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A Comparison of the Ways in Which the United States and European Nations Treat Chronic Kidney Disease

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Table of Contents

Thesis Summary	3
Abstract	4
Introduction	5
Design and Methodology	10
Literature Review Findings	13
Healthcare Provider Survey Findings	20
Analysis and Synthesis	23
Conclusions	30
Appendices	
Appendix A: Satisfaction Survey for Dialysis Patients	33
Appendix B: English Version of Healthcare Provider Survey	36
Appendix C: Spanish Version of Healthcare Provider Survey	38
Appendix D: Answers to Survey from Physician’s Assistant	41
Appendix E: Answers to Survey from Nurse Practitioner	44
Appendix F: Answers to Survey from Medical Doctor	49
Bibliography	51

Thesis Summary

This thesis analyzes the similarities and differences between the ways in which the United States and various European nations treat chronic kidney disease (CKD). This thesis utilizes a literature review and discussion with healthcare providers in the United States and Spain. According to the National Kidney Foundation, chronic kidney disease affects 10% of the world's population; however, very few individuals receive treatment for their condition. Hopefully, this research elucidates the factors leading to increased treatment rates. Factors to be considered include vascular access site, health status, diet, age, satisfaction with level of care, nonadherence levels to treatment, and healthcare costs.

Abstract

European nations and the United States of America have vastly different outcomes in their treatment of end-stage renal disease (ESRD) patients, specifically when considering survival rate and patient satisfaction level. Unfortunately, no study has ever detailed the reasons why this is the case. This thesis explores and compares the methods by which the United States and European nations treat chronic kidney disease (CKD) and ESRD patients. A literature review aimed to determine factors contributing to the varying outcomes between the two nations, and a Healthcare Provider Survey was crafted and administered to United States healthcare providers in order to determine their attitudes towards the US method of treating CKD and ESRD patients. This survey was also analyzed and compared to the healthcare literature to determine what healthcare providers believe about the healthcare system versus what the literature supports. Overall, this project concluded that myriad factors play into the varying levels of outcome for European and American CKD and ESRD patients. Some of these factors include variations in vascular access practices, time spent on dialysis, type of dialysis, number of transplants performed, diet, lifestyle habits, medications, age of population, prevalence of co-morbid diseases, nonadherence rates, satisfaction with ESRD care, and time spent with a provider during each visit. With the enumeration of contributing factors previously identified, further research should focus on distinguishing the best practices of American and European ESRD care.

Introduction

The kidneys are one of the body's most essential organs and play a vital role in keeping a person alive. They function in the filtering of a person's blood and in the regulation of electrolyte concentrations (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2017). Chronic Kidney Disease (CKD) refers to any disease or condition which causes kidney function to decline over an extended period of time (Mayo Clinic, 2021). Over time, CKD progresses and is categorized into five stages based on Glomerular Filtration Rate (GFR) as well as by the degree to which the kidneys have lost some functionality. For example, when the GFR of a person decreases to 15 or under, this stage is termed CKD Stage 5, End-Stage Kidney Disease, or End-Stage Renal Disease (ESRD) (DiMaria, 2022).

ESRD must be treated via Renal Replacement Therapy (RRT) which seeks to fill the place of the kidney's normal bodily role of filtering the blood and removing wastes. Treatment methods include peritoneal dialysis, hemodialysis, and kidney transplantation (Johns Hopkins Medicine [JHM], n.d.). Firstly, peritoneal dialysis requires a surgical intervention to place a tube into one's abdomen so that the body's peritoneum membrane can function in filtering out waste using a special cleansing solution. Peritoneal dialysis is typically performed at home, over a long period of time (about 7-9 hours) every night (JHM, n.d.).

Next, hemodialysis requires surgical intervention to create an access point for hemodialysis treatment, whether that be through placing a catheter or creating a graft or fistula. A catheter is a plastic tube utilized for vascular access and is normally a temporary solution. Grafts and fistulas are more permanent solutions that combine a vein and artery from the patient to create better flow. This access point is typically in one's arm (Fresenius

Kidney Care, n.d.) Hemodialysis can be performed at home, in a dialysis center, or at a hospital; however, it is most commonly performed in outpatient dialysis centers.

Hemodialysis treatment normally only occurs three times a week with each session lasting between four to five hours (JHM, n.d.).

Lastly, kidney transplants are the preferred treatment method for most patients, as many prefer not being reliant on a machine. A kidney transplant is a surgery that removes a kidney from a deceased or living donor and places the donor kidney into the recipient. According to the Mayo Clinic's (2023) research on kidney transplants, kidney transplants are associated with "better quality of life, lower risk of death, fewer dietary restrictions, and lower treatment cost" when compared to dialysis treatment options. Kidney transplant patients still must comply with a strict regimen of medications to prevent transplant rejection (Mayo Clinic, 2023). As of April 2023, the Organ Procurement and Transplantation Network, run by the US Department of Health and Human Services, states that almost 90,000 individuals are waiting for a kidney transplant (Organ Procurement and Transplantation Network, 2023).

CKD and ESRD place a large burden on healthcare within the United States and around the globe. According to the National Institute of Diabetes and Digestive and Kidney Diseases (2021) more than one in seven US adults have CKD and over 786,000 Americans are living with ESRD. Presently in the United States, 37 million adults have been diagnosed with CKD (National Kidney Foundation [NKF], n.d.). Worldwide, CKD is an even larger issue as the global prevalence of CKD has been estimated at 13.4% (Lv & Zhang, 2019). To illustrate this vast quantity of people, given a world population of 7 billion people, this calculates to approximately 950 million people living with CKD.

To complicate matters further, healthcare systems around the world continue to improve and people have longer average life spans than in the past (World Health

Organization, 2022). This rise in average life expectancy has been accompanied by an increase in slowly developing, long-term chronic conditions like diabetes and hypertension. As the number of people with diabetes and hypertension grows, rates of CKD will continue to increase in the coming years, as CKD is associated with both of these conditions (Lv & Zhang, 2019). Given the worldwide nature of the challenges associated with CKD and ESRD, researchers have investigated the outcomes of patients within the United States, as compared to the rest of the world.

Some of this early research was conducted by Held et al. (1990) who demonstrated that the five-year survival rate for ESRD patients on renal replacement therapy was lower in the United States than in Europe. Nissenson (2012) and Blum (2019) both confirm these findings through their analysis of more recent data further suggesting that the United States has worse outcomes for patients on dialysis than their European counterparts. Xie et al. (2018) demonstrated that the United States has an overall higher incidence and prevalence of CKD than Europe does, with an average prevalence rate from 1990-2016 of 14.8%. The literature provides many possible explanations for the observed differences in outcome, which will be further explored throughout this thesis.

Despite all of the research regarding best treatment practices for CKD and ESRD patients, there are large differences in the ways European nations and the United States treat both diseases. (Blum, 2019 & Kramer et al., 2012). For example, according to Thurlow et al. (2021) the United States treats about 30% of its ESRD patients via transplantation, while 63% receive hemodialysis and about 7% participate in peritoneal dialysis. Meanwhile in Europe, rates of transplantation vary widely but are generally around 50%, while hemodialysis rates are at 45% and peritoneal dialysis rates are at 5% (Thurlow et al., 2021). Robinson & Port (2009) comment on the differences between the type of vascular access ESRD patients receive in the United States versus Europe. The United States uses grafts and

catheters- two renal access methods associated with higher infection rates than an arteriovenous fistula (AVF) the preferred method of Europeans (Robinson & Port, 2009). Earlier research demonstrated that the United States utilized a graft for hemodialysis access in over one-third of patients (Goodkin et al., 2001).

Overall, this thesis explores the differences observed in the survival rates and outcomes of CKD and ESRD patients in Europe and the United States of America. It must be noted that there are obvious challenges in comparing these two populations, as the United States is a country, while Europe is a continent with a collection of countries. Furthermore, the collection of data analyzed and compared is not normally the same in both locations. The United States is known for being more rigorous in its data collection than their European counterparts (Robinson & Port, 2009). Regardless, the field of CKD is ripe for analysis, as seen by much of the cited research regarding the challenges facing the CKD population, including rising case load, varying methods of and access to treatment, and disparities between Western European nations and the United States in long-term outcomes. This thesis expands on the current body of research within the field of nephrology and chronic kidney disease and builds upon that research by including a comparison of the perspectives of healthcare providers in both European nations and the United States regarding their treatment of patients with CKD and ESRD.

My interest in this thesis topic developed from my family's involvement with CKD and ESRD. My father was diagnosed with ESRD in 2017 after his GFR finally declined below 15 (he had remained at CKD Stage 4 for around fifteen years). My father began in-center hemodialysis in July 2018. He remained on hemodialysis in-center for a period of five months before he transitioned to at-home peritoneal dialysis in November. I thoroughly enjoyed aiding my father with his peritoneal dialysis, and this experience truly solidified my desire to be a physician, as well as my interest in chronic kidney disease treatment. In August

2019, my father thankfully received a kidney from a living donor, who was one of my high school teachers. My family travelled to the Medical University of South Carolina for the transplant, and I stayed with my dad in the hospital over the next few days. This experience further cemented my interest in chronic kidney disease treatment, as I had the opportunity to talk with many transplant surgeons, nephrologists, residents, and nurses with whom I discussed the themes of this thesis.

Design and Methodology

An extensive review of the available literature and research regarding the treatment of chronic kidney disease (CKD) and end-stage renal disease (ESRD) in the United States and Europe was conducted. Despite Europe being a continent and not a country, Europe was chosen for comparison due to its similarity in levels of development, payment systems for ESRD care, and general classification as “Western civilization”. Also, the European Union offers an interesting comparison to the United States due to size similarities, as well as some similarities in governance. This literature review utilized the PubMed and Cumulative Index of Nursing and Allied Health (CINAHL) databases, which were accessed through the University of South Carolina’s system. The databases’ results were limited to only English and Spanish results and to adult populations. Results were also only considered since 2000, with one notable exception made for the work of Held et al. (1990) due to its historical significance in being perhaps the first international comparison datasets between Europe and the United States. This time frame was chosen, since very few complete and comparative data sets have been finished, with the most recent being the Dialysis Outcomes and Practice Patterns Study (DOPPS) which was completed in 2001 (Goodkin et al., 2001).

Search terms utilized on the PubMed database were “International Comparison Dialysis,” which yielded 323 results, and “International Comparison Chronic Kidney Disease Treatment,” which provided 237 results. From these results, the titles of the papers were read to determine whether or not the papers spoke to the observed differences in outcomes between European and United States ESRD and CKD patients. If a paper was identified as speaking to the observed differences in outcomes, the abstract of the paper was read, and then it was either selected to be reviewed more extensively or was excluded based on relevance to the aforementioned topic.

A similar process occurred when utilizing the CINAHL database. The first time through the database, the search terms “dialysis” AND “United States” and then “dialysis” AND “Europe” were utilized, making use of the Boolean operator system on CINAHL. These provided 2,957 results and 311 results, respectively. To further refine the papers, the terms “chronic kidney disease” AND “international” AND “comparison” were utilized, yielding only 58 results. Lastly, a search using the terms “dialysis” AND “international” AND “comparison” was done, which provided 57 results. These results were analyzed using the same method that was utilized to filter through the PubMed results.

To ensure that the literature review was complete, searches were made on Google Scholar and on Google by making use of the terms searched in the PubMed system, “International Comparison Dialysis,” and “International Comparison Chronic Kidney Disease Treatment.” Other search terms were included to narrow the results based on factors that were hypothesized to contribute to differences observed between European nations and the United States. Some of these search terms included “nonadherence and dialysis,” “international dialysis satisfaction,” and “international diet differences chronic kidney disease.” After this process was completed, nineteen articles were selected for literature review from the time period specified, and one article from outside the time period was selected, as aforementioned, due to its historical significance. Analysis of the twenty articles was done on a Microsoft Excel document that noted any significant findings from each of the sources.

After completion of the literature review, the second phase of this research project commenced. This stage focused on conducting a survey of dialysis patients to assess their satisfaction levels with the dialysis care that they receive. The goal of this survey was to gather data on how patients feel about their dialysis and see if their attitudes towards dialysis were trending with outcomes from previous research. As demonstrated by research completed

by Doyle et al. (2012) as well as Junewicz & Youngner (2015) patient satisfaction rates are generally correlated with better treatment outcomes for a variety of different conditions.

The survey was crafted based on questions from the ICH CAHPS Survey, or the In-Center Hemodialysis Consumer Assessment of Healthcare Providers and Systems Survey (n.d.). The ICH CAHPS Survey is designed to gauge the satisfaction of the patients with their in-center hemodialysis care, and as such, was chosen as a good model on which to base the survey. The survey that was created can be found in Appendix A. The survey was then attempted to be distributed to patients from dialysis centers within South Carolina and Spain. Unfortunately, the survey was unable to be distributed due to an inability to gain access to the private dialysis systems. It was also deemed that a survey of this magnitude was outside the scope of this senior thesis project. However, this research remains important and will be a pertinent area of future research.

Instead of the dialysis patient satisfaction survey, an alternative approach was utilized. A survey was created for healthcare providers in the United States and in Spain, which somewhat overlapped with the patient satisfaction survey which was already created. This provider survey was designed to demonstrate perceived advantages and disadvantages of their respective country's methods for treating CKD and ESRD patients. The survey was first written in English, as shown in Appendix B, and was later translated into Spanish, making slight adjustments to the questions and wording, portrayed in Appendix C. The survey was then sent to three United States healthcare providers, a nephrologist, a nurse practitioner, and a physician's assistant, all working within the nephrology field. Meanwhile the Spanish version of the survey was sent to a hospital in Spain where the author of this thesis had a connection from his summer, pre-medical shadowing internship. Answers were compiled from each of the sources, with the exception of the nephrologist in Spain who was unable to be contacted, and can be seen in Appendices D-F.

Literature Review Findings

Twenty articles from various sources were selected to be reviewed. These articles will be briefly summarized and reviewed throughout this section and then connected with the Healthcare Provider Survey in the Analysis/ Synthesis section.

Thurlow et al. (2021) demonstrate that the five-year survival rate on dialysis within the United States is 7% lower than in Europe (48% to 41%) using the International Society of Nephrology's 2019 Global Kidney Health Atlas international, cross-sectional survey.

Thurlow et al. (2021) also discuss the variations in ESRD and CKD treatment methods throughout the world. According to their figures, the United States treats 30% of its ESRD patients using transplant, while it treats 63% with hemodialysis (HD) and about 7% with peritoneal dialysis (PD), as demonstrated in Figure 1. Meanwhile, in Europe, transplant rates range from 50-70%, HD rates from 25-45%, and PD is relatively constant throughout at about 5%, as shown in Figure 2. Furthermore, Thurlow et. al (2021) highlight that the United States uses less grafts presently than in the past for HD treatment; however, their rates (~28%) are still almost 20% higher than Europe (~10%). Lastly, the United States, on average, has patients on HD for 214 minutes (Thurlow et al., 2021).

Figure 1

Breakdown of the United States Renal Replacement Therapy Methods Usage (Thurlow et al., 2021)

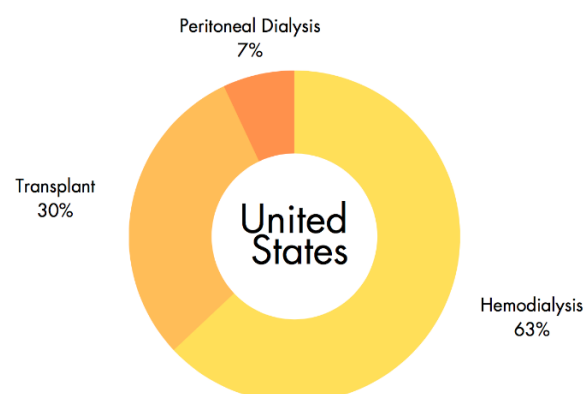
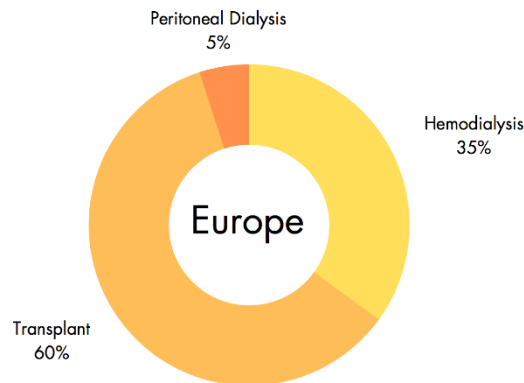


Figure 2

Breakdown of European Nations Renal Replacement Therapy Methods Usage (Thurlow et al., 2021)



Xie et al. (2018) made use of the Global Burden of Disease study data from 1990-2016 to analyze the changes in CKD internationally. This article demonstrates once again that the prevalence of CKD in Europe is lower than in the United States, which sits at around 15%. Xie et al. (2018) also share that the two most common reasons for CKD and ESRD are diabetes mellitus and hypertension, respectively.

Gallieni et al. (2009) spotlight the international differences in vascular access approach between nations across the globe. Gallieni et al. (2009) also demonstrate that there are numerous factors affecting life expectancy and quality of life metrics for CKD patients, such as rates of underlying conditions due to various factors such as diet, transplantation rates, variations within dialysis method usage, and overall healthcare systems' approaches to CKD care. All these factors play into Western European nations having better outcomes, with respect to life expectancy, quality years added, and cost burden, than the United States (Gallieni et al., 2009). The researchers demonstrated that in 2002, 41.6% of HD patients had access through a graft, 26.3% used a catheter, and only 32.7% used an arteriovenous fistula (AVF). Meanwhile in Europe, 80% was AVF and only 10% of HD access was via graft. Gallieni et al. (2009) also analyzed the DOPPS data set from 2009 which revealed AVF

usage in the US was at 47%, while grafts decreased to 28%. The researchers also discuss that the vascular access methods utilized by the US are more commonly associated with vascular access site infections (Gallieni et al., 2009).

Robinson & Port (2009) first delve into the US Renal Data System (USRDS) database, which was compared to the European Dialysis & Transplant Association (EDTA) database. Previously, the USRDS database was utilized in an elementary study done by Helm et al. (1990). The general trend from these databases is that the USRDS shows a higher mortality rate for CKD and ESRD patients than the EDTA. This trend was confirmed by the DOPPS data run by the researchers. Robinson & Port (2009) also discuss life expectancy rates and quality of life metrics for CKD patients at a large scale, indicating that there is a large gap in the amount of data collected between European nations and the United States, which explain some of the gaps in outcomes. The researchers mention that the US has a population of ESRD patients who are older and sicker than their European counterparts, while regional health differences, like diet, also play a role. Finally, Robinson & Port (2009) mention similar transplantation rates between the US and European nations, while they estimate that US vascular access practices account for 6-19% of the increase in US mortality, when compared to Europe.

Yoshino et al. (2006) highlight again that the differences in mortality between the US and Europe, with respect to their ESRD patients, is largely unexplained. Yoshino et al. (2006) in their cross-sectional World Health Organization database study estimate that the United States has nearly 20% more deaths caused by cardiovascular disease for its population who are on dialysis than Europe. The researchers propose a few theories as to why the gap in mortality exists, such as diet differences between the United States and Europe, as well as the United States having a “lower standard” for care, meaning that more sick patients get treated (Yoshino et al., 2006).

Karen Blum (2019) discusses the observed differences in the prevalence of CKD in Europe and the United States in her article. Blum cites Dr. Kitty Jager as presenting on the US having a higher incidence of risk factors for CKD and ESRD, such as diabetes and obesity. Blum also discusses how the US has a larger elderly population than Europe, as well as a 50% higher prevalence of diabetes mellitus than Europe. Blum also mentions the differences in prescribed blood pressure medications between the United States and Europe (more beta-blockers in the United States and RASS inhibitors in Europe). The most interesting point from Blum is that the US has the “largest unrealized opportunity for improvement of CKD DALYs (disability-adjusted life years).” Blum (2019) also examines the differences in observed blood pressure, as Europeans, on average have a systolic blood pressure 7 mm Hg higher than their US counterparts. Blum cites a study by Alencar de Pinho et al. (2019) which examined this discrepancy and noted that this may be explained by the fact that Europe is centered at 49° latitude, while the US is centered at 39°. For every 5° of latitude increase, there is a corresponding increase in systolic blood pressure by 5 mm Hg (Alencar de Pinho et al., 2019).

Goodkin et al. (2001) detail some results from the DOPPS international study conducted in the late 1990s and early 2000s. Goodkin et al. (2001) reveal that the amount of US dialysis patients who are diabetic is 48.9%, while in Europe that number is only 21%. The researchers also discuss how over one-third of US healthcare facilities prefer grafts over AVF creation for vascular access (Goodkin et al., 2001).

Held et al. (1990) performed one of the original analyses comparing US and European systems for treating CKD and ESRD patients utilizing comparative data from the USRDS and EDTA systems. One notable drawback from this system was that data collection for both sources was not equal. Regardless, important findings from this early work demonstrated that

US patients were older, more diabetic, and did not survive as long as their European counterparts (Held et al., 1990).

The study performed by Cruz et al. (2003) was an interesting one, as it only reflected data from European nations. This study conducted using the DOPPS database demonstrated that the mean time that European patients were on dialysis per visit was 234 minutes (~4 hours). It also showed that European nations only experienced a mortality rate of 15-16 per 100 patient years, a very good rate. Lastly, Cruz et al. (2003) highlighted that Spain and European nations prioritize their dialysis patients seeing a provider during each visit, as 90% of Spanish respondents to the DOPPS survey said they saw a doctor during each visit.

Kramer et al. (2012) used 22 regional renal registries from 2003 - 2005 to conduct their statistical analysis. Kramer et al. (2012) highlighted the high cost of dialysis and renal replacement, as it was shown to be on average 2-3% of healthcare spending in each country. The researchers also demonstrated that the United States has a lower two-year survival rate for patients on dialysis than those in Europe. Lastly, Kramer et al. (2012) highlight the considerable spending of the US on renal care, yet demonstrate their inferior outcomes.

Since a patient satisfaction survey was unable to be distributed to current dialysis patients by the researcher of this senior thesis, an attempt was made to estimate patient satisfaction utilizing scientific literature. Unfortunately, no international comparison of satisfaction between European and United States patients could be found. Rajasekaran et al. (2022) conducted an anonymous patient survey of nine US HD clinics which indicated, on average, patients were 80% (4/5 ratings) satisfied with their care. Meanwhile, in Europe, Drozd et al. (2018) highlighted that patient satisfaction in European dialysis clinics averaged a score of 9/10 or 90%.

Patient satisfaction was also attempted to be gauged through nonadherence studies. It should be noted that nonadherence was studied due to its known variability between

European nations and the United States. Miyata et al. (2018) conducted surveys of nearly 200 US and Japanese patients on dialysis and found that US patients in this sample were 23% nonadherent while Japanese patients completely adhered to treatment. This study also spotlighted the difference in health literacy regarding the patient's own condition between Japanese and US patients, as US patients answered more questions incorrectly regarding their ESRD (Miyata et al., 2018). Saran et al. (2003) had previously used the DOPPS survey in order to analyze differences in nonadherence. The researchers found a rate of 7.9% nonadherence in the US, while there was only a .6% rate of nonadherence for Europeans (Saran et al., 2003).

Allen Nissenson (2012) wrote an article comparing the outcomes of dialysis patients around the world, mostly utilizing data from the United States and comparing it to Asian nations, like China. Nissenson (2012) demonstrates that increased provider visits decrease the number of hospitalizations a patient must undergo, and overall concludes that the US has worse dialysis outcomes than the rest of the world.

Briggs et al. (2019) speak to the issue of varying degrees of usage of hemodialysis and peritoneal dialysis and explain why PD is a better method overall for health outcomes (lower cost and higher satisfaction rates). Throughout most of the world PD usage is low (normally less than 10%). The researchers share how Western European nations are decreasing their usage of PD and use it less than the US. This is an interesting paradox considering the better outcomes seen in Western European nations and must be taken into account when considering the varying degrees of success observed in Western European nations and the US. Briggs et al. (2019) discuss how PD requires more training for patients and could increase the amount of health literacy.

Tokgoz (2009) shares that PD is a better method of renal replacement therapy than HD, as it protects residual kidney function, and it leads to higher satisfaction rates for

patients. Tokgoz (2009) also details that his study demonstrates a survival advantage for PD patients one to two years after the onset of dialysis. Van de Luitgaarden et al. (2013) detail issues that may prevent PD usage, including that PD does not work as well as HD for diabetic patients and more staff is needed for the training of PD than for just HD clinic management. Although PD is cheaper in the long run, it may cost more at the beginning since supplies must be bought.

Shin et al. (2005) highlight that their research has revealed an equal survival rate for HD and PD; however, their USRDS data demonstrates a difference of nearly \$30,000 in the cost of treatment. HD annual treatment cost was calculated at \$72,189, while PD annual treatment was \$44,111. Lastly, Devoe et al. (2016) demonstrate the need for education of dialysis patients about PD. Devoe et al. (2016) show that patients are four times more likely to choose to enroll in PD after receiving training regarding PD.

Healthcare Provider Survey Findings

A survey of healthcare professionals within the United States, specifically within the state of South Carolina, was conducted. Three healthcare providers from different professions were selected to be surveyed (nurse practitioner, physician's assistant, and medical doctor). These healthcare providers also worked in a variety of settings, as one provider works almost exclusively in the hospital, while another works almost exclusively at in-center hemodialysis clinics, and the final works at a mix of the two. A survey of a physician from Europe (Spain) was also attempted; however, no response was received despite multiple contact attempts and methods.

The healthcare professional survey was created to analyze whether the ideas surrounding CKD and ESRD treatment held by healthcare providers aligns with the statistical data. Since the scope of this senior thesis project was too small for a patient satisfaction survey, which also failed due to a lack of connections and patient privacy considerations, it was determined that a healthcare professional survey would be an appropriate substitution. Although patient satisfaction with dialysis could not be directly gauged, questions were posed to medical providers from all different perspectives.

Briefly, the healthcare provider survey asked questions regarding themes that had emerged from the literature review analysis, such as peritoneal dialysis usage, considerations in treatment plan determination, the need for education of patients, and patient demographic and outcome information. The specific English questions posed by the survey can be found in Appendix B, while the Spanish version can be found in Appendix C. The answers from each of the medical providers are provided in this thesis in Appendices D-F.

The answers of each of the providers must be discussed in order for comparisons and conclusions to be drawn with the literature review. First, all three providers noted that

peritoneal dialysis (PD) was their preferred treatment method for ESRD patients, when not considering transplant as an option. All three providers cited PD as having more success than hemodialysis (HD); however, the physician's assistant, who mostly focuses her time as a provider in the hospital, noted that although PD is normally better, some patients do well on HD in-center for years. When asked about what considerations were taken into account when determining an ESRD patient's treatment plan, each provider mentioned different aspects that were analyzed including lifestyle goals, social support, co-morbidities, living arrangements, patient's preference, and age. All three providers also mentioned that PD is not used more due to a lack of patient education and the fear that is associated with being one's own healthcare provider. Two other interesting comments on why PD is not utilized more emerged, as the physician's assistant surveyed noted that skilled nursing facilities do not accommodate PD, which plays a role in elderly patients' decisions, and the nurse practitioner, who mostly works at in-center HD clinics, remarked that many patients who start on HD never want to switch, especially when they start urgently. Staffing was acknowledged to be an issue at many US HD facilities by the medical doctor.

When asked what is most needed within the US healthcare system to treat CKD and ESRD patients, all three providers responded that education as well as a focus on prevention are sorely needed. Similarly, two out of three providers denoted that the biggest problem with the way the US approaches treating CKD and ESRD patients is that the US has a reactive system, not a proactive one, while the medical doctor stated that the US's dependence on HD is its greatest flaw. The merits of having universal access to dialysis treatment were acknowledged as the greatest part of the US's treatment plan by two providers, while one provider included the US's high rates of transplants, as well as the choice of treatment plan. Interestingly, all three providers remarked that from their interactions with providers from other nations, they discovered they treat patients more with PD (it should be noted that these

providers were from Canada, not from Europe). Patient age estimates varied; however, the providers agreed that the average age was likely around 60. All providers also stated that diabetes and hypertension cause the majority of ESRD in the US. When asked about patient satisfaction based on renal replacement therapy method (HD or PD) one provider stated that PD patients are more satisfied, while the other two mentioned that they believe less patients are satisfied with their care today than in the past. The two providers who spent more time at in-center HD facilities or in outpatient settings, estimated that the majority of patients have caregivers, while the physician's assistant stated that it was likely fifty-fifty. Finally, all of the providers estimated the life span of patients on dialysis to be between 5 – 10 years, with an average of 7 years.

Analysis and Synthesis

Notable findings from the Healthcare Provider Survey and the Literature Review must be discussed in order to find common themes and to understand where gaps in knowledge may exist, as well as what future research needs to be performed.

When the three healthcare providers were asked to identify the best parts of the United States treatment of CKD and ESRD, two providers remarked on the ability of everyone to access dialysis care. Interestingly, none of the articles reviewed mentioned this access capability of the American healthcare and European healthcare systems. Likely, this is due to the fact that each European nation has a different healthcare system with its own complexities. However, it is true that every ESRD patient, who is a US citizen, who goes on dialysis will receive Medicare to aid with the costs of treatment (American Kidney Fund, n.d.). The other healthcare provider surveyed said that the amount of transplants the United States performs is the best part of the United States' treatment of ESRD patients. This is fascinating since the United States performs less transplants, as a percentage of overall ESRD patients treated, than do their European counterparts. The United States treats 29% of its ESRD patients via kidney transplantation while other nations in Europe range from ~40% - 70% (Thurlow et. al, 2021). The United States has a much larger population than the individual European countries and performs more transplants per year than any individual nation.

All three healthcare providers surveyed pointed to the United States healthcare system for ESRD and CKD patients failing most in the areas of prevention and patient education. The literature reviewed certainly supported this idea, as the population of United States ESRD patients surveyed by Miyata et al. (2018) were demonstrated to have lower health literacy rates than their Japanese peers. Unfortunately, no comparative United States and

European health literacy article could be found. However, as demonstrated by Miyata et al. (2018) nonadherence can be associated with lower health literacy rates. Furthermore, Saran et al. (2003) show that the United States has more nonadherence at 7.9% than their European counterparts, at .6%, based off of the DOPPS data. The providers surveyed also mentioned that the United States relies too much on HD and does not perform enough kidney transplants. The article written by Karen Blum (2019) supports this claim, as she identifies that the United States performs more renal replacement therapy than Europe. This is also evidenced by Thurlow et al. (2021) as aforementioned.

The Healthcare Provider Survey answers revealed a belief that patients are less satisfied with their ESRD treatment than in the past. It must be noted that the providers surveyed only spoke to American patients, so any comparison with European patient satisfaction is difficult, especially since the European provider survey was not returned. Even so, it is possible that US patients are less satisfied with their ESRD treatment today, while this trend may not have emerged within Europe. Although no international comparison study on patient satisfaction could be found within the literature, two similar patient satisfaction surveys were completed separately in the United States and in Europe. Rajasekaran et al. (2022) found via an anonymous survey of dialysis patients in the US that patients were on average, 80% (4/5 rating) satisfied with their dialysis care. Meanwhile, Drozdz et al. (2018) present evidence that European patients are more satisfied with their care, as they responded with a 90% (9/10 rating) satisfaction score, on average. More research should be conducted regarding patient satisfaction, as Doyle et al. (2012) and Junewicz & Youngner (2015) both demonstrate that increased patient satisfaction generally is associated with better patient outcomes. This research is especially needed at present, since a few US dialysis centers are working on improving the patient experience through the addition of amenities like juice bars, high-bandwidth Wi-Fi, and heated chairs (Weaver, 2014). The impact on the

satisfaction of patients due to amenities like these would make for a good area of future research.

All providers responded that diabetes and hypertension are the two most common causes of ESRD and CKD. Xie et al. (2018) confirm this finding through their study of the Global Burden of Disease data. Surprisingly though, the United States does not seem to lead Europe in both categories, just in more cases of diabetes (Blum, 2019). The United States population has a 50% higher prevalence of diabetes than Europe; however, Europe has on average, a systolic blood pressure that is 7 mm Hg higher than their US counterparts (Blum, 2019). Yoshino et al. (2006) suggest that diet plays a large role in the different rates of diabetes observed between locations. The United States has an unhealthier diet than their European counterparts. Alencar de Pinho et al. (2019) propose an interesting theory that some level of the variation seen in hypertension cases between the United States and Europe could be due to the differences in the degree of latitude between the two locations. The researchers found that for every 5° increase in latitude, there was a corresponding increase of 5 mm Hg of systolic blood pressure (Alencar de Pinho et al., 2019). Other theories that were proposed by Alencar de Pinho et al. (2019) included the difference in hypertension medications prescribed between Europe and the United States and differences in lifestyle habits, such as smoking. Overall, it must be concluded, as suggested by Xie et al. (2018) that diabetes mellitus is the most important contributing factor to the development of CKD and ESRD.

One provider responded that the average lifespan of an individual on HD was seven years, while another suggested an average range of five to ten years. This data was supported by Thurlow et al. (2021) whose mortality rate per 100 patient years suggested a lifespan around this length. Spain and Europe's mortality rate per 100 patient years were found to be 15 and 16, respectively (Cruz et al., 2003). This was much lower than the United States with

mortality rate per 100 patient years of between 18 and 33 (Thurlow et al., 2021). These figures are depicted in Figure 3.

Figure 3

Mortality Rate Comparison per 100 Patient Years (Thurlow et al., 2021 & Cruz et al., 2003)



Europe is depicted on the left side of this figure with a mortality rate of 16, while the US is on the right side with a mortality rate of 26.

The healthcare provider survey results also demonstrated that providers believe the United States ESRD population of patients is older, with an average of around 60 years. This was supported by Held et al. (1990) and Robinson & Port (2009) as both studies found that the United States had a more elderly population of patients on dialysis than Europe did. All providers surveyed also said they believe PD is a better method for renal replacement therapy than HD. Two providers also seemed to imply, without directly stating, that PD has a better survival rate than HD. This is a fascinating claim to evaluate within the literature, as the literature is torn as to whether this is true. Shin et al. (2005) van de Luitgaarden et al. (2013) as well as Devoe et al. (2016) indicated that their studies had shown PD and HD had the same survivability rates. Meanwhile, Briggs et al. (2019) spotlight that their research shows PD leads to a longer survival rate than HD. Regardless of whether PD has a longer survival rate than HD, PD has other clear advantages over HD, such as a lower cost, and it has a higher satisfaction rate with patients, likely due to having more control over day-to-day life (Briggs et al., 2019, & Tokgoz, 2009). Considering this, providers surveyed were asked why PD is

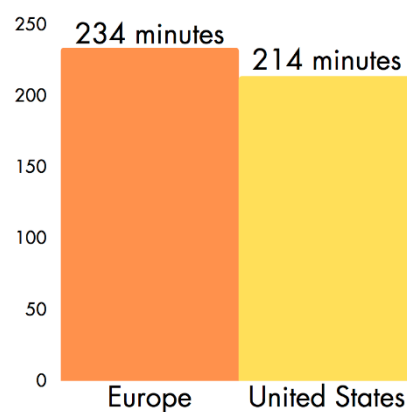
not used more, and the literature was also analyzed to try and answer this question. One provider answered that skilled nursing facilities are not equipped to take ESRD patients who are on PD. As aforementioned, with the United States' dialysis population being more elderly, this makes sense, even though no article could be found on this point. Providers also mentioned that some patients decide not to go on PD due to the space required for storage of materials and due to some patients fearing being their own caretaker. These claims were not explicitly evaluated in the literature. The literature also spoke to the issue of why PD was not utilized more, as the most recent estimate of the way the US treats ESRD suggested that only 7% of US patients used PD and less than 5% in Europe (Thurlow et al., 2021). Van de Luijngaarden et al. (2013) discussed that PD can initially be more expensive for a patient than HD is, even though PD saves a patient money over the long run. This barrier can be too much for many patients to overcome and in part may explain why ESRD patients from higher socioeconomic statuses use PD more than those from lower socioeconomic statuses (Briggs et al., 2019). An additional reason explored was that PD is not the best option for patients with diabetes mellitus, as these patients have better outcomes on HD (van de Luijngaarden et al., 2013). Lastly, PD requires more investment into staffing than HD clinics are currently able to support (Devoe et al, 2016 & Briggs et al., 2019). HD centers are normally responsible for training patients how to perform PD at home safely and effectively; however, as demonstrated by the provider survey, low HD staffing is currently an issue.

A very interesting finding from the healthcare provider survey was that all of the healthcare providers surveyed believe that the United States is “behind the curve on PD.” The providers were specifically referring to Canada, which uses PD more than the United States; however, the United States remains one of the countries that utilizes PD the most (Thurlow et al., 2021 & Briggs et al., 2019).

Other significant findings were made utilizing only the literature review. For instance, although no comparison survey or analysis was found on mean dialysis time for Europe and the United States, two separate articles mentioned the mean dialysis time for both locations. Cruz et al. (2003) mentioned that patients in Europe spent an average of 234 minutes on HD, while Thurlow et al. (2021) demonstrated that the United States only had a mean HD time of 214 minutes, one of the shorter ones in the world. This is depicted graphically in Figure 4. This is significant because longer dialysis session lengths are associated with better survival rates for HD patients, less hospitalizations, as well as better treatment outcomes, with respect to laboratory values (Tentori et al., 2012).

Figure 4

Mean Time Spent on Dialysis per Session in Europe and the United States (Cruz et al., 2003 & Thurlow et al., 2021)



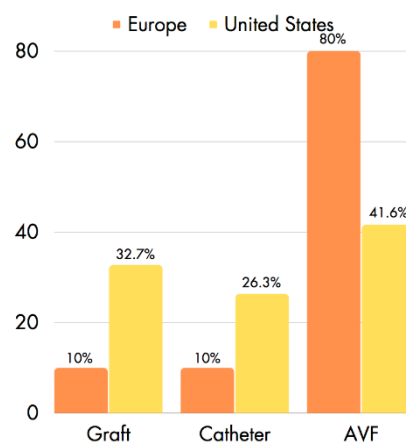
On a related note, the literature review revealed that United States ESRD patients spend less time with physicians, on average, than their European counterparts. Cruz et al. (2003) denote that 90% of European ESRD patients responded that during all or almost all of their visits to ESRD treatment facilities they saw a physician. Nissenson (2012) speaks to this issue within the United States and says that one of the greatest problems facing United States ESRD care is that not enough time is being spent with patients. Research has demonstrated

that more time and visits with a provider leads to a decrease in hospitalizations (Nissenson, 2012).

Another factor that is affecting the difference in survival rates between US and European ESRD patients is the type of vascular access utilized. Goodkin et al. (2001), as well as Gallieni et al. (2009), both speak to the different types of vascular access utilized by Europeans and the United States to perform HD. The DOPPS study showed that over one-third of US providers preferred placing a synthetic graft in their patients so that they could access HD treatment (Goodkin et al., 2001). More recent data from Gallieni et al. (2009) highlighted that 41% of HD patients received a synthetic graft, while 26.3% of patients received a catheter. The European data demonstrated that 80% of vascular access sites created were arteriovenous fistulas, while catheters and grafts were each 10% (Gallieni et al., 2009). This is significant due to the fact that catheter and synthetic graft usage have been associated with a higher incidence of infections for HD patients (Gallieni et al., 2009). Robinson & Port (2009) estimate that between 6 – 19% of the differences in mortality rates between European and US ESRD patients can be attributed to the differences in vascular access practices. These practices are graphically depicted below in Figure 5.

Figure 5

European versus United States Vascular Access Patterns (Goodkin et al., 2001 & Gallieni et al., 2009)



Conclusions

The mortality rate difference between ESRD patients in the United States and Europe has no simple cause. The observed differences are contributed to by variations in vascular access practices, time spent on dialysis, type of dialysis used, number of transplants performed, diet, lifestyle habits, medications utilized, age of population, prevalence of co-morbid diseases which impact ESRD treatment, nonadherence rates, satisfaction with ESRD care, and time spent with a provider during each visit. There are likely other factors which contribute to the differences in survival rates of ESRD treatment between Europe and the United States, as well. While some of these factors have been studied at length, many of these factors have not been explored, such as variation in patient satisfaction levels with dialysis care, as well as time spent with a provider during each visit. Furthermore, some studies have attempted to calculate the contribution that some of these factors play in the different rates of mortality seen in Europe and the United States. One study estimated that 6 – 19% of the variation in mortality rate should be attributed to the differences in vascular access care (Robinson & Port, 2009). It also seems obvious that the health status of a population in ESRD plays a major role in the differences observed between survival rates in Europe and the United States. The determining factor for ESRD treatment type and for CKD development is whether a patient has diabetes mellitus. The fact that the United States has a 50% higher prevalence of diabetes than Europe should help explain observed outcome differences (Blum, 2019).

Future Practice Suggestions

In the future, the United States should look to change its vascular access strategies, as it presently relies too heavily upon catheters and grafts. More resources and time should be spent on patient education, which would likely help with the higher rates of nonadherence, as

well as the lower levels of health literacy observed in United States patients, when compared to Japanese and European ESRD patients. Additionally, the United States should continue to look to expand its transplantation efforts by adding more funding into transplantation surgery programs or incentivizing living organ donation. The United States healthcare system should also prioritize the time a patient spends with their provider, as they are currently lagging behind their European peers. Lastly, the United States should expand its proportion of ESRD patients who undergo PD. This would include expanding staffing in HD clinics so more education about PD could be provided, and it would include increasing access of PD to skilled nursing facilities.

Limitations

The limitations of this thesis must be acknowledged. First, the Healthcare Provider Survey only included answers from three healthcare providers. All of these healthcare providers were from South Carolina, as well. It is likely that regional variation exists between the practices of in-center HD clinics and nephrology offices across the United States. This healthcare provider sample may not be representative of United States Nephrology providers as a whole. Second, the Healthcare Provider Survey attempted to gauge the opinions of healthcare providers in the United States as well as in Europe about the state of their location's ESRD treatment. No healthcare provider from Europe provided answers to this survey, despite several attempts made by the author of this thesis. Third, this thesis attempted to gauge patient satisfaction rates with their dialysis care in Europe and in the United States. Unfortunately, due to the scope of this project, as well as difficulties in accessing patients at dialysis clinics in Europe and the US, a survey was unable to be distributed. Lastly, most of the literature reviewed for this project relied on datasets which had been compiled in the 1990s or in the early 2000s. It is likely that healthcare data and trends have somewhat changed since the collection of these datasets.

Future Research

Future research topics should include another survey like the DOPPS survey or the survey done by Held et al. (1990) which were both international research team projects. These projects truly analyzed the discrepancies in ESRD treatment from every angle, as they took data from national databases. A way to improve on these studies, though, would be to ensure that all nations who responded to the study included the same categories of information. Other future research should include an international comparison study of patient satisfaction with their HD care in the United States and Europe. This research would be invaluable in evaluating another aspect of the differences in ESRD treatment within the United States and Europe. Future researchers should endeavor to analyze why the United States has such a high nonadherence rate in ESRD treatment, as opposed to Japan and Europe.

Acknowledgements

I would like to thank Dr. Teri Browne and Dr. Mohammed Alzubaidi for agreeing to serve on my Senior Thesis Committee and for their contributions in editing this thesis.

Appendices

Appendix A

Satisfaction Survey for Dialysis Patients

Satisfaction Survey for Dialysis Patients – Adapted from ICH CAHPS survey by Medicare.

Survey Instructions:

This survey is optional for you to complete and will be used for research purposes.

Answer each question by filling in the open circle to the left of your chosen answer. Your chosen answer choice should look like this:

- My answer choice

1. How long have you been getting dialysis?

- Less than 3 months
- 3 months to 1 year
- 1 year to 5 years
- Over 5 years

2. Over the past 3 months, how often did your kidney doctors really care for you and listen to what you were saying?

- Never
- Sometimes
- Usually
- Always

3. Over the past 3 months, how often did your kidney doctors spend enough time with you?

- Never
- Sometimes
- Usually
- Always

4. On a scale of 0-10, where 0 is the worst kidney doctors possible and 10 is the best kidney doctors possible, what number would you use to rate your kidney doctors?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

- 10
5. Over the past 3 months, how often did you feel that your dialysis staff (nurses, technicians, dieticians, not doctors) really cared for you and listened to what you were saying?
- Never
 - Sometimes
 - Usually
 - Always
6. Over the past 3 months, how often did you feel that your dialysis staff (nurses, technicians, dieticians, not doctors) made you comfortable?
- Never
 - Sometimes
 - Usually
 - Always
7. Over the past 3 months, how often did you feel that your dialysis staff (nurses, technicians, dieticians, not doctors) behave in a professional manner?
- Never
 - Sometimes
 - Usually
- Always
8. On a scale of 0 to 10, where 0 is the worst dialysis staff possible and 10 is the best possible dialysis staff (nurses, technicians, dieticians, not doctors) what number would you use to rate your dialysis staff?
- 0
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
9. Over the past 3 months, how often did you feel that the dialysis center was as clean as it could be?
- Never
 - Sometimes
 - Usually
 - Always

10. Over the past 3 months, how often did you feel that your dialysis needs were met at your care center?
- 5
 - 6
 - 7
 - 8
 - 9
 - 10
- Never
- Sometimes
- Usually
- Always

11. On a scale of 0 to 10, where 0 is the worst possible dialysis treatment and 10 is the best possible dialysis treatment, what number would you use to rate your dialysis experience overall?

- 0
- 1
- 2
- 3
- 4

12. What is your race? (One or more categories may be selected)

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Pacific Islander
- Mixed Race

Thank you for your participation in this survey!

Appendix B

English Version of Healthcare Provider Survey

I'm working on my Senior Thesis project to complete all the requirements to graduate from the USC Honors College. My topic is comparing the treatment of chronic kidney disease between Europe and the United States (I am not looking at preventative measures... really just once a patient has CKD). Aside from reviewing the scientific literature on the topic, I wanted to interview physicians from both areas about their thoughts/ observations.

1. How long have you been a nephrologist?
2. How do you treat most of your patients? (hemodialysis, peritoneal dialysis, transplant etc.)
 - a. Do you have a preferred treatment method, excluding transplant? Why?
 - b. Do your patients have more success on a particular treatment method, excluding transplant?
 - c. What factors do you consider in determining a treatment plan for your patients (GFR level, socioeconomic status, etc.)?
 - d. Does having enough room to store materials play a role in whether peritoneal dialysis is chosen?
3. Why is peritoneal dialysis not used more?
4. Are there enough hemodialysis clinics to treat patients?
5. In your opinion, where is the most improvement needed within the United States system for treating chronic kidney disease?
6. In your opinion, what is the best part about how the United States treats CKD?
7. In your opinion, what is the worst part about how the United States treats CKD?
8. What would your ideas be for improving how chronic kidney disease is treated within the United States?

9. Have you been overseas for conferences or talked to physicians from other nations about how they treat CKD?
 - a. Were there many differences?
 - b. What did you like/ dislike about the ways that they treated CKD?
10. Are there any new developments in treatment methods utilized to treat CKD?
11. What is the typical age of a patient who is on dialysis (under 30, 30-40, 40-50, etc.)?
12. Do you treat CKD more in males or females?
13. Are patients who are on dialysis generally satisfied with their care?
14. How do the majority of patients pay for their treatment?
15. Is the number of patients who need CKD care increasing or decreasing?
16. Do most patients have caregivers who can assist them?
17. Do most patients continue to work while on dialysis?
18. Most common cause for patient's CKD?
19. How long do patients live on dialysis on average, if unable to receive a transplant?
20. Do you have any other thoughts/ suggestions on my topic? (Thank you!)

Thank you for your assistance with my research. I greatly appreciate all of your time!

Appendix C

Spanish Version of Healthcare Provider Survey

Estoy trabajando en una tesis de mi último año de la universidad para completar mis requisitos para que pueda graduarme de la universidad de Carolina del sur con honores. Mi tema es la comparación de los métodos usados para tratar la enfermedad renal crónica (ERC) entre los EE.UU. y Europa (no soy analizando las medidas de prevención... solamente, cuando un paciente tiene ERC). Aparte de reseñando la literatura científica, quería escribir médicos de ambas áreas geográficas para obtener sus pensamientos y observaciones.

1. ¿Cuánto tiempo lleva trabajando como nefrólogo?
2. ¿Cómo trata a la mayoría de sus pacientes? (¿con hemodiálisis, diálisis peritoneal, o trasplante?)
 - a. ¿Tiene un método preferido, excepto trasplante? ¿Por qué?
 - b. ¿Tienen más éxito sus pacientes en un método de tratamiento, excepto trasplante?
 - c. ¿Cuál factores considera en su determinación de un plan por tratamiento (la tasa de filtración glomerular, estatus socioeconómico, presencia de un cuidador)?
 - d. ¿La habilidad de un paciente para guardar los materiales (tener bastante espacio) juega un papel en la decisión del método de tratamiento?
3. ¿Por qué no usa la diálisis peritoneal más en Europa?
4. ¿Hay bastante clínicas de hemodiálisis para tratar todos los pacientes que lo necesitan?
5. ¿En su opinión, cuál área del tratamiento de la enfermedad renal crónica podría ser mejorado lo más dentro de España?

6. ¿En su opinión, cuál es lo mejor parte de la manera en que España trata a la enfermedad renal crónica?
7. ¿En su opinión, cuál es lo peor parte de la manera en que España trata a la enfermedad renal crónica?
8. ¿Cómo mejoraría Ud. la manera en que España trata a la enfermedad renal crónica?
9. ¿Ha viajado por conferencias o ha hablado a médicos de los Estados Unidos o otro país en Europa sobre las maneras en que tratan a la enfermedad renal crónica?
 - a. ¿Había muchas diferencias?
 - b. ¿A qué le gustaba sobre las maneras en que el/ los país/ países trataba(n) a la enfermedad renal crónica?
10. ¿Hay nuevos desarrollos en los métodos de tratamiento por la enfermedad renal crónica?
11. ¿En este momento, cuántos personas (aproximadamente) están esperando por un trasplante de riñón en España?
12. ¿Cuáles son los factores que determinan la elegibilidad de un paciente por recibir un trasplante en España? ¿Puede describir este proceso un poquito?
13. ¿Quiénes son los empleados que tratan a los pacientes con la enfermedad renal crónica en España? (ej.: médicos, etc.)
14. ¿Cuáles son los requisitos generales para cuando un paciente necesita empezar diálisis en España? (ej.: la tasa de filtración glomerular, nivel de creatinina, etc.)
15. ¿Cuál es la edad típica de sus pacientes en diálisis (debajo de 30, 30-40, 40-50, etc.)?
16. ¿Trata Ud. a la enfermedad renal crónica más en los hombres o las mujeres?
17. ¿En su opinión, son satisfechos con su cuidado la mayoría de los pacientes en diálisis?
18. ¿Cómo pagan por su tratamiento la mayoría de sus pacientes?

19. ¿Está aumentando o está bajando el número de pacientes quien requieren cuidado por la enfermedad renal crónica?
20. ¿Tienen cuidadores la mayoría de sus pacientes?
21. ¿Continúan a trabajar cuando están en diálisis la mayoría de los pacientes?
22. ¿Cuál es la causa más común de la enfermedad renal crónica de sus pacientes?
23. ¿Por cuánto tiempo viven los pacientes, en promedio, si no pueden recibir un trasplante?
24. ¿Tienen otros pensamientos o sugerencias sobre mi tema? Si no, muchísimas gracias por todo su tiempo.

Gracias otra vez por su ayuda con mis investigaciones. ¡Me lo agradezco todo su tiempo!

Appendix D

Answers to Survey from Physician's Assistant

1. How long have you been a nephrologist? *I have been practicing as a PA in nephrology for about 9 years.*
2. How do you treat most of your patients? (hemodialysis, peritoneal dialysis, transplant etc.)
 - a. Do you have a preferred treatment method, excluding transplant? Why? *My preferred method would be peritoneal dialysis because I believe it provides the majority of patients with the best quality of life.*
 - b. Do your patients have more success on a particular treatment method, excluding transplant? *It depends on the patient honestly. I like to think home modalities (home hemo or PD) generally result in more success because those patients are generally more satisfied; however, we also have plenty of patients who have successfully done in-center hemo for years as well.*
 - c. What factors do you consider in determining a treatment plan for your patients (GFR level, socioeconomic status, etc.)? *Lifestyle goals, social support, co-morbidities, living arrangements/conditions.*
 - d. Does having enough room to store materials play a role in whether peritoneal dialysis is chosen? *Yes. Patients often cite having a small house that is already crowded as a reason they don't choose to do PD.*
3. Why is peritoneal dialysis not used more? *Certain patients don't like the idea of doing dialysis at home. Despite education, they feel it's less clean or that they are unable to perform it adequately. The fact that most rehabs and SNFs do not accommodate PD patients is a barrier as well. We often have to transition people from PD to HD so they can go to facilities.*

4. Are there enough hemodialysis clinics to treat patients? *In our area we have sufficient clinics*
5. In your opinion, where is the most improvement needed within the United States system for treating chronic kidney disease? *We need more education at PCP level and during early stages of CKD. Many people don't realize their diabetes and high blood pressure will eventually lead to CKD and possible dialysis if left poorly controlled. We also need more resources for dialysis education. Patients require repetition typically before they accept that dialysis is likely in their future and begin to plan accordingly.*
6. In your opinion, what is the best part about how the United States treats CKD? *New meds and research. Transplant*
7. In your opinion, what is the worst part about how the United States treats CKD? *It's reactive instead of proactive/preventive if that makes sense.*
8. What would your ideas be for improving how chronic kidney disease is treated within the United States?
9. Have you been overseas for conferences or talked to physicians from other nations about how they treat CKD? *We had a physician from Canada come speak to our group about PD. Based on her talk, it seems like we are a bit behind the curve on urgent start PD and PD in general compared to where she practices in Canada.*
 - a. Were there many differences?
 - b. What did you like/ dislike about the ways that they treated CKD?
10. Are there any new developments in treatment methods utilized to treat CKD? *We have two new drug classes being used to treat CKD, which is exciting. Prior to the SGLT-2s and Kerendia there had not been any new CKD treatments for a while.*

11. What is the typical age of a patient who is on dialysis (under 30, 30-40, 40-50, etc.)?
Hard to say. 50-80 probably? We have several younger patients as well, but averaging all the patients the mean age is probably about 60ish.
12. Do you treat CKD more in males or females? *Not sure to be honest. Seems relatively equal.*
13. Are patients who are on dialysis generally satisfied with their care? *It depends. I find those who are not satisfied are often generally dissatisfied with their medical care in general, not just their dialysis care specifically. It does feel like less and less patients are satisfied in general these days though.*
14. How do the majority of patients pay for their treatment? *Medicare/Medicaid*
15. Is the number of patients who need CKD care increasing or decreasing? *Increasing*
16. Do most patients have caregivers who can assist them? *Many do, but plenty do not*
17. Do most patients continue to work while on dialysis? *No, most do not.*
18. Most common cause for patient's CKD? *Diabetes/HTN*
19. How long do patients live on dialysis on average, if unable to receive a transplant? *I think the average is about 5-10 years, but this varies significantly*
20. Do you have any other thoughts/ suggestions on my topic? (Thank you!)

Appendix E

Answers to Survey from Nurse Practitioner

1. How long have you been a nephrologist?

I am a Nurse Practitioner and have been practicing in nephrology for 11 years (will be 12 years in 4/2023).

2. How do you treat most of your patients? (hemodialysis, peritoneal dialysis, transplant etc.)

The treatment of patients is individual. Once patients transition to Chronic Kidney Disease Stage 4, GFR less than 30, we start working towards dialysis and transplant education.

The patients ultimately are the ones who choose their treatment. We highly recommend a home dialysis method, but we still have a large population who chooses in-center hemodialysis.

- a. Do you have a preferred treatment method, excluding transplant? Why?

My preferred dialysis choice is peritoneal dialysis. I believe that the patient feels better and has more quality of life with peritoneal dialysis. While there is still a lot of work and requires a great deal of medical supplies in the home, they are performing peritoneal dialysis while they are sleeping, and so their waking hours are their own to spend how they want to spend them. I also believe that peritoneal dialysis has less cardiovascular complications/risks.

- b. Do your patients have more success on a particular treatment method, excluding transplant?

I believe that patients do better overall on peritoneal dialysis.

- c. What factors do you consider in determining a treatment plan for your patients (GFR level, socioeconomic status, etc.)?

The treatment plan is determined mostly by the patient and their family. Hopefully with proper education, they will choose what is best for them. Certainly, socioeconomic status does play a part, but education level also plays a part. Fear and anxiety of doing home dialysis is also a factor that plays into determining treatment plan.

- d. Does having enough room to store materials play a role in whether peritoneal dialysis is chosen?

Yes. I do believe that it does. There have been several patients that could not do peritoneal dialysis either due to the size of their home/apartment and/or they did not want all the medical supplies in their home. Also, if they do not have a stable home (homeless or staying with a roommate/family temporarily) also plays a role in that choice.

3. Why is peritoneal dialysis not used more?

I believe that fear and anxiety play a huge factor in this. Patients do not feel that they could ever be equipped to be able to perform peritoneal dialysis at home.

I also believe that the nephrologist's personal preference plays a role in the choice of dialysis method.

Also, if the patient has not been educated properly, they will typically choose in-center hemodialysis.

Lastly, if the patient is started urgently on dialysis in the hospital, 99% of the time, they are started on in-center hemodialysis, and at that point, they typically choose to stay on in-center because it is what they know.

4. Are there enough hemodialysis clinics to treat patients?

In the Greenville/Upstate area, Yes.

5. In your opinion, where is the most improvement needed within the United States system for treating chronic kidney disease?

EDUCATION! Education in the community about kidney disease so that the shame of the disease can be eradicated. And education within the medical system about earlier referrals for CKD.

6. In your opinion, what is the best part about how the United States treats CKD?

Choice of dialysis treatment, access to dialysis

7. In your opinion, what is the worst part about how the United States treats CKD?

Lack of earlier referrals to evaluate if the patient can at least slow the progression of CKD.

8. What would your ideas be for improving how chronic kidney disease is treated within the United States?

EDUCATION!

9. Have you been overseas for conferences or talked to physicians from other nations about how they treat CKD?

Several years ago, I was at the National Kidney Foundation meeting in New Orleans, and I had a breakout session with 2 physicians who practice in Canada.

- a. Were there many differences? *They used Peritoneal Dialysis more than in-center HD.*
- b. What did you like/ dislike about the ways that they treated CKD? *I was very impressed that they*
10. Are there any new developments in treatment methods utilized to treat CKD? *For patients with CKD stage 2-CKD stage 4 with GFR greater than 20, the newest SGLT2i have been a wonderful addition to help prevent progression of CKD.*
11. What is the typical age of a patient who is on dialysis (under 30, 30-40, 40-50, etc.)? *Our typical patient's age is 60.*
12. Do you treat CKD more in males or females? *I treat more males than females.*
13. Are patients who are on dialysis generally satisfied with their care? *I believe that they can acknowledge that they feel better and understand that this is a life-sustaining treatment. However, I believe that the life of dialysis is hard. It is a huge adjustment to their lifestyle.*
14. How do the majority of patients pay for their treatment? *The majority of the patients pay for their dialysis treatments with Medicare dollars.*
15. Is the number of patients who need CKD care increasing or decreasing? *Increasing*
16. Do most patients have caregivers who can assist them? *Yes.*
17. Do most patients continue to work while on dialysis? *No. Most choose to go on disability.*
18. Most common cause for patient's CKD? *Hypertension and diabetes*

19. How long do patients live on dialysis on average, if unable to receive a transplant? *7 years*

20. Do you have any other thoughts/ suggestions on my topic? (Thank you!)
Nephrology is a beautiful specialty. The patients are widely diverse in culture, education, and socioeconomic status. One of the beauties of working in this specialty is meeting and getting to know the patients and their families. And when one of our patients gets a transplant, it is a celebration. I am grateful for this specialty, and I am excited to see others like yourself join forces to improve patients life, both in years and in quality.

Appendix F

Answers to Survey from Medical Doctor

1. How long have you been a nephrologist? *6 years*
2. How do you treat most of your patients? (hemodialysis, peritoneal dialysis, transplant etc.)
 - a. Do you have a preferred treatment method, excluding transplant? Why? *Home dialysis preferred as it gives patient flexibility to continue to work, go on vacation, and is gentler.*
 - b. Do your patients have more success on a particular treatment method, excluding transplant? *Home dialysis is more successful as the patients tend to be healthier and more adherent*
 - c. What factors do you consider in determining a treatment plan for your patients (GFR level, socioeconomic status, etc.)? *age, working full time job?, availability of social support (partner to help with dialysis)*
 - d. Does having enough room to store materials play a role in whether peritoneal dialysis is chosen? *Yes for PD*
3. Why is peritoneal dialysis not used more? *Gentler and more flexible days and better quality of life*
4. Are there enough hemodialysis clinics to treat patients? *Yes but staffing (nursing) is an issue after COVID-19*
5. In your opinion, where is the most improvement needed within the United States system for treating chronic kidney disease? *more access to transplant and more focus on prevention*
6. In your opinion, what is the best part about how the United States treats CKD? *Dialysis is paid for by Medicare or Medicaid*

7. In your opinion, what is the worst part about how the United States treats CKD? High in center dialysis (85-90%)
8. What would your ideas be for improving how chronic kidney disease is treated within the United States? *Early referral to transplant. Artificial kidney, xenotransplant*
9. Have you been overseas for conferences or talked to physicians from other nations about how they treat CKD?
 - a. Were there many differences? *More home dialysis*
 - b. What did you like/ dislike about the ways that they treated CKD? *NA*
10. Are there any new developments in treatment methods utilized to treat CKD?
Xenotransplant
11. What is the typical age of a patient who is on dialysis (under 30, 30-40, 40-50, etc.)?
> 50 years
12. Do you treat CKD more in males or females? *male*
13. Are patients who are on dialysis generally satisfied with their care? *Home dialysis patients are more satisfied*
14. How do the majority of patients pay for their treatment? *Medicare and Medicaid*
15. Is the number of patients who need CKD care increasing or decreasing? *Increasing*
16. Do most patients have caregivers who can assist them? *I'd say 50% do*
17. Do most patients continue to work while on dialysis? *Not most. Most in center dialysis patient file for disability. Some home dialysis continue to work*
18. Most common cause for patient's CKD? *Diabetes and HTN*
19. How long do patients live on dialysis on average, if unable to receive a transplant?
Depends on age they start dialysis and what modality they start on (in center for home. Look at USRDS data.
20. Do you have any other thoughts/ suggestions on my topic? (Thank you!)

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