). I mitigated this threat by cross-checking and ensuring that the dependent variables are measured accordingly. The next key threat to internal validity that may influence the study is selection which is caused by the adopted sampling technique (Krauth, 2011). Stratified random sampling was used to overcome the threat of selection. In this regard, all the subjects had an equal chance of being in the comparison groups. Experimental mortality also influences the internal validity (Morgan & Gliner, 2009). Experimental mortality occurs where some participants discontinue participating in the study (Krauth, 2011). This study was not affected by this threat because the researcher used archival data which was already recorded prior to the study.

Validity refers to the extent to which the research findings are generalizable to other contexts (Morgan & Gliner, 2009). Threats to external validity include population and ecological validity (Krauth, 2011). I adoptedstratified random sampling was adopted to mitigate the threat of population validity. This ensured that the sample was representative of the study population. Additionally, the sample was drawn from participants of different age groups. Ecological validity is also an aspect of the external validity and refers to the generalizability of research findings to other settings (Hyett et al., 2014). The threat of ecological validity could affect this study since studies in other settings, i.e. countries, have established different findings.

Ethical procedures. There are different ethical principles that should be followed in research studies particularly studies that engage human subjects. The ethical principles are applied in different stages of the research process. These principles include the participants' right to privacy and right to informed consent. In this regard, I obtained permission from relevant authorities to conduct the study (Howard et al., 2010). The anonymity of the original participants was upheld by the researcher. The data was de-identified to protect the patients' privacy and confidentiality against revealing demographic information. I also adopted and upheld the non-plagiarism policy by ensuring that any content drawn from other studies is well acknowledged through proper in-text citations and proper references. I maintained objectivity in reporting the findings of the study without biasness.

Summary

The purpose of the study is to examine the efficacy of PD alone, HD alone, switching from PD to HD as well as establish whether social factors (age and gender) and medical conditions (diabetes and CVD) pay a role in ESRD technique failure. Information for this study was gathered from morbidity and mortality wave which can be measured quantitatively from ESRD patient's records in health institutions. The covariates in the study were social, physical, and biological factors. These included geographical locations, gender, age, medical conditions, marital status, and race.

Secondary data was used in this study. Data was collected from National Dialysis Center where permission was requested from the relevant authorities in charge of the records via the use of a permission letter and memorandum of understanding and data use agreement. The study target population was ESRD patients in the National Dialysis Center where stratified random sampling was used to select a total sample of 30,000. Only patients who had undergone dialysis as mode of ESRD treatment and began treatment in the US was included. Further patients with cardiovascular diseases and diabetes were part of the sample frame. R software was used in data analysis.

The data was screened and cleaned where omissions, incorrect entries, outliers, and spelling errors were checked. In data analysis, descriptive statistics were used to summarize the data and chi-square test of independence was used to test associations. Relative risk was used to examine probability of occurrences across different groups while Cochran Mantel Haenszel was used to test the relationship between two variables upon inclusion of their factor. There are various factors that affected the internal and external validity. In this study, the internal validity was threatened by maturation, measurement of dependent variable, selection of the subjects, and experimental mortality. However, there were various measures that were taken into consideration to reduce the threats such as the use of stratified random sampling. The external validity was threatened by some of the factors such as population sample and ecological validity. Nevertheless, population sample was addressed by ensuring that the sample was representative enough of the whole population. I considered and upheld certain ethical procedures. Participants' confidentiality was observed during the study. Material and content that was borrowed from the works of other researchers was paraphrased, cited, and referenced appropriately.

Chapter 4: Results

Introduction

The purpose of this quantitative retrospective study was to examine whether the timing of the switch from PD to HD is more effective in maintaining renal function than PD or HD alone, including whether demographic factors (age, gender) and comorbidities (diabetes, CVD) significantly improve renal function and survival times for ESRD patients. In the study, I explored the independent and multivariate socio-demographic (age and gender) and comorbidities determinants that are associated with improved renal function with switching from PD to HD for ESRD patients on dialysis. The socio-demographic examined were age and gender while comorbidities were medical conditions (diabetes and CVD). The Chi-square test of independence was used to show the relationship between cardiovascular disease, diabetes, and demographic factors and optimal dialysis time for switching from PD to HD. The Mantel Haenszel test was used to estimate whether demographic factors or comorbidity factors are independent over ESRD patients' survival times while cox-proportional hazard regressions were used to analyze the association between the survival of a patient and a number of explanatory variables (age, gender, cardiovascular, and diabetes).

The study was guided by the following research questions and hypotheses.

RQ1: Is the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic and comorbidity patient factors?

RQ2: Do comorbidities modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for demographic patient factors?

RQ3: Do demographic patient factors modify the dialysis time for switching from PD to HD for ESRD Patients associated with improved renal function and survival times, when controlling for comorbidity patient factors?

Research Hypotheses

Hypotheses

$H_0$1: The timing of the switch from PD to HD does not impact renal function and survival times when controlling for demographic and patient factors.

H_a1: The timing of the switch from PD to HD impacts renal function and survival times.

$H_0$2: Comorbidities do not impact the dialysis time of switching from PD to HD when controlling for demographic patient factors.

H_a2: Comorbidities impact the dialysis time of switching from PD to HD when controlling for demographic patient factors

$H_0$3: Demographic factors do not impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors.

H_a3: Demographic factors impact the dialysis time of switching from PD to HD when controlling for comorbidity patient factors?

Data Collection

The data was obtained from a database of more than 128,000 ESRD dialysis patients from National Dialysis Center. Out of these patients, a sample of 30,000 patients randomly distributed over three dialysis modes (PD, HD, PD to HD) was used. The PD represents the sample of patients who initiated dialysis and completed the study period under PD mode. The HD represented the sample of patients initiating dialysis and completed the study while on HD mode. PD to HD represented the number of patients who enrolled in the study by initiating dialysis using PD and switched to HD mode after undergoing treatment for a mean duration of 46 months through the PD dialysis. The sample size of 30,000 patients was obtained by use of stratified random sampling. The sampling frame for the study included patients who begun treatment and dialysis in the USA, list of patients aged 20 years and above, patients with ESRD, and patients with cardiovascular and diabetes diseases. The sampling frame contributed to obtaining a sample of 30,000 patients out of 128,000 files from the National Dialysis Center Database. The software used for the data analysis was R, which is statistical software for analyzing complex data (Kelley, Lai, & Wu, 2008). The main objective was to examine optimal switching times for PD to HD patients that will best preserve residual renal function. Also, the impact of demographic factors and comorbidities on ESRD patients was examined.

Study Results

Descriptive Statistics

This section represents the demographics of the study population. In order to determine the optimal switching times for PD-HD patients and compare their performance with PD only and HD only patients, it was important to determine the social demographic factors and comorbidities across the dialysis mode. Table 2 presents the demographic and social factors across the dialysis modes.

Table 2

Number of Patients' across demographic and social factors by dialysis modes.

	Dialysis mode			
	HD	PD	HD-PD	Total
Race				
White	7128 (23.76%)	7029 (23.43%)	7103 (23.68%)	21260 (70.87%)
African-American	2003 (6.68%)	2139 (7.13%)	20147 (6.82%)	24289 (20.63%)
Hispanic	651 (2.17%)	654 (2.18%)	642 (2.14%)	1947 (6.49%)
Other	218 (0.72%)	178 (0.59%)	208 (0.69%)	604 (2.01%)
Education level				
High School	1039 (3.46%)	984 (3.28%)	1019 (3.40%)	2132 (10.14%)
Diploma	1252 (4.17%)	1299 (4.33%)	1186 (3.95%)	3737 (12.45%)
Degree	7443 (24.81%)	7511 (25.04%)	7572 (25.24%)	22526 (75.09%)
Masters	180 (0.60%)	124 (0.41%)	152 (0.50%)	456 (1.52%)
Doctorate	86 (0.29%)	82 (0.27%)	71 (0.24%)	239 (0.8%)
Technical failure				
Peritonitis	825 (2.75%)	8792 (29.31%)	4703 (15.68%)	14320 (47.73%)
Acute Myocardial Infarction	405 (1.35%)	421 (1.40%)	374 (1.25%)	1200

				(4.0%)
Cerebrovascular disease	180 (0.60%)	213 (0.71%)	207 (0.69%)	600 (2.0%)
Withdrawal from dialysis	8590 (28.63%)	574 (1.91%)	4716 (15.72%)	13880 (46.27%)
Gender				
Males	4242 (14.14%)	4239 (14.3%)	4249 (14.16%)	12730 (42.60%)
Females	5758 (19.19%)	5711 (19.04%)	5751 (19.17%)	17220 (57.40%)
Diabetes type				
Diabetes with renal manifestations	9788 (32.63%)	9808 (32.69%)	1804 (6.01%)	21400 (71.33%)
Diabetes Mellitus with chronic kidney disease	107 (0.36%)	93 (0.31%)	100 (0.33%)	300 (1.0%)
No diabetes	105 (0.35%)	99 (0.33%)	8096 (26.98%)	8300 (27.67%)
Cardiovascular disease type				
Hypertensive Chronic kidney Disease	9620 (32.07%)	9580 (31.93%)	9600 (32.00%)	28800 (96.0%)
No Hypertensive Chronic Disease	380 (1.27%)	420 (1.40%)	400 (1.33%)	1200 (4.0%)
State				
Alive	9170 (30.57%)	9138 (30.46%)	9167 (30.56%)	27475 (91.58%)
Dead	830 (2.77%)	862 (2.87%)	833 (2.78%)	2525 (8.42%)

The total number of patients in the stratified sample was 30,000. The stratified sample has equal number of patients for each stratum. The strata included the three dialysis modes, PD, HD and the PD-HD. There were 10,000 patients in each of the dialysis modes. The highest percentage of patients in the sample was Caucasian/Non-Hispanic (70.87%). It was followed by African-American (20.63%), Hispanic (6.49%), and other races (2.10%). The percentages for the races varied greatly from each other but all the races were evenly distributed across the dialysis modes as illustrated in Table 2. Most of the patients were university graduates (75%) while the least number of patients were those with a doctorate degree (0.8%) as shown on Table 2. The patients were also evenly distributed across the dialysis modes by education level. An analysis was also done of the patient's technique failures across all the three dialysis modes. The results showed that the main causes of technique failures were PD which contributed to 48% of failures and withdrawal from dialysis with 46 %. The acute myocardial infarction and cerebrovascular disease had little effect on patients' failure with 4% and 2% respectively. The sample had more female patients with a percentage of 57% compared to their male counterparts with a percentage of 43%. Both males and female patients were equally distributed across the dialysis modes as shown in Table 2 with the males and females in each dialysis mode constituting around 14% and 19% respectively in each mode. Examining the comorbidities of patients in each dialysis mode revealed that 71% of the patients had diabetes with renal manifestation, 1% of the patients had diabetes with chronic kidney disease, and 27% had no diabetes. Most of the patients with diabetes with renal manifestation initiated and completed dialysis using PD alone or HD alone mode.

Most of the patients without diabetes initiated dialysis using PD and then switched to HD later. On the basis of cardiovascular diseases, 96% of the patients had hypertensive chronic kidney disease. The patients were evenly distributed across the dialysis modes with regard to cardiovascular diseases. Out of the 30,000 patients in the sample, only 8.42% of them died during the study. Among those who died, 2.77% were HD patients, 2.87% were PD patients, and 2.78% were HD-PD patients. More than 90% of the patients in the sample are still alive. Both groups of patients were evenly distributed across the dialysis modes as shown on Table 3.

Table 3

Patients' age statistics across dialysis modes

Dialysis	Statistic					
Mode	Mean	Median	Min	Max	Range	Sd
PD	62.2	63	42	83	41	11.25
HD	62.13	63	42	83	41	11.34
PD-HD	62.72	64	21	91	70	11.91

The patients had a mean age of 62 years for each dialysis mode. PD-HD patients had a wider range in terms of their ages, 70 years, in contrast to that of PD patients and HD patients who both had a range of 41 years. The variation of the ages is similar, from 11.25 to 11.91, across the dialysis modes. The youngest ESRD patient in the sample was 21 years old and the oldest patient was 91 years old. The distribution of ages for the different dialysis modes is presented in Table 4.

Table 4

Patients' dialysis duration (months), GFR score and RRF score statistics.

	Duration		GFR		RRF	
	PD	HD	PD	HD	PD	HD
PD only and HD only patients' statistics						
Mean	17.62	15.66	26.33	29.46	7.99	8
Median	13.0	13.0	24	29	8	8
Min	0	0	2	4	4	4
Max	104.0	116.0	55	55	12	12
Range	104.0	116	53	51	8	8
Sd	16.81	13.13	15.21	15.04	2.58	2.57
PD-HD patients' statistics						
Mean	46.12	17.81	31.1	24.88	7.56	6.37
Median	37	12	32	25.6	7.21	6.06
Min	0	0	1.6	1.28	3.01	2.53
Max	121	113	83.23	66.58	14.73	12.52
Range	121	113	81.63	65.30	11.72	9.99
Sd	31.36	16.42	14.68	11.74	2.85	2.40

Note. GFR is glomerular filtration rate score and RRF is residual renal function score.

On average, PD-only patients in the sample spent more time in dialysis, about 17 months on average, than HD-only patients who spent an average of 15 months in dialysis. PD-only patients had more varying analysis durations than HD only patients. The means and standard deviations of GFR and RRF scores are similar for the two groups with 8 and 2.6 respectively as shown in Table 4. The results also showed that PD-HD patients on average spend more time in the PD mode than HD mode. The dialysis durations for PD-HD patients vary more than the dialysis durations for both PD alone and HD alone patients. The GFR and RRF score for PD-HD patients vary more at the PD stage than at the HD stage.

The ages of the patients were further categorized into four groups: below 40 years old, 40 to 60 years old, 61 to 80 years' old, and more than 80 years old. The patients were evenly distributed across gender by age as shown on Figure 2. Majority of the patients in each gender are aged between 40 years and 80 years. Most of the ESRD patients in each gender are aged between 61 years and 80 years. Only 0.2% of the patients were below 40 years.

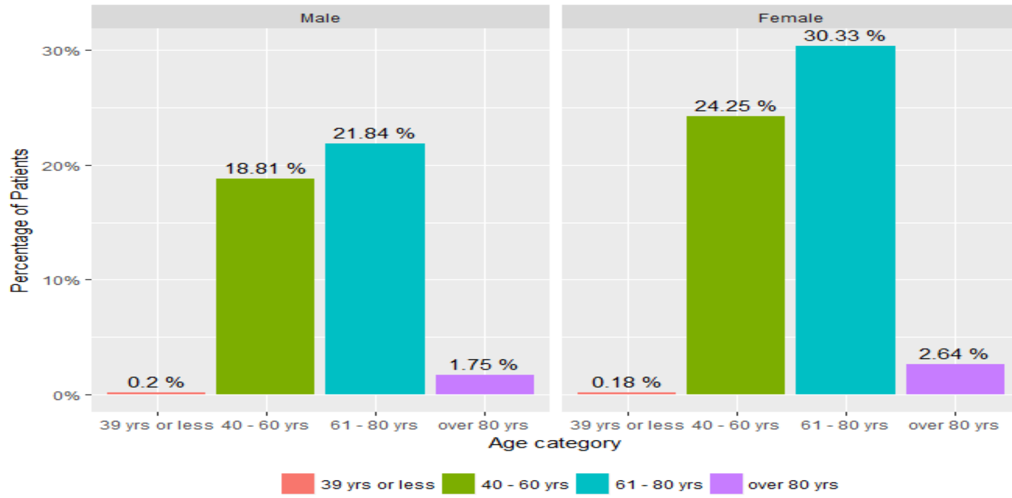

*Figure 2***.** Patients' age distribution across gender.

Figure 3 shows the relationships in the patient's comorbidities. The analysis revealed 67.74% of the patients in the sample had both diabetes with renal manifestations and hypertensive chronic kidney disease and 27.47% of the patients were non-diabetic but had hypertensive chronic kidney disease. Only 0.2% of the patients in were non-diabetic with no CVD.

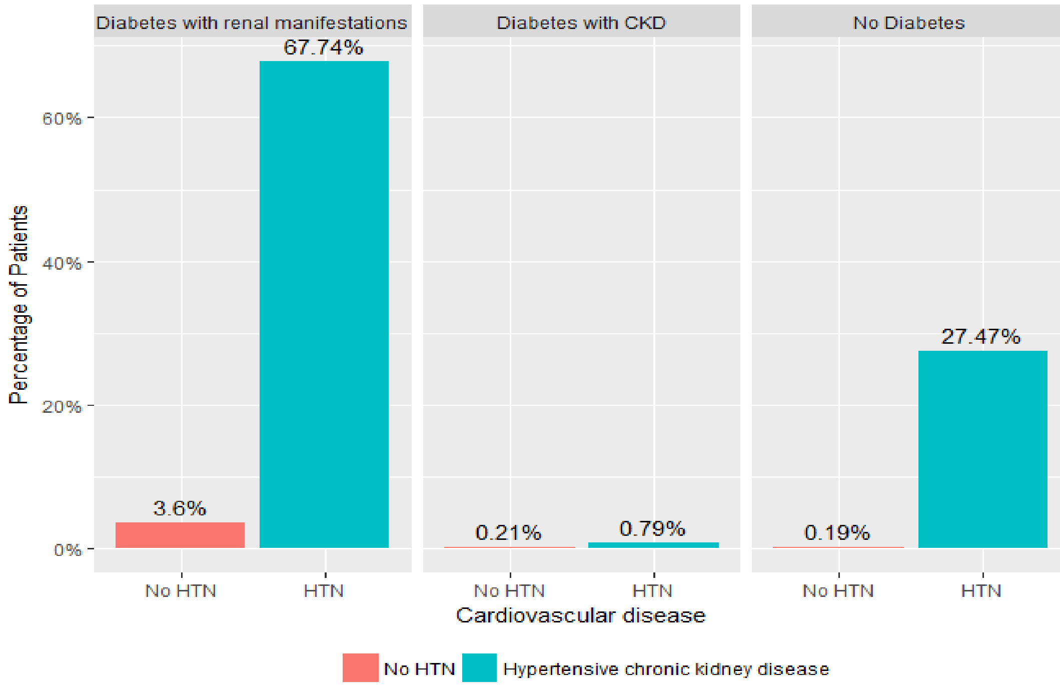

Figure 3. Patients' diabetes type across cardiovascular diseases.

The number of females who died in each age category is slightly higher than the number of males who died in each age category as shown in figure 4. This can be attributed to the fact that there were more females than males in the sample The number of female patients aged between 40 years and 60 years who died represent 2.28% of the whole sample and are slightly higher than those aged between 61 years and 80 years who died representing 2.16% of the whole sample. On the other hand, the difference in the number of male patients in these two categories who died is very small at 1.89% and 1.87% respectively.

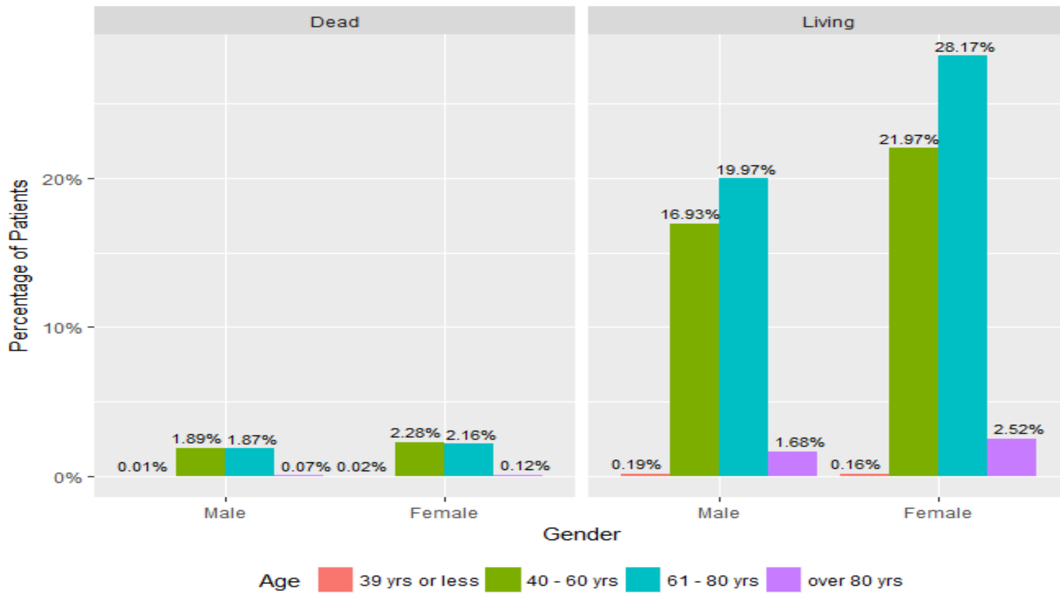

Figure 4. Patient's state across demographic factors (gender and age).

On the basis of co-morbidities, analysis showed that the largest percentage of patients who survived are those with both hypertensive chronic kidney disease and diabetes with renal manifestation followed by those who were non-diabetic but had hypertensive chronic kidney disease at 67% and 25% of the whole sample respectively. The percentages of patients who survived or died across diabetes type and cardiovascular disease are as presented in figure 5.

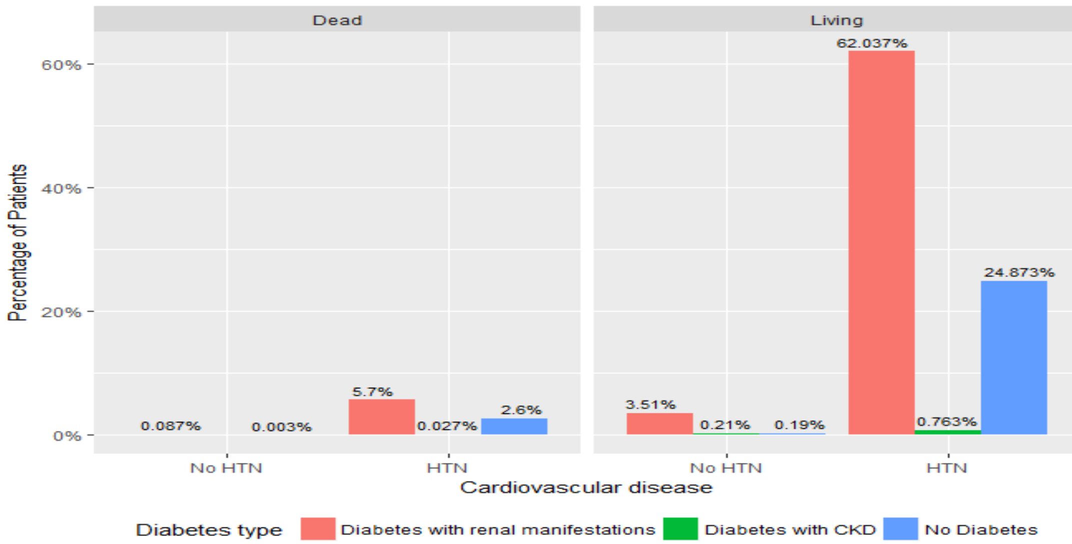

Figure 5. Patient's state across co-morbidities (cardiovascular disease and diabetes).

The distribution of technique failures is similar across patients' state as shown on figure 6. Technical failures resulting from peritonitis constitute the highest percentage of the patients who died representing 4.28% followed by technical failures resulting from withdrawal from dialysis at 3.96%. Technique failures resulting from cerebrovascular disease constitute the least percentage of the whole sample with 0.06%, among the patients who died and 1.94% among the patients who survived. The percentage of technical failures resulting from acute myocardial infarction is more than twice that of those resulting from cerebrovascular disease among the patients who survived. In comparison, the percentage of technical failures resulting from acute myocardial infarction among the patients who died is twice the percentage of technical failures resulting from cerebrovascular disease.

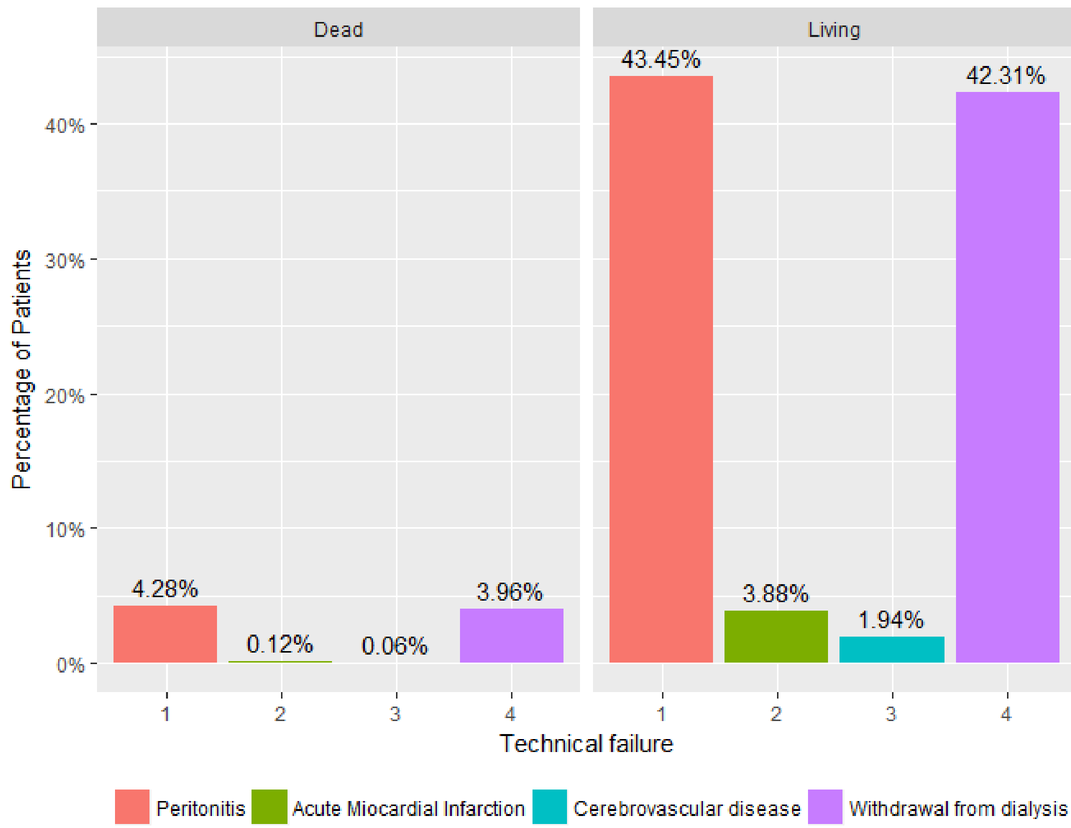

Figure 6. Patients' technical failures across state.

Research Question One

In this section, the effect of timing of the switch from PD to HD in maintaining renal function for PD-HD patients and the effect of demographic factors (age, gender) and co-morbidities (diabetes, CVD) on the residual renal function and survival times for ESRD patients are examined. The effect of switching dialysis mode from PD to HD by comparing the FGR scores of patients for different switching times was determined. First the average loss of renal function for each category of patients was visualized on a boxplot then the Kaplan Meier survival curves are used to visualize the survival of the different categories of patients. The Kaplan Meier survival curves are used to analyze time taken before the occurrence of the death of a patient in the sample and the number of patients surviving at each time interval. To determine whether this difference in the survival rates is significant, the log rank tests were used. Cox-proportional hazard regressions were used to investigate the association between the survival rate of a patient and both demographic (age and gender) and co-morbidity (CVD and diabetes) factors.

Figure 7 demonstrates the time taken by ESRD patients to switch dialysis modalities from PD to HD. Results demonstrates that the optimal time for switching dialysis modalities was 9 months with majority (8.7%) switching at this time.

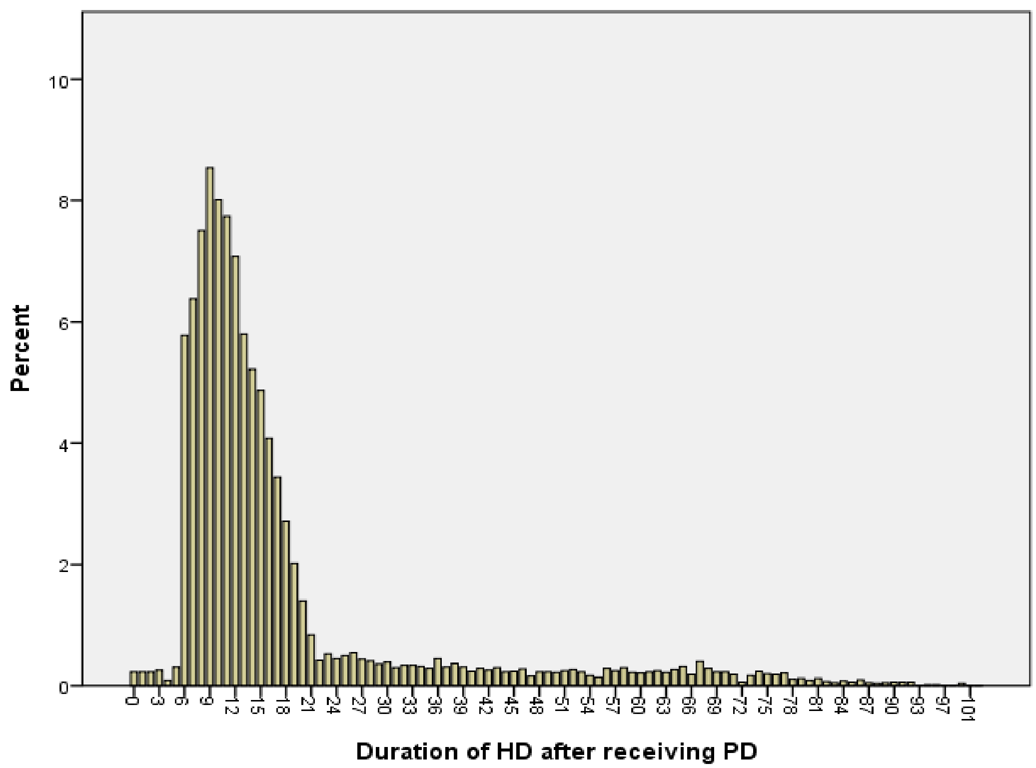

Figure 7. Optimal dialysis for switching dialysis modes from PD to HD

The RRF and GFR scores for PD-HD patients in the sample was measured two times, 16 days before switching from PD to HD and 60 days after switching. The average

GFR and RRF scores are lower after switching from PD to HD compared to prior to switching**.**

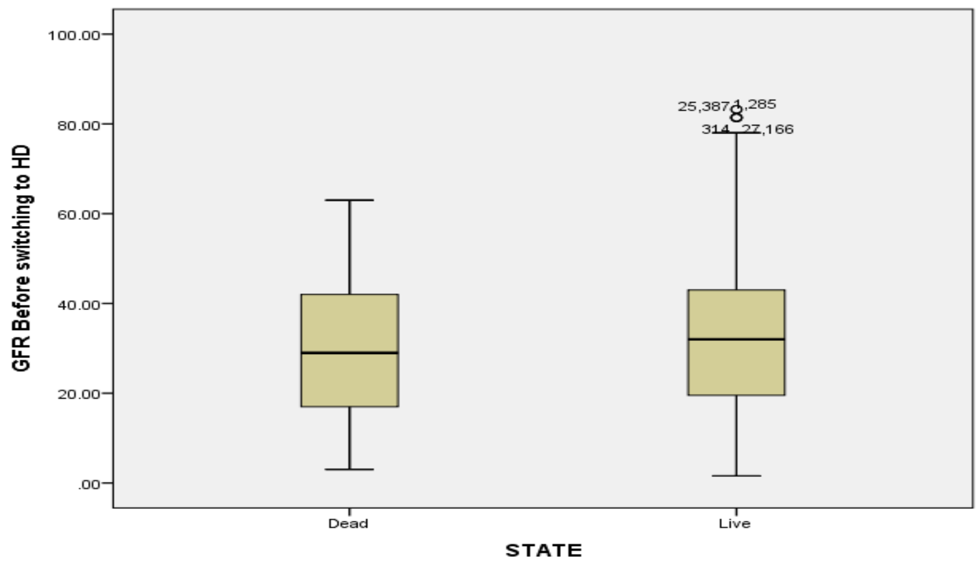

Figure 8. GFR score of PD-HD patients before switching to HD, across state.

From figure 8, it is evident that PD-HD patients who died had a less varied distribution of GFR score than those who survived as shown by the shorter interquartile ranges. A t test on the two means, under the assumption of equal variances, showed that there was a significant difference in mean GFR across the two groups of patients. The t statistic was -3.473 with a p value of 0.001 at 9998 degrees of freedom.

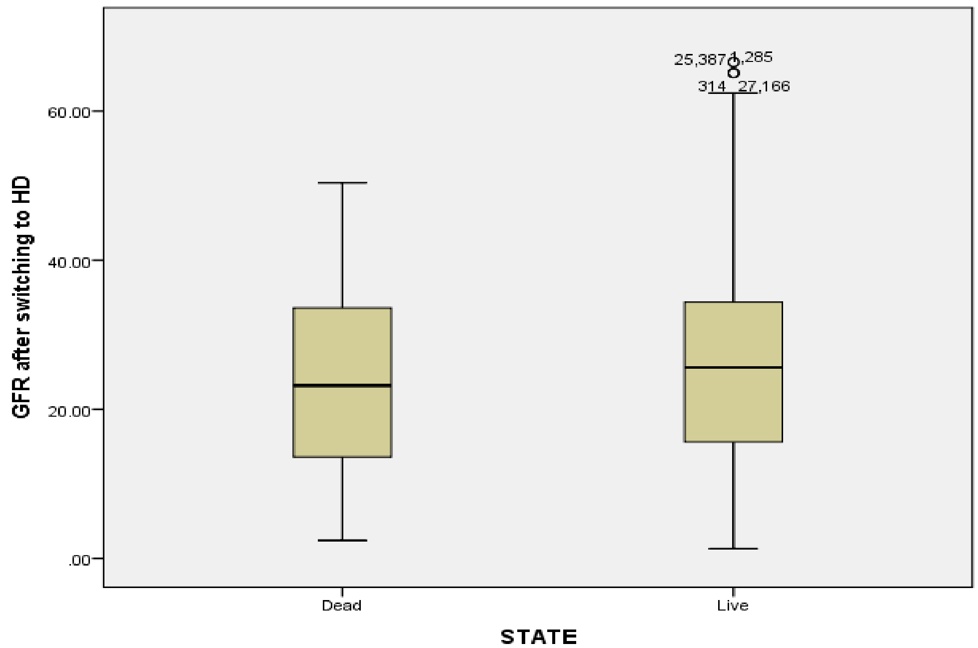

Figure 9. PD-HD patients' GFR scores after switching to HD.

The distribution of GFR scores for PD-HD patients after switching to HD mode is as shown on figure 9. Once again, the patients who survived had a wider range of GFR scores compared to those who died. The t-test statistic, with equal variances, for analyzing the two means was -3.5 with a p value of 0.001 showing that the two groups of patients had significantly different means. A paired sample t-test comparing the GFR scores before and after the switch showed that the GFR means were statistically different with a p value of 0.000.

The durations spent by PD-HD patients on each mode of dialysis were also analyzed. Figure 10 shows that the ranges for durations spent by patients who died and those who survived were relatively equal but the means were not, with the surviving patients spending, on average, less time than those who died. The statistic for the independents samples test was 2.046 with a p value of 0.041 implying that the difference in means was significant.

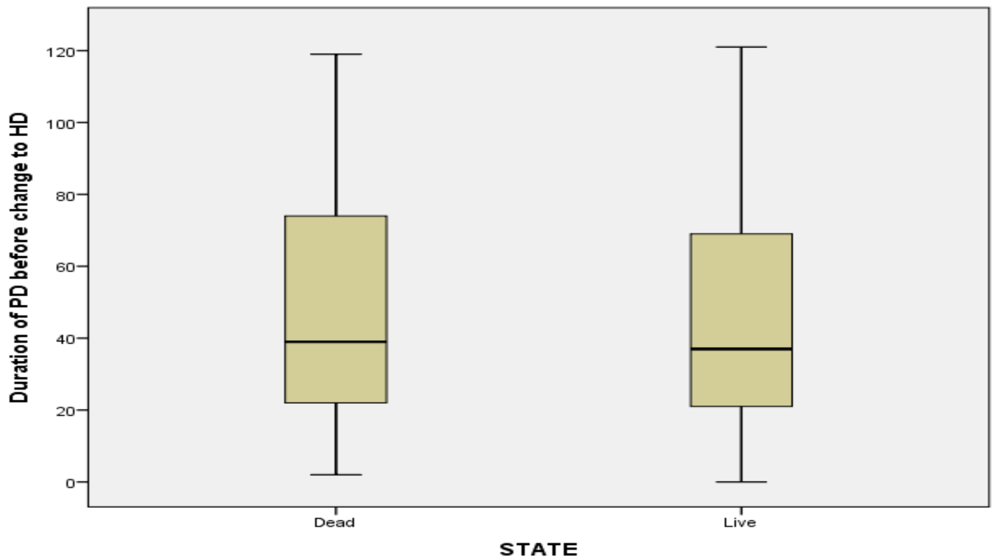

Figure 10. PD-HD patients' PD durations.

Figure 11 shows the distribution of the HD durations for PD-HD patients. Both the mean GFR after switching to HD for the patients who survived and those who died have a lot of outliers on the upper side. The figure shows that there was a group of PD-HD patients who spent longer durations on HD relative to the mean duration spent by PD-HD patients on HD meaning that the distribution of HD times is skewed to the right – the mean HD duration is higher than the median HD duration. The statistic for an independent samples test, assuming unequal variances, on the means of the two groups was -3.451 with a p value of 0.001 implying that there is a significant difference in the durations spent by PD-HD patients after switching to HD between the patients who died and those who survived.

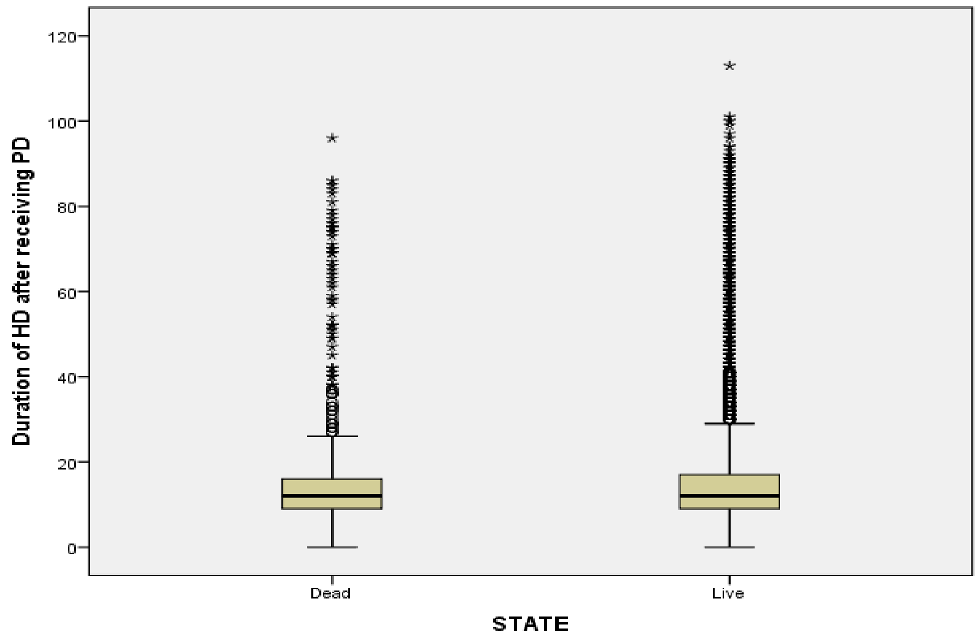

Figure 11. PD-HD dialysis durations.

To analyze the effect of switching dialysis modalities from PD to HD on the improvement of GFR, a *t*-test was conducted. Table demonstrates the descriptive statistics before and after switching to HD. The results show that mean GFR before switching to HD was 31.098 with a standard deviation of 14.679 while the mean value of GFR after switching to HD was 24.879 with a standard deviation of 11.743.

Table 5

Descriptive statistics

	Mean	N	Std. Deviation	Std. Error Mean
GFR before switching to HD	31.0984	10000	14.67936	.14679
GFR after switching to HD	24.8787	10000	11.74349	.11743

Table 5 depicts the results of the t-test analysis. Results show that there was switching dialysis modalities from PD to HD has a significant improvement on GFR. Switching from PD to HD improves patients GFR as shown by the changes in GFR values; GFR before switching to HD (*M*= 31.098) and GFR after switching to HD (*M*= 24.879).

Table 6.

Results of t-test analysis

	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2 tailed)
GFR Before switching to HD - GFR after switching to HD	6.21967	2.93587	.02936	211.851	9999	0.000

To analyze the effect of switching times on the loss of renal function, the switching times were grouped into four strata and the average loss of renal function per day was determined by calculating the average decrease of GFR score for each HD-PD patient in each category. The average decreases are shown on figure 12. The center horizontal line on each boxplot represents the median, the dots represent the mean decrease in GFR score per day for the category and the label is its value. The mean decrease in GFR score decreases with increase in age. PD-HD patients who took at least 73 months before switching to HD have the highest interquartile range in their average decrease in GFR scores.

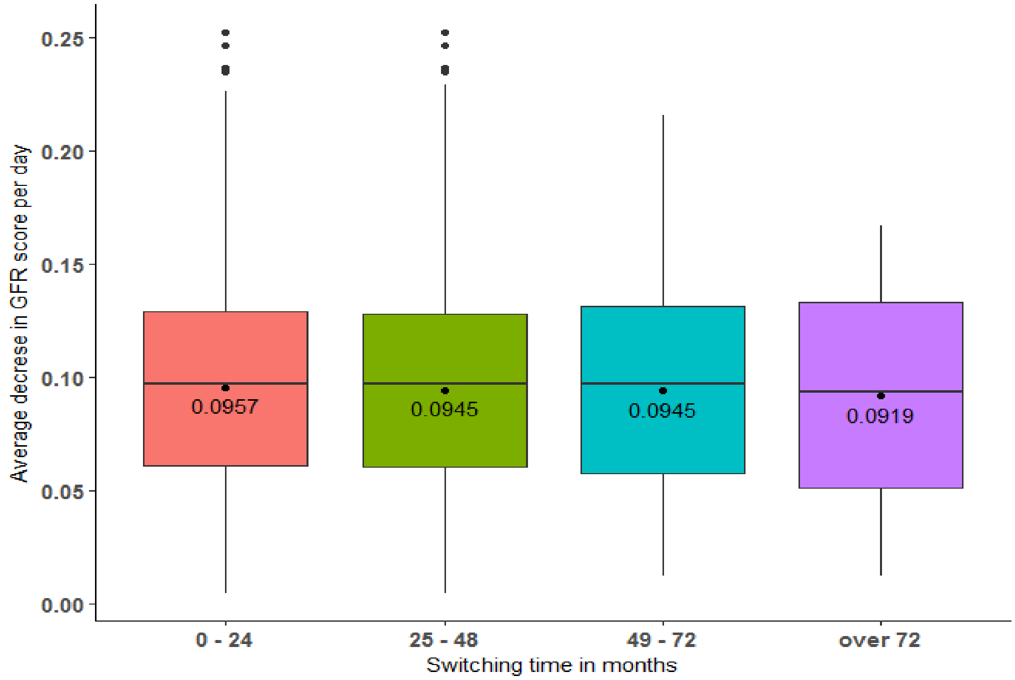

Figure 12. Average decrease in GFR score per day for different switching times.

Based on gender, male patients who took at most 24 months before switching to HD and those who took at least 73 months before switching had a higher loss of residual renal function per day than the females as shown on figure 13. On the other hand, male patients who switched dialysis mode between 25 and 72 months had a lower loss or residual renal function per day than the females.

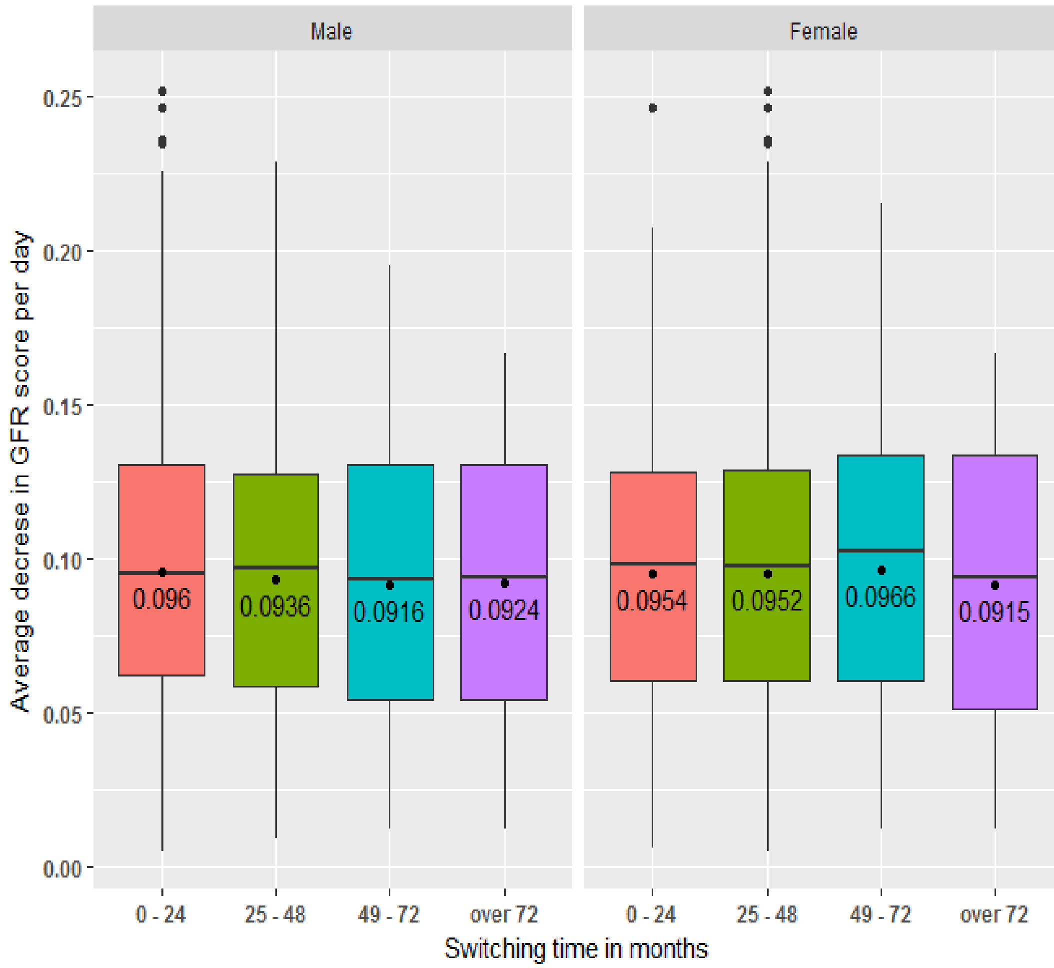

Figure 13. Average decrease in GFR across gender.

Examining the survival rates of PD-HD patients across gender, the analysis showed that there is no significant difference between male and female patients' survival rates as shown in figure 14 below. The gender variable had only two levels; male and female. The p-value for the log rank test is 0.145 which is greater than the significance level of 0.05. This implies that the survival rates do not vary significantly across gender. The coefficient for the females in the cox-proportional hazard regression using males as the base level is – 0.148 with a p-value of 0.0335 which is less than 0.05 implying that females are at a significantly lower hazard of dying from ESRD compared to males.

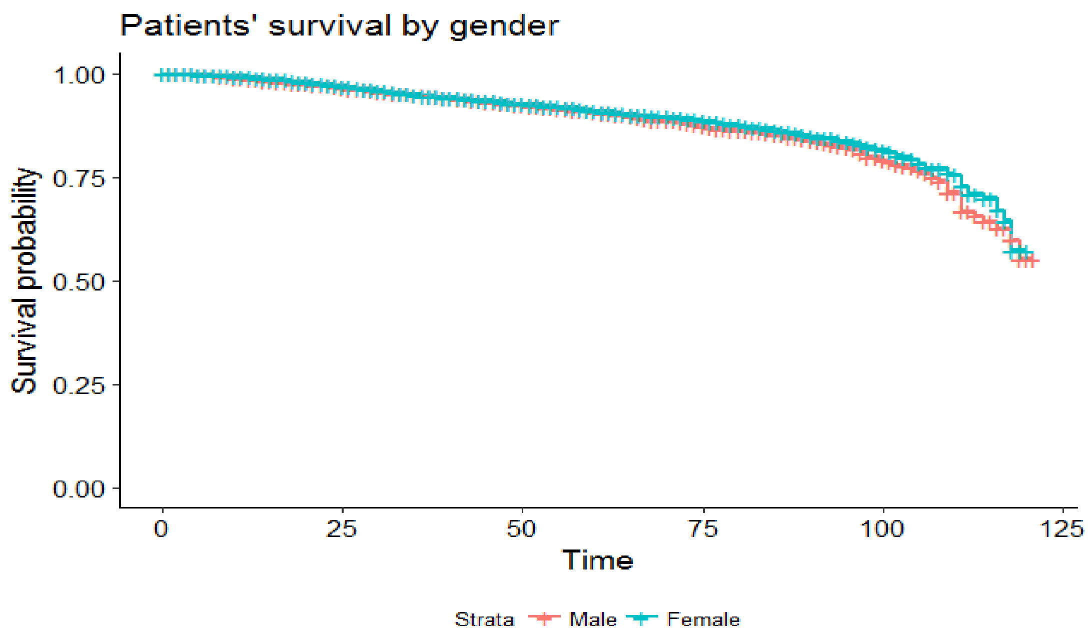

Figure 14. PD-HD patients' survival rates by gender.

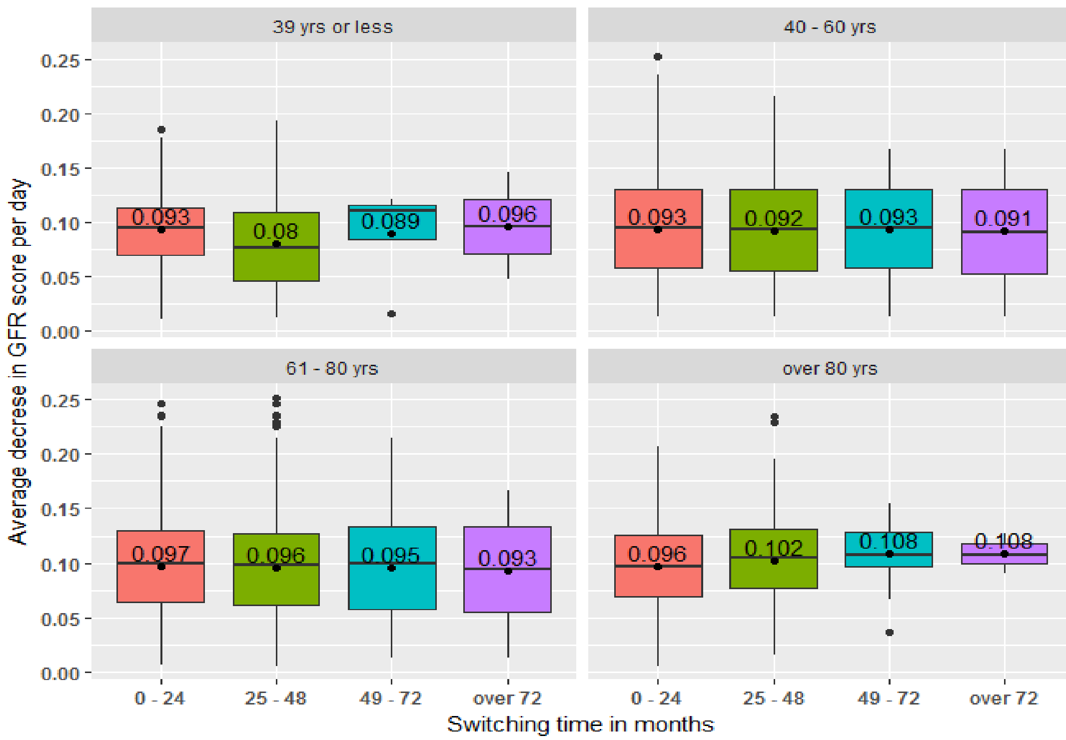

Figure 15. Average decrease in GFR across age.

Examining the loss of renal function across age reveals that patients who are over 80 years old and have taken more than 24 months before switching to HD had the highest loss of renal function depicted by a daily decrease of GFR score of more than 0.1 mL/min/1.73 m2 as shown on figure 15. On the other hand, patients who are less than 40 years old and took between 25 months and 48 months before switching to HD had the lowest daily reduction in GFR score of 0.8 mL/min/1.73 m2.

Across age, there were four levels; patients aged below 40 years, those aged between 40 years and 60 years, those aged between 60 years and 80 years ,and those aged over 80 years as shown in figure 16. On the basis of survival rates, patients aged between 40 and 60 years and those aged between 60 and 80 years had a higher survival rate than those patients aged below 40 years or aged over 80 years. The p-value for the log rank test is 0.0001 indicating a significant difference in survival rates across age categories. Using patients aged below 40 years as the base level, the cox proportional hazard regression revealed that patients aged between 40 and 60 years and those aged between 61 and 80 years are at a higher hazard than the base level with regression coefficients 0.71 and 0.19 respectively and p values 0.0254 and 0.5494 respectively. According to the p values, the coefficient for those aged between 40 and 60 year is significant. In comparisons, patients aged over 80 years are at an insignificant lower hazard relative to the base level with a regression coefficient of –0.6079 and a p-value of 0.099.

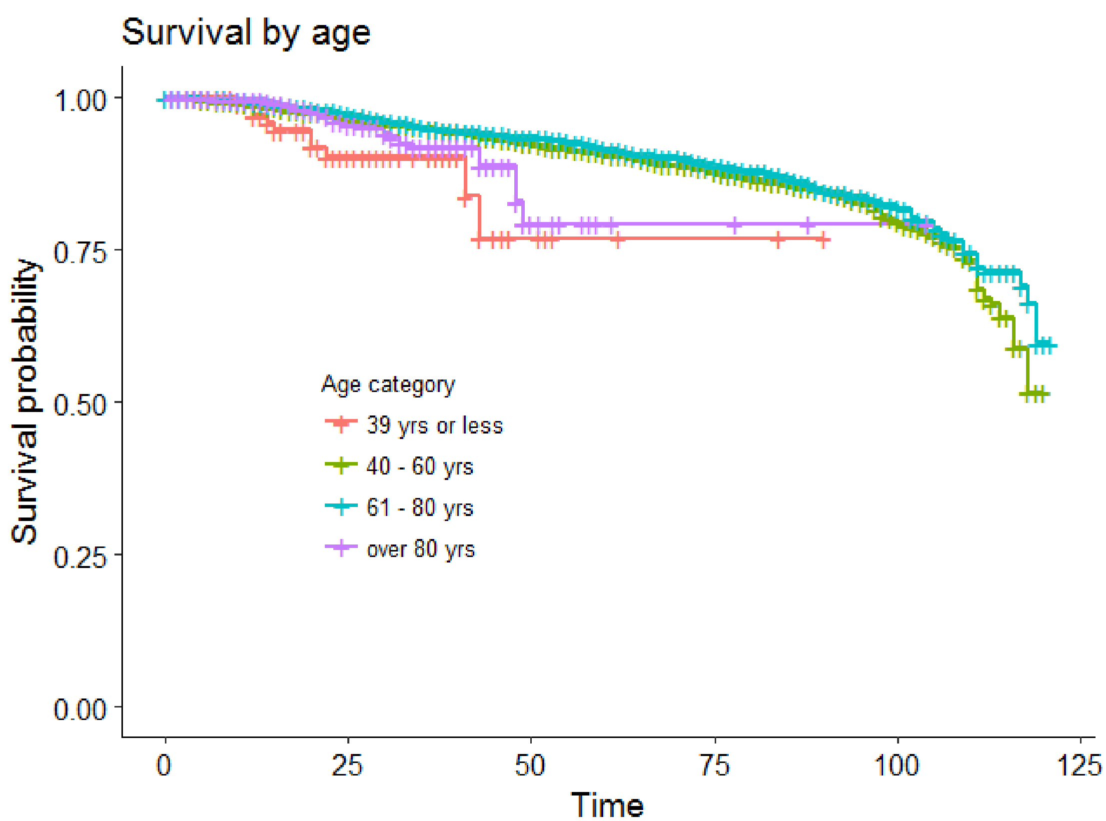

Figure 16. PD-HD patients' survival rates by age.

Research Question Two

The average loss of renal function was compared for cardiovascular disease measured by the decrease in GFR score. Patients without hypertensive chronic kidney disease had a higher daily loss of renal function compared to patients without hypertensive chronic kidney disease as shown on figure 16. This can be explained be the fact that though the percentage of ESRD patients in the sample without a cardiovascular disease was only 4%, most of these patients were diabetic. The percentage of diabetic patients without a cardiovascular disease in the sample was 96% (67.74% + 0.79% + 27.47%). Thus, the higher loss of renal function among patients without hypertensive chronic kidney disease can be attributed to diabetes.

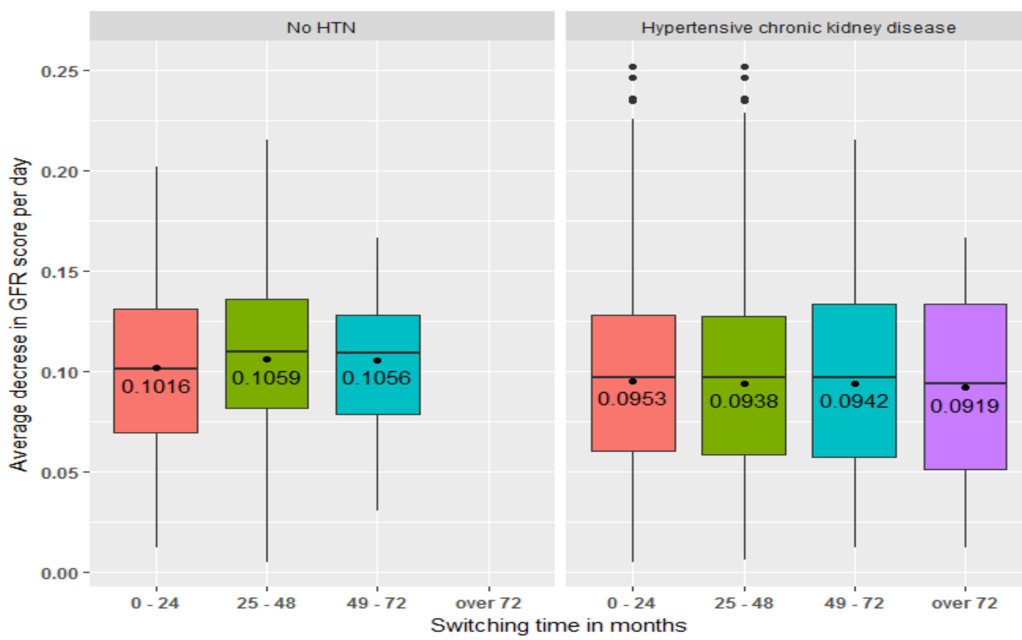

Figure 17. Average decrease in GFR across cardiovascular disease.

Patient's CVD had two levels. The first level is patients without hypertensive chronic kidney disease (No HTN) and the second level is patients without hypertensive chronic kidney disease (HTN). The sections of the curve crossed with lines are the censored values (patients who were still alive by the end of the study). With regard to survival rates, patients with hypertensive chronic kidney disease had worse survival rates than those without. The survival rate is indicated in figure 17. The p-value for the log rank test is 0.695 indicating an insignificant difference in survival rates across cardiovascular disease. The coefficient for the patients with hypertensive chronic kidney disease in the cox-proportional hazard regression was determined using patients without hypertensive chronic kidney disease as the base level. The coefficient obtained was 1.3164 with a p-value < 0.0001, which is less than 0.05, implying that patients with hypertensive chronic kidney disease are at a significantly higher hazard compared to those without.

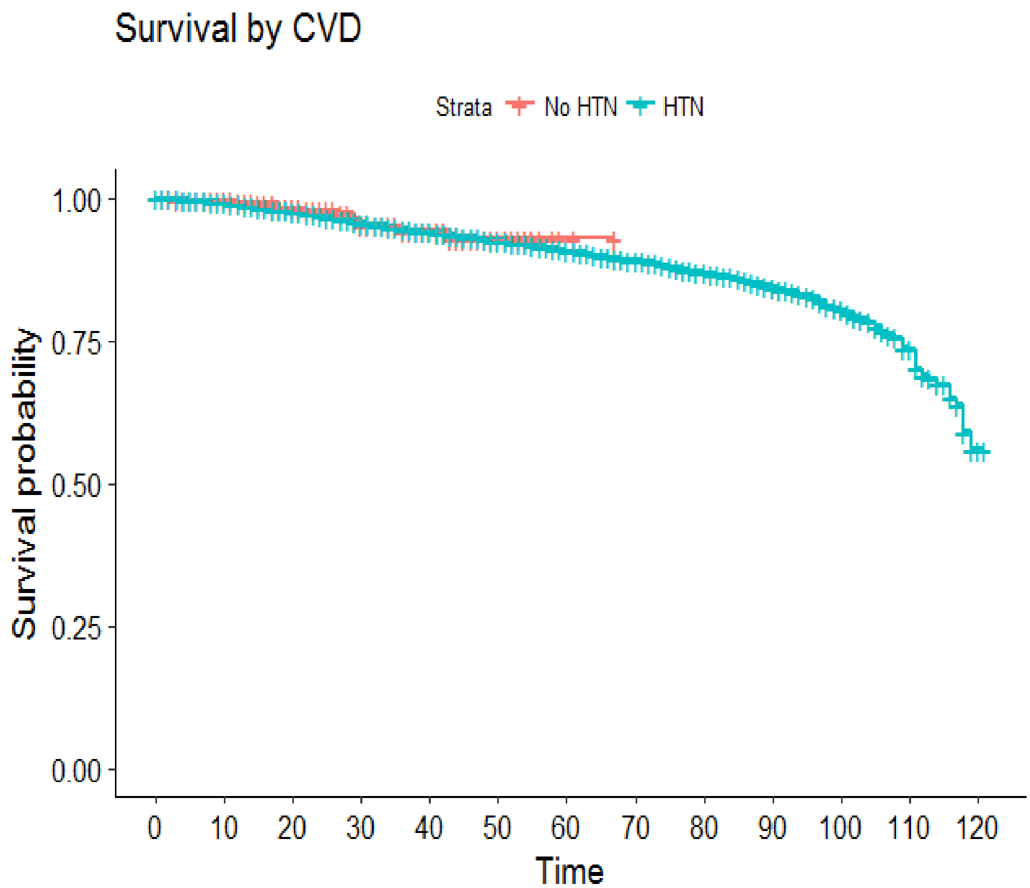

Figure 18. PD-HD patients' survival rates by cardiovascular disease.

On the basis of diabetes type, there were three levels of diabetes. The first represented patients without diabetes. The second one is patients with diabetes with chronic kidney disease and the third one is patients with diabetes with renal manifestations. Investigating the average loss of renal function across diabetes type revealed that patients with diabetes with chronic kidney disease had the highest daily loss of residual renal function followed by those with diabetes with renal manifestations as shown on figure 18. Non-diabetic patients had the least loss of renal function per day. All the diabetic patients in the sample took at most 72 months in PD before switching to HD.

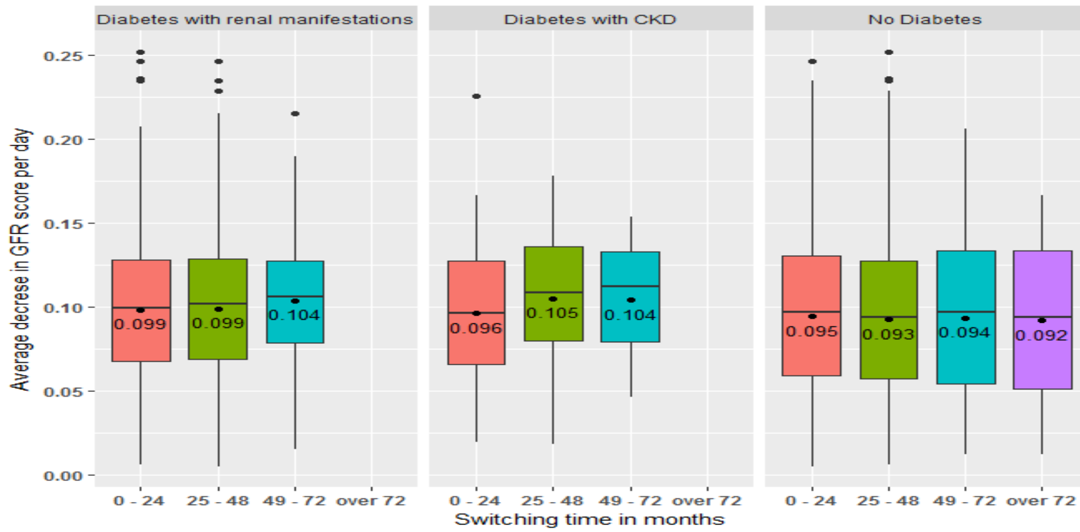

Figure 19. Average decrease in GFR across diabetes type.

The survival rates of PD-HD patients without diabetes were lower than the survival rates of those with diabetes. The survival curves for patients with either diabetes with renal manifestation or diabetes mellitus with chronic kidney disease are close to each other as shown in figure 19. This implies that the survival rate for the two types of diabetes is similar. The difference between survival rates for diabetic patients and non-diabetic patients was tested using the log-rank test. The p-value for the log-rank test is 0.107 which is less than the significance value (5%) implying that survival rates significantly vary across diabetes type. For the cox proportional hazard, non-diabetic patients were specified as the base level. The regression coefficients for the patients with diabetes with renal manifestation and those with chronic kidney disease are – 1.783 and – 0.155 implying that, relative to the non-diabetic patients, the hazard decreases if a patient is diabetic. This decrease for patients with diabetes with renal manifestation is significant with p value < 0.000 while that one for patients with diabetes with chronic kidney disease is insignificant with a p value of 0.978.

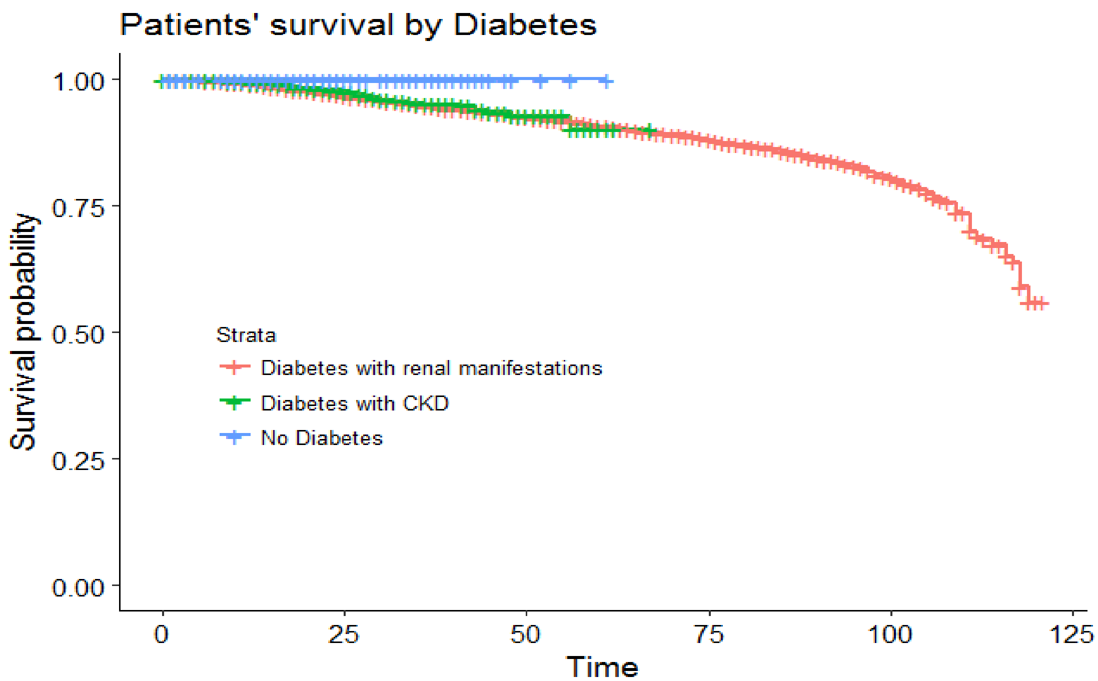

Figure 20. PD-HD patients' survival rates by diabetes type.

Research Question Three

Cochran Mantel Haenszel test was used to determine whether the effects of demographic factors and co-morbidity factors on optimal switching times for PD-HD ESRD patients are independent. The Cochran Mantel Haenszel is the test of conditional dependence with a null hypothesis that two variables are independent over a third factor. The test was used to determine whether co-morbidities are independent over demographic factors.

Effect of co-morbidities on GFR across gender. The effect of diabetes and cardiovascular diseases on GFR was tested to determine whether it was similar across gender. The three way contingency table 7 summarizes the total GFR across diabetes and cardiovascular diseases for gender. Applying Cochran Mantel Haenszel test on table 5; yields a p-value of 0.0062 which is less than α-level of 0.05 implying that the effect of co-morbidities on GFR varies across gender.

Table 7

Patients' medical conditions(total GFR) across gender.

Diabetes type	Cardiovascular disease	Gender	
		Male	Female
Diabetes with renal manifestation	HTN	1.61	2.39
	No HTN	6.21	8.74
Diabetes with chronic kidney disease	HTN	0.14	0.09
	No HTN	0.46	0.39
No diabetes	HTN	0.06	0.11
	No HTN	33.8	45.99

Effect of co-morbidities on GFR across age. The total GFR across diabetes and CVD over age tested is presented in table 8. The p-value for the Cochran Mantel Haenszel test on the contingency table yielded a p-value of 0.0002 which is less than α-level meaning that the effect of co-morbidities on GFR varies across age.

Table 8

Patients' medical conditions (total GFR) across age.

Diabetes type	Cardiovascular disease	Age category in years			
		< 39	40-60	61-80	> 80
Diabetes with renal manifestation	HTN	0	0.42	2.21	0.69
	No HTN	0	1.86	8.75	2.64
Diabetes with chronic kidney disease	HTN	0	0.02	0.1	0.06
	No HTN	0	0.09	0.47	0.19
No diabetes	HTN	0	0.04	0.09	0.06
	No HTN	0.77	38.90	41.4	1.22

Effect of co-morbidities over optimal dialysis switching times across gender. The co-morbidities over optimal dialysis times for PD-HD patients across gender are presented in table 9 below. Applying Cochran Mantel Haenszel test on the table yields a p-value of 0.029. This implied that the effect of co-morbidities on optimal dialysis times vary across gender.

Table 9

Summary of co-morbidities over optimal dialysis times for PD-HD patients.

Diabetes type	Cardiovascular disease	Gender: Male	Gender: Female
Diabetes with renal manifestation	HTN	2.30	3.58
	No HTN	9.57	14.77
Diabetes with chronic kidney disease	HTN	0.22	0.12
	No HTN	0.67	0.70
No diabetes	HTN	0.06	0.14
	No HTN	28.36	39.50

Effect of co-morbidities over optimal dialysis switching times across age. The co-morbidities over optimal dialysis times for PD-HD patients across age are presented in table 10 below. The p-value for the Cochran Mantel Haenszel test on this contingency table yielded a p-value of 0.0001 which is less than our significance level meaning that the effect of co-morbidities on optimal dialysis times varies across age. This indicates that the relationship between co-morbidity factors and both GFR and optimal dialysis times varies across age.

Table 10

PD-HD patients' dialysis times across age.

Diabetes type	Cardiovascular disease	Age category in years			
		< 39	40-60	61-80	> 80
Diabetes with renal manifestation	HTN	0	0.75	3.75	1.38
	No HTN	0	3.70	15.68	4.96
Diabetes with chronic kidney disease	HTN	0	0.03	0.15	0.16
	No HTN	0	0.11	0.81	0.45
No diabetes	HTN	0	0.04	0.15	0.02
	No HTN	1.68	28.24	35.47	2.47

Moreover, multivariate cox proportional regressions revealed the following associations between the survival of a patient and combinations of both demographic factors (age and gender) and co-morbidities (cardiovascular disease and diabetes type). Three regressions were done. The first one was between the patients' survival and co-morbidities (cardiovascular disease and diabetes type), the second one between patient's survival and demographic factors (age and gender), and the third one between patient's survival and both the co-morbidities and demographic factors (cardiovascular disease, diabetes type, age and gender). The cox proportional results are shown on table 11.

Table 11

Cox proportional regression results.

Factor	Coefficient	Hazard Ratio	P value
Co-morbidities (diabetes type and cardiovascular disease)			
Hypertensive chronic kidney disease	-0.0468	0.654	0.878
Diabetes with renal manifestations	-1.791	0.1667	< 0.0001
Diabetes with chronic kidney disease.	-15.53	<0.0001	0.978
Demographic factors (age and gender)			
40 – 60 years	0.7314	2.0779	0.0227
61 – 80 years	0.2091	1.2325	0.5144
80 - years	-0.588	0.5549	0.1102
Female	-0.1359	0.8729	0.0513
Co-morbidities and Demographic factors			
Hypertensive chronic kidney disease	-0.0715	0.931	0.8146
Diabetes with renal manifestations	-1.697	0.1833	< 0.0001

Diabetes with chronic kidney disease.	15.39	<0.0001	0.9778
40 – 60	0.9511	2.589	0.0031
61 – 80	0.6081	1.837	0.0587
80 -	0.2894	1.336	0.4357
Female	-0.1393	0.8699	0.0458

Since all the four independent variables for these cox proportional regressions are categorical, one level of each factor was used as the base level. For diabetes type the levels were no diabetes (base level), diabetes with renal manifestations, and diabetes with chronic kidney disease. The levels for cardiovascular disease were hypertensive chronic kidney disease and no hypertensive chronic kidney disease (base level). For gender, the levels were male (base level) and female while the levels for age were less than 40 years (base level), less than 61 years (40-60), less than 81 years (61-80), and greater than 80 years.

The base level is used as the reference while interpreting the cox proportional coefficients. For co-morbidities, patients with no diabetes were used as the base category for diabetes type and those with no cardiovascular disease were used as the base category for cardiovascular disease. For demographic factors, patients aged less than 40 years were used as the base category for age and male patients were used as the base category for gender.

In table 11, a positive cox proportional regression coefficient implies that the risk of death is higher while a negative coefficient implies the risk of death is lower. The hazard ratio is calculated as the exponent of the regression coefficient. It shows the factor by which each factor reduces or increases the hazard relative to the base category/categories. P values less than 0.05 indicate significant regression coefficients.

Including both CVD type and diabetes type in the cox regression model showed that relative to a patient who is not suffering from either diabetes or a CVD, the risk of death is significantly lower if an ESRD patient is suffering from diabetes with renal manifestations with regression coefficients – 1.791 and p value< 0.0001 as shown in table 9. Similarly, including both age and gender in the regression model showed that the risk of death is significantly higher if a patient is aged between 40 and 60 years relative to a male patient who is aged below 40 years. The risk of death is significantly lower, however, if the patient is female with a p value of 0.0513.

Including both demographic factors (age and gender) and co-morbidities (CVD and diabetes) in the cox proportional regression model showed that relative to a male patient aged below 40 years and not suffering from either a cardiovascular disease or diabetes, the risk of death significantly decreases if the patient is either female or is suffering from diabetes with renal manifestations with p values 0.0458 and <0.0001 respectively. By comparison, this risk of death significantly increases if the patient is aged between 40 and 60 years with a p value of 0.0031.In conclusion, the effect of co-morbidities on both GFR and optimal dialysis switching time vary across both age and gender. Similarly the effect of demographic factors on GFR and switching times will vary across co-morbidities. Thus the optimal dialysis switching time is dependent on the health condition, the age, and the gender of the patient.

Summary

The study investigated whether the timing of the switch from PD to HD is more effective on maintaining renal function than PD or HD alone, including demographic factors (age, gender) and co-morbidities (diabetes, CVD) significantly improve renal function and survival times for ESRD patients compared to either PD or HD alone. The study also sought to understand the optimal dialysis time taken by patients switching from PD to HD due to various reasons such as technique failure or death. The study also assessed the effect of demographic characteristics and co-morbidities on the optimal dialysis for switching. Results from Kaplan Meir estimate indicate that majority (92%) survived in between the study period. Results from log-rank also show that the survival rates for patients with and without diabetes are varying whereby Kaplan Meir estimates indicated that the survival rates of non-diabetic after switching were higher than those with diabetes. Patients between age 40 and 60 years had the best survival rates as well as patients with cardiovascular diseases after switching dialysis modes. Moreover, the mantel haenszel test focused on examining whether demographic factors or co-morbidity factors are independent over ESRD patients' survival times. The results showed that the effect of co-morbidities on patients GFR varies across gender and age. Similar results were obtained on the effect of co-morbidities on the optimal time for switching varying across age and gender. Cox proportional hazard regressions showed that patients with CVD have less survival times compared to patients with cardiovascular diseases whereas patients between ages 40 and 80 years have higher hazards of dying as compared to patients below 40 years and above 80 years.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The section presents the discussion of findings in relation to the research questions while simultaneously explaining the theoretical perspective. The research study focused on examining whether the timing of the switch from PD to HD is more effective in maintaining renal function than PD or HD alone considering the demographic factors (age and gender) as well as the comorbidities (diabetes and CVD). In addition, I examined whether the timing of the switch from PD to HD significantly improve renal function and survival times for ESRD patients compared to either PD or HD alone. Several studies have been conducted on examining the effect of PD, HD, or switching from PD to HD on maintaining renal function but the studies employed a small sample size. However, my study aimed at filling the gap by employing a large sample size of records of patients from a national registry database of over 128,000 patients undergoing dialysis at National Dialysis Center. Moreover, the study focused on establishing the impact of optimal dialysis time for switching from PD to HD on ESRD patients residual renal function and survival times. The study focused on whether there is an improvement when controlling for demographics and comorbidities. This chapter discusses the results in relation to the literature review whereby the discussion is aligned with the research questions of the study. The first section highlights summary of study findings, the second section details the study objectives while the last section presents the conclusion and recommendations for future work.

Summary of Findings

The study examined whether switching dialysis modes from PD to HD improves patients' residual renal function and survival rates while controlling for demographics and comorbidities. A national database consisting of 128,000 medical records of patients undergoing dialysis was utilized. Descriptive findings showed that there were more female patients (57%) than male patients (43%) across the three dialysis modes PD, HD, and PD to HD. The sample chosen consisted more of whites (70.87%) and more than two-thirds of the patients were university graduates. Among the three dialysis modes, the majority (91.58%) of the participants examined in the study are alive. Moreover, the mean age of patients engaging in dialysis was 62 years whereby the minimum age was 21 years while the maximum age was 91 years. In addition, the larger percentage of the ESRD patients had diabetes as well as CVD (hypertension).

Results illustrated that the optimal duration for switching dialysis modalities was 9 months. The major cause for switching was peritonitis which was a result of technique failure. The findings for the first research question indicated that the optimal dialysis for switching had an impact on the survival rates and the residual renal functions for patients with end stage renal diseases. The results demonstrated that there was significant difference between dead and live patients for patients on PD and after switching to HD. It was discovered that patients who had died hads had spent more time on PD than patients who were still living. Additionally, patients who were still alive spent more time on HD than those how had passed away. Specifically, the findings show that of the majority of patients switching from PD to HD that survived were patients without diabetes as compared to those diagnosed with diabetes. The log-rank test confirmed the significant difference. Log-rank values indicated that patient's survival rates varied significantly across patients with comorbidities whereby patients with cardiovascular diseases were observed to have better survival times than patients without cardiovascular diseases.

In addition, the findings showed that patient's survival does not vary significantly across gender but varies significantly across age whereby patients aged between 40 and 50 years had best survival rates. Moreover, the effect of comorbidities on patient's GFR varied significantly across both the age and gender. The results demonstrated that switching from PD to HD had significant effect on patient's GFR. A *t* test conducted revealed that significant difference on GFR was observed for patients before and after switching to HD. The GFR for patients decreased after switching to HD depicting effectiveness of switching dialysis modes. The findings answered the second research question which indicated that the patient's comorbidities had a significant impact on the optimal dialysis time for switching when controlling for gender. The effect of comorbidities on optimal dialysis time for switching across gender was found to be significant, as indicated by the Cochran Mantel Haenszel test. The findings indicated that the optimal switching times for patients without diabetes and hypertension were higher across gender compared to patients with diabetes and CVD. Similarly, effects of comorbidities over optimal dialysis switching time varied significantly across age. Female patients and non-diabetic patients were found to have higher survival rates.

The third research question focused on establishing the effect of demographic characteristics on patients' optimal dialysis time for switching when controlling for the patient's comorbidities. The findings indicated that male respondents were associated with shorter durations for switching. In addition, gender had an effect on switching times when controlling for the GFR and survival rates. Male patients taking different durations for switching were observed to have lower residual renal function compared to female counterparts. Moreover, results showed that there was no significant gender difference in patients' survival rates. In addition, patients aged 40-60 years had better optimal dialysis switching modes, improved survival rates, as well as improved GFRs. Patients aged 40 to 80 years had better hazards of surviving compared to patients over 80 years and below 40 years.

Limitations of the Study

Limitations are considered as the occurrences that arise in the study which are beyond the researcher's control (Simon & Goes, 2013). Limitations affect the study outcomes as well as results and every study is bound to have study limitations (Simon & Goes, 2013). The limitation of this study is the use of secondary data. Secondary data is associated with possible errors and biasness (Tasić & Feruh, 2012). Possible errors of secondary data arise from invalidation of data, the presence of the sampling and non-sampling errors, as well as reduced data reliability (Tasić & Feruh, 2012). The secondary data may be tampered with due to attitudes of the person organizing the collection of data. In addition, organizations conducting the data collection may exercise carelessness or confusion in the recording of the data which contributes to invalid results (Tasić & Feruh, 2012). As for the research study, limitations of the secondary data is the similarity of descriptive findings for the three dialysis modes; PD, HD, and PD to HD. This may have been attributed with errors in the data collection process.

Recommendations

The research findings found varied results on the effect of optimal dialysis time for switching among ESRD patients. The factors contributing to technique failure were distinct. However, various studies also indicated that the reasons for technique failure among the PD have not yet been researched (Chaudhary, 2011). The study focused on contributing to theory by examining the reasons contributing to technique failure among ERSD patients initiating dialysis by use of PD. In addition, the study found out that demographic characteristics of ESRD patients influenced patient survival rate and improved renal replacement therapy. However, the study did not provide the reasons for the existence of gender differences in improving renal replacement therapy and survival times. This provides a basis for conducting further studies to examine the reasons female ESRD patients have better survival outcomes as compared to the male ESRD patients.

Implications

Implications of Theory

Research Question 1. The research question focused on identifying the optimal dialysis time for switching from PD to HD for ESRD Patients when controlling for demographic and comorbidity patient factors. The findings indicated that the optimal duration for switching from PD to HD among ESRD patients was 9 months. The results differ with the findings by Jaar (2009) who found that 70% of ESRD patients initiating dialysis with PD switched to HD within the first two years. The reason for switching was due to dialysis technique failure which is caused by different factors (Chaudhary, 2011). In order for the patients to switch from PD to HD or the technique failure to occur, patients must have engaged dialysis under the PD mode for 6 months while other patients consider swapping to HD permanently (Descœudres et al., 2008). The study results indicate that the major technique failure was PD.

However, a study by Betty et al. (2013) indicated that patients switch dialysis modes within the first year or second year after initiating dialysis. The main reasons for switching from PD to HD were increased costs of dialysis provision, hospitalization, as well as medication (Betty et al., 2013). In addition, the technique failure of the PD still remains high as observed in studies by Matthew et al. (n.d) and Hsieh et al. (2017); thus, research as towhy the technique failure in PD is high is still needed. The study findings are constituent with major research studies conducted which indicated that PD is the major cause of technique failure (Chaudhary, 2011; Workeneh, Guffey, Minard, & Mitch, 2015). Though the main reason of switching from PD to HD is PD, a majority of participants may experience inadequate dialysis, the presence of burnout as well as persistent exit site infection (Workeneh et al., 2015).

The technique failure was observed to prevail within the first one or two years after initiating dialysis under PD. The findings also indicated that withdrawal from dialysis was a major cause of technique failure. This aligns with the findings by Weinhandl et al. (2016) who found that the reason for switching from PD to HD was withdrawal from the dialysis. In addition, other causes of technique failure that emerged observed in my findings are acute myocardial infarction and cerebrovascular disease.

Quinn et al. (2010) indicated that technique failure is caused by individual complications of the dialysis modality which results to death. It is thus, essential to detect factors contributing to technique failure early enough by monitoring infection rates to improve survival (Bechade et al., 2014).

The research hypothesis focused on determining whether the timing of the switch from PD to HD impacts renal function and survival times. The findings indicated that patients spent most of their dialysis times at PD as compared to the patients that engaged in HD. A larger number of patients under PD before switching to HD lived and took an average duration of 45 months compared to patients that died that took an average duration of 48 months. Moreover, there were a great number of patients surviving after switching to HD whereby those surviving took a longer period in HD compared to those that died. The results are consistent with the study by Sinnakirouchenan and Holley (2011) who indicated that the survival advantage of patients under PD continues for 1.5 to 2 years. The risk of death of patients over time becomes greater or equal to the in-center HD. Similar results were recorded by Pajek et al. (2014) who observed the risk of median time to death under PD was 2.73 years before switching to HD. Long-term survival rates are recorded in PD and at risk death of patients starting dialysis at PD becomes lowered (Chen, Mehrotra, & Kalantar-Zadeh, 2014). Patient's performance is steady at PD for the first two years where patients decide to switch to HD afterwards (Pike et al., 2017).

In addition, most of the patients that were included in the sample survived. The patients without diabetes survived longer than the patients with diabetes. Similarly, patients with CVD were observed to have longer survival rates than patients without cardiovascular. The findings are inconsistent with the findings of a study conducted by Liu et al., (2013), which indicated that the survival rates for the patients with CVD under PD and HD have not yet been established. The long optimal dialysis for switching was observed due to the fact that young adults with diabetes and CVD perform better PD than in HD (Yang et al., 2015). The determination of the survival rates for patients under PD or in HD have been challenging due to the fluctuation of methodologies used in various studies. Results demonstrated that significant difference on GFR was observed for patients before and after switching to HD. The GFR for patients decreased after switching to HD depicting effectiveness of switching dialysis modes. Results were consistent with the study by Ghaffari et al. (2013) that demonstrated that initial dialysis through the use of PD is associated with management and improvement of residual renal function where the management residual renal function improves patient’s survival rates. Similarly, Chaudhary et al. (2011) and Dalal et al. (2011) indicated that starting dialysis modality using PD increases preservation of RRF when one has switched to HD thus, supporting the switching technique.

Research Question 2. The research question focused on the impact of comorbidities on the optimal dialysis time for switching from PD to HD for ESRD Patients when controlling for demographic patient factors. The research question also focused on assessing whether the presence of comorbidities for switching patients significantly affects the residual renal function when controlling for demographics. The findings indicated that there were varying results of patient’s cardiovascular diseases and diabetes on residual GFR across the gender. The GFR for patients without diabetes and without hypertension was higher for females compared that of males. The findings conform to the findings of a study by Cadnapaphornchai and Teitelbaum (2014) who indicated that ESRD patient’s residual renal function is maintained by controlling co-morbidities. However, findings obtained in a study conducted by Tian et al., (2016) established that the presence of cardiovascular diseases among hypertension as well increase in comorbidities such as diabetes contributes to volume overload and thus reduced renal replacement therapy.

The patients with cardiovascular diseases have worse results and outcomes in relation to survival rates as compared to ESRD patients without diabetes and cardiovascular diseases (Zyga & Kolovos, 2013). The demographic characteristics of ESRD patients significantly contribute to the reduction in residual renal replacement therapy (Mathew et al., 2016). The findings indicated that the GFR for ESRD patients without diabetes and hypertension varied significantly across the age group of patients. Specifically, the GFR for ESRD patients without hypertension and diabetes was observed to be high for patients within the age group of 40 to 60 years. The findings are consistent with results of a study by Tian et al. (2016) who observed that older patients are more likely to have problems with residual renal functions due to increased volume overload. Studies by Weinhandl et al. (2010) and Shen et al. (2012) indicated that younger patients have better survival rates under PD than older adults. The results of the study indicated that the effect of co-morbidities on optimal dialysis times for switching varies significantly across gender.

The results depicted that for the patients without diabetes and without hypertension, the optimal dialysis times was high in females as compared to males. The findings are consistent with the results of a study by Hecking et al. (2014) who indicated patients with co-morbidities are more likely to shift from PD to HD. Moreover, the great number of switching is expected to rise among male than females as the males are prone to coronary diseases as well as diabetes. Similar results were observed for the age group where the optimal dialysis times for patients between 40 to 60 years and 60 to 80 years was observed to be high . Studies conducted indicate that there is improved quality of life for younger adults in PD than on HD (Noshad et al., 2009; Stanley, 2010). In addition, a timely transfer from PD to HD is expected to raise survival rates and decrease patient's mortality rates especially for the patients with cardiovascular diseases and diabetic patients. The elderly patients are prone to contract these diseases which force them to shift to HD as it is more manageable for the elderly patients (Stanley, 2009). However, a study conducted by Jaar et al. (2009) did not find any significant difference for the patients switching from PD to HD across the age, gender, diabetes, and cardiovascular diseases.

Research Question 3. The study aimed to establish the impact of demographic characteristics on optimal dialysis time for switching when controlling for co-morbidities. The results showed that patients' age and gender significantly contribute to the variation of optimal dialysis time for switching. More importantly, males are considered to switch earlier than females. The males GFRs and RRFs were significantly observed to be lower than the females on varying durations for switching. Weinhandl et al. (2010) found a positive contribution of demographic factors such as age and gender on the choice of dialysis technique, switching mode and the survival rates. In addition, age was considered to vary the durations for switching whereby patients having shorter duration times were aged between 40 and 80 years. Younger patients are associated to initiate dialysis with PD as it improves their outcomes compared to the elderly who have better patient outcomes on HD (Weinhandl et al., 2010; Yeates et al. (2012). The presence of co-morbidities such as diabetes affects the adoption of dialysis modes according to age. Thus, the elderly are considered to have longer durations for switching when initiating dialysis on PD.

The findings indicate that for patients in the same durations of switching, the older adults (80 years or more) were considered to have the highest loss of RRFs as depicted by their GFR compared to patients aged 40 years and below. It is important for the age to be adjusted to 65 years for ESRD patients planning to initiate dialysis on PD and then switching to HD as it associated with improved outcomes among patients. Age as a risk factor to survival rates is observed to affect the time of switching. The elderly patients are associated with high loss of renal replacement therapy due to the presence of diseases such as diabetes and cardiovascular disease. The majority of patients starting renal replacement therapy in the USA are patients aged 75 years or more (Franco & Fernandes, 2013; Seckinger et al., 2016). In addition, patients aged between 40 and 80 years have better survival rates compared to patients aged 80 years or more or below 40 years. The findings showed that patient survival for the elderly was better than that of the young population which is are inconsistent with major studies (de Melo et al., 2016).

However, patients over 80 years were observed to have lower hazards to survival. The metabolic functions, as well as psychological functions of body organs, decrease with increase in age. The elderly has lower life expectancy and lack exercises which contribute to a rise of chronic diseases (Segall et al., 2015; Seckinger et al., 2016). Moreover, patients at the age of 60 years with no diabetes have better survival rates than patients at the age 60 years with diabetes (Yamaga et al., 2012).

Implications for Practice

The research study revealed various results to be useful in managing the end stage renal disease. The results indicated that patients on minimum spent 37 months to switch from PD to HD. It is expected that timely switching from PD to HD would help improve the survival rates and mortality rates of the ESRD patients (Stanley, 2010; Jaar et al., 2010). The initiation of dialysis by use of PD is considered to be effective than initiating dialysis on HD. Specifically, the younger population is advantaged to begin dialysis with PD before switching as it associated with improved patients survival outcomes (Stanley, 2010; Workeneh et al., 2015; Erez et al., 2016; Pike et al., 2017) and improved residual renal function (Dalal et al., 2011; Chaudhary et al., 2011; Ghaffari et al., 2013). The ESRD patients aged 40 years and above initiating dialysis by use of PD have better survival outcomes in the initial stages but the condition worsens as the time for switching is delayed (Wang at al., 2017). The study results showed that the most risk factor for technique failure among ESRD patients was peritonitis. Several other studies have shown that peritonitis is the major cause for technique failure (Chaudhary, 2011; Workeneh et al., 2015; Pajek et al., 2014; Wang et al., 2017). The patients undergoing dialysis by use of PD are required to maintain extra care to minimize infections.

In addition, healthcare professionals and medical facilities are required to raise the awareness of patients on proper use of dialysis tools to minimize incidences of peritonitis. In addition, the majority of ESRD patients spent most of their time at PD dialysis as compared to HD dialysis. The use of dialysis modality under PD is associated with lower cost of therapy and flexibility schedule (Chui et al., 2013; Ghaffari et al., 2013; Tataradze et al., 2016). In order to improve patient outcomes, the patients should be advised to start dialysis under PD in order to enhance the freedom from frequent hospital visits and have less interference with everyday life (Erez et al., 2016). The findings indicated that patients without diabetes have longer survival times after switching from PD to HD. Moreover, patients with diabetes and cardiovascular diseases perform better under PD than in HD (Stanley, 2010; Erez et al., 2016). Thus patients with diabetes and cardiovascular diseases should switch dialysis modality in order to increase survival.

The rise in patients BMI contributing to co-morbidities makes the patients switch dialysis modality in order to deal with mortality rates (Jaar et al., 2009). The GFR and the renal replacement therapy for the elderly continue to worsen due to the increased co-morbidity risk factors. Moreover, due to the increased risk factors of coronary diseases among male patients, the switching is likely to increase (Hecking et al., 2014). Thus, males should be challenged to live healthy lifestyles to avoid co-morbid diseases. In addition, switching to hemodialysis is associated with several challenges such as hindrance of mobility, minimal socializing, increased costs, stress, and poor adherence to treatment (Nasiri et al., 2013; Ahmad & Al Nazly, 2014). It is, therefore, important for patients to initiate dialysis for a longer period by use of PD before switching in order to improve their survival rates.

Conclusion

The study examined whether the timing of the switch from PD to HD is more effective in maintaining renal function than PD or HD alone considering the demographic factors (age and gender) as the co-morbidities (diabetes and cardiovascular diseases). The study focused on examining whether switching from PD to HD improves the residual renal function or survival rates other than HD or PD alone. Patients' optimal dialysis time was established to be 9 months which is necessary for patients with cardiovascular periods. Patients with end stage renal disease are expected to spend more time in Peritoneal Dialysis due to challenges of mobility, adhering to dialysis as well as spending more time in the hospital. However, several studies indicated that the survival rates of ESRD patients associated with peritoneal dialysis are very low, thus advocating for timely transfer to HD. Moreover, there lacks empirical findings as to why there is increased technique failure among ESRD patients using peritoneal dialysis.

In addition, the study indicated that technique failure was the major reason for switching modalities. The main risk factor for technique failure was identified to be peritonitis. Several studies have shown that peritonitis arises due to infections of the machines and equipment. Moreover, technique failure arose due to withdrawal from dialysis and presence of co-morbidity complications. Patients spent more time in peritoneal dialysis as compared to hemodialysis. The younger patients with cardiovascular diseases and diabetes are observed to spend more time in peritoneal dialysis as it associated with improved patient outcomes. In addition, the determination of survival rates in peritoneal dialysis and hemodialysis is challenging due to the existing fluctuations in various research methodologies.

The impact of co-morbidities on the residual renal function varied significantly across age and gender. The GFR for the patients without diabetes and hypertension was higher in females as compared to that of men. Men are observed to have high incidences of co-morbidities which influence changes in their GFR compared to females. The GFR for patients without diabetes and hypertension was considered high for patients aged 40 to 60 years. The younger patients have better survival rates than the older population since the older patients are more likely to have problems with residual renal functions due to increased volume overload. In addition, female patients without diabetes and hypertension have a high optimal time for switching.

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