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Effects of disease and hemodialysis adequacy in patients with arterial stiffness

Efeitos da doença e adequação da hemodiálise em pacientes com rigidez arterial

Efectos de la enfermedad y adecuación de la hemodiálisis en pacientes con rigidez arterial

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ABSTRACT

Objectives: To analyze the adequacy of hemodialysis treatment in patients with arterial stiffness and to associate the effects of renal disease with sociodemographic and clinical factors. **Method:** A cross-sectional epidemiological study with 149 chronic renal patients undergoing hemodialysis treatment, in the interior of the State of São Paulo. They used to measure arterial stiffness with the Dyna-MAPA® device. The tests statistical were multivariate linear regression, t Student and chi-square were applied to the biomarkers and the occurrence of arterial stiffness. **Results:** Most were of productive age, professionally inactive, male, in a stable union, water, and food restriction, and with less than 48 months of dialysis treatment and 36.9% of patients had arterial stiffness. The biomarkers creatinine, urea, and phosphorus were increased, hematocrit and hemoglobin were decreased, mean interdialytic weight was 2.34 ± 1.4kg, and most of the Kt / V inadequate. The effects of renal disease were statistically significant with those enrolled in the transplant list, longer treatment time, and increased creatinine. **Conclusion:** These results are expected to reduce cardiovascular morbidity and mortality in these patients.

Keywords: Chronic kidney disease; Quality of life; Hemodialysis; Arterial stiffness; Pulse wave velocity.

RESUMO

Objetivos: Analisar a adequação do tratamento hemodialítico em pacientes com rigidez arterial e associar os efeitos da doença renal com os fatores sociodemográficos e clínicos. **Método:** Estudo epidemiológico, transversal realizado com 149 renais crônicos em tratamento de hemodiálise, no interior do Estado de São Paulo. Utilizou para medida da rigidez arterial o aparelho de Dyna-MAPA®. Foram aplicados os testes de regressão linear multivariada, *t Student* e o qui-quadrado para os biomarcadores e a ocorrência de rigidez arterial. **Resultados:** A maioria estava em idade produtiva, inativa profissionalmente, do sexo masculino, em união estável, fazendo restrição hídrica e alimentar e com menos de 48 meses de tratamento dialítico e 36,9% dos pacientes apresentavam rigidez arterial. Os biomarcadores creatinina, ureia e fósforo estavam aumentados, hematócrito e hemoglobina estavam diminuídos, média de peso interdialítico de 2,34 ± 1,4 kg, e a maioria do Kt/V inadequado. Quanto aos efeitos da doença renal observou-se significância estatística com os inscritos na lista de transplantes, maior tempo de tratamento e aumento da creatinina. **Conclusão:** Espera-se que esses resultados proporcionem a diminuição da morbimortalidade cardiovascular desses pacientes.

Palavras-chave: Doença renal crônica; Qualidade de vida; Hemodiálise; Rigidez arterial; Velocidade de onda de pulso.

RESUMEN

Objetivos: Analizar la adecuación del tratamiento hemodialítico en pacientes con rigidez arterial y asociar los efectos de la enfermedad renal con los factores sociodemográficos y clínicos. **Método:** Estudio epidemiológico, transversal realizado con 149 renales crónicos en tratamiento de hemodiálisis, en el interior del Estado de São Paulo. Utilizaron el instrumento para medir la rigidez arterial el aparato de Dyna-MAPA®. Se aplicaron los pruebas de Regresión Lineal Multivaria, t Student y el Chi-Cuadrado para los biomarcadores y la ocurrencia de rigidez arterial. **Resultados:** La mayoría estaba en edad productiva, inactiva profesionalmente, del sexo masculino, en unión estable, haciendo restricción hídrica y alimentar y con menos de 48 meses de tratamiento dialítico y 36,9% de los pacientes presentaban rigidez arterial. Los biomarcadores creatinina, urea y fósforo estaban aumentados, hematocrito y hemoglobina estaban disminuidos, media de peso interdialítico de 2,34 ± 1,4 kg, y la mayoría del Kt / V inadecuado. En cuanto a los efectos de la enfermedad renal se observó significancia estadística con los inscritos en la lista de trasplantes, mayor tiempo de tratamiento y aumento de la creatinina. **Conclusión:** Se espera que estos resultados proporcionen la disminución de la morbimortalidad cardiovascular de estos pacientes.

Palabras clave: Enfermedad renal crónica; Calidad de vida; hemodiálisis; Rigidez arterial; Velocidad de onda de pulso.

INTRODUCTION

Chronic Kidney Disease (CKD) is a public health problem and accounts for a large portion of the expenses for the Brazilian Unified Health System (SUS) that are spent on non-communicable chronic diseases.[1]

In July 2016, there were 122,825 patients undergoing renal replacement therapy (RRT) in Brazil.[2] Patients with CKD require health education because it is a disease that affects an individual's lifestyle, while fluid restrictions, lack of treatment adherence, and physical inactivity are major cardiovascular risk factors threatening to decrease the survival of patients. These are modifiable factors and health workers should monitor and sensitize patients with chronic kidney disease regarding changing their habits to improve quality of life.[3]

Health-Related Quality of Life (HRQoL) is based on the individuals' perceptions and on the impact of various relevant clinical and non-clinical aspects that influence the lives of patients, such as perception of general health, physical health, mental/emotional state, social role, sexual life, and aspects of diseases, in addition to indirect consequences, such as unemployment and financial problems.[4]

Being confronted with a chronic kidney disease with the perspective to be dependent on an invasive therapy such as hemodialysis, as well as having to comply with food and fluid restrictions and deal with its symptoms, may lead patients with CKD to experience conflicts and difficulty coping with it.[5]

Many patients undergoing hemodialysis have problems dealing with the effects of kidney disease, while the treatment needs to be adequate. Inadequate hemodialysis is associated with higher mortality rates and an increased number of healthcare actions.[6]

Hemodialysis adequacy is important to ensuring the quality of dialysis individually and routinely provided in order to decrease the effects caused by the accumulation of uremic toxins in the body, which contribute to anorexia and malnutrition.[7] Thus, nephrology nurses play an essential role in the patients' self-care management process and should understand how patients deal with the limitations imposed by CKD and dialysis treatment. Self-care effectiveness depends on proper guidance provided by the entire nephrology health team.[6]

The high risk of Cardiovascular Diseases (CVD) needs to be assessed, in order to implement preventive and intervention strategies, essential to managing patients undergoing hemodialysis.[8]

Arterial stiffness, which precedes cardiovascular diseases, is characterized by decreased compliance of great arteries. The phenomenon occurs both with aging and in the presence of diseases associated with the cardiovascular system, such as diabetes, atherosclerosis and chronic kidney disease.[8] Patients with CKD undergoing dialysis are at a greater risk of mortality when presenting increased arterial stiffness.[9] Pulse wave velocity (PWV) is a non-invasive assessment of arterial stiffness that should be performed in patients at the onset of chronic kidney disease to accomplish vascular access of the artery-venous fistula, which also contributes to preventing cardiovascular diseases.[10]

Nursing care directed to patients with CKD can use self-care education in hemodialysis treatment, promoting modifications in lifestyle, encouraging treatment adherence and providing nutritional support to control the disease and consequently improve RHQoL.[11]

Thus, this study's objective was to analyze hemodialysis adequacy among patients with arterial stiffness and correlate the effects of chronic kidney disease with sociodemographic and clinical factors.

MATERIAL AND METHODS

This cross-sectional and epidemiological study with a quantitative approach was conducted in the hemodialysis unit of a university hospital located in the interior of São Paulo, Brazil, from August 2016 to July 2017.

The sample was composed of 149 patients with chronic kidney disease undergoing hemodialysis who met the following inclusion criteria: older than 18 years of age; with a diagnosis of CKD and undergoing hemodialysis for more than six months; both sexes; with no cognitive deficits, according to a medical diagnosis. Patients who were transferred to another modality of treatment (peritoneal dialysis or kidney transplantation) were excluded. The following statistical parameters were considered when calculating the sample size: 95% confidence interval and maximum statistical error of 5.0%. The minimum sample size was calculated to be 140 individuals, considering this study population (N=300).

The medical records of patients in Nefrodata Computerized Record System were searched to confirm sociodemographic data (sex, age, paid job, city of origin, means of transportation) and clinical data (fluid and food restriction, blood pressure, interdialytic weight, blood glucose, Kt/V, creatinine, pre-dialysis urea, potassium, calcium, phosphorus, hemoglobin, hematocrit, exercises, leisure, and length of treatment). Clinical data followed the clinical guidelines provided by the Brazilian Ministry of Health for patients with chronic kidney disease.[12]

The variables concerning the effects of kidney disease were: decreased intake of fluids; food restrictions; daily living activities; leisure; dependency on physicians and health workers; stress; and length of treatment.

Laboratory exams explaining the intensity of kidney disease effects were also used, namely blood glucose, creatinine, urea, potassium, calcium, phosphorus, hemoglobin, hematocrit, and Kt/V. The patients' clinical histories and laboratory results were collected from the electronic medical record where patients' information is stored. Laboratory exams followed recommendations of protocols for patients with end-stage renal disease. Kt/V was obtained from a microcomputer program using the Daugirdas equation and urea kinetics for its computation. A Kt/V below 1.2 indicated dialysis was inadequate.[13]

Arterial stiffness, measured with a Dyna-MAPA® device, is a non-invasive procedure that assessed arterial stiffness through pulse wave velocity (PWV). Dyna-MAPA® provides data such as sex, pulse pressure, weight, height, heart rate, systolic blood

pressure (SBP), diastolic blood pressure (DBP), body mass index (BMI), and arterial and aortic stiffness measures. A PWV equal to or greater than 10 m/s indicated arterial stiffness.[14]

The measures were taken during a hemodialysis session and took 30 minutes. Patients supported their arms on a movable support so that the brachial artery would be at heart level and cuffs appropriately sized for arm circumference were used.

Minitab 17 (Minitab Inc.) was used to analyze the variables concerning effects of kidney disease. The following tests were performed: Student's t-test for independent samples, to compare quantitative variables with the occurrence of arterial stiffness; and the Chi-squared test was used to check for potential associations between qualitative variables; and tests of hypotheses using multivaritate linear regression analysis. The level of significance was set at 5% (P<0.05).

The study was approved by the Institutional Review Board at the São José do Rio Preto Medical School (No. CAAE46445715.3.3.0000.5415). The patients signed free and informed consent forms.

RESULTS

Most of the 149 participants were men (58.8%); 50.5% were aged from 18 to 60 years old; 73.34% were in stable unions; 38.3% had up to five years of schooling; 66.6% were undergoing hemodialysis treatment from six to 48 months; 66% were retired; and 66% resided in other cities and used public transportation to commute to the hemodialysis unit.

Regarding the clinical data presented in table 1, 31.1% of the patients presented diabetes mellitus as an underlying disease associated with Systemic Arterial Hypertension; 25% were on the kidney transplant waitlist; 49% were normotensive, with interdialytic weight below two kilograms, on average; 73% reported compliance with fluid restrictions and 67% compliance with food restrictions. The laboratory exams of most patients revealed a change in outcomes: the results concerning creatinine (52%), urea (74%), and phosphorus (56%) showed an increase, while hematocrit (58%) and hemoglobin (74%) decreased. The participants gained 2.34 Kg ± 1.4 kg of interdialytic weight, on average, and Kt/V was inadequate in 72%.

Table 2 presents the clinical variables concerning the effects of kidney disease that presented a significance level of 5% (P<0.05): length of treatment (p=0.042) and being on the kidney transplant waitlist (p=0.002).

The Linear Regression analysis concerning biochemical markers used to compare the variables of kidney disease effects showed statistical significance for creatinine (p=0.038).

Of the 149 patients addressed in this study, 55 (36.9%) presented arterial stiffness. Spearman's correlation was used to analyze association between the results of laboratory exams and arterial stiffness, which most frequently affected those with systolic arterial hypertension (Table 3).

The analysis of laboratory exams correlated with arterial stiffness among patients undergoing hemodialysis showed statistical significance for the variable SBP (p-value=0.015).

Table 1. Distribution of the clinical variables of patients undergoing hemodialysis in a university hospital in the São Paulo, Brazil 2017.

Clinical variables	n (%)
Fluid restriction	
Yes	108 (73)
No	41 (27)
Food restriction	
Yes	99 (67)
No	50 (33)
Blood pressure	
Hypertensive	70 (47)
Normotensive	74 (49)
Hypotensive	5(04)
Interdialytic weight	
<2 Kg	71 (47)
2.1 to 4 Kg	65 (44)
>4.1 Kg	13 (09)
Blood glucose	
Adequate	90 (60)
Inadequate	59 (40)
Kt/V	
Adequate	43 (28)
Inadequate	106 (72)
Creatinine	
<1.5	7 (05)
1.6 to 7.5	64 (43)
>7.6	78 (52)
Pre-dialysis urea	
Adequate	40 (26)
Inadequate	109 (74)
Potassium	
<5	93 (62)
>5.1	56 (38)
Calcium	
Hypocalcemia	40 (26)
Normal	100 (67)
Hypercalcemia	9 (07)
Phosphorus	
Hyperphosphatemia	83 (56)
Normal	66 (44)
Hemoglobin	
Adequate	40 (26)
Inadequate	109 (74)
Hematocrit	
Adequate	65 (44)
Inadequate	84 (58)

Table 2. Analysis of dependence between clinical variables regarding the effects of kidney disease among patients undergoing hemodialysis in a university hospital in the interior of São Paulo, Brazil 2017

Variables	Non-standardized coefficients		Standardized coefficients	p-value*
	B	Standard error	Beta	
Exercise	0.588	3.622	0.014	0.871
Leisure	-2.405	3.223	-0.169	0.457
Length of treatment	-0.077	0.037	-0.169	0.042
Fluid restrictions	1.434	3.891	0.034	0.713
Food restrictions	-1.674	3.758	-0.041	0.657
Interdialytic weight	-0.482	1.119	-0.035	0.668
Transplant waitlist	11.437	3.674	0.257	0.002
City	-2.669	3.196	0.068	0.405

*P-value concerning the Linear Regression test for independent samples P<0.05.

Table 3. Analysis between laboratory exams and arterial stiffness among patients undergoing hemodialysis in a university hospital located in the interior of São Paulo, Brazil 2017

Variables	p-value*
Exercise	0.976
Leisure	0.664
Length of treatment	0.448
Kidney disease side effects	0.742
Fluid restrictions	0.078
Food restrictions	0.451
Interdialytic weight	0.234
Transplant waitlist	0.631
City	0.125
PAS-mmHg	**0.015**
PAD-mmHg	0.907
Blood glucose	0.396
Creatinine	0.648
Urea	0.958
Hematocrit	0.817
Hemoglobin	0.304
Potassium	0.817
Phosphorus	0.89

*P-value concerning Student's t-test and Chi-squared for independent samples at p<0.05.

DISCUSSION

Most of the 149 participants were men. According to the Brazilian Society of Nephrology, the 2016 Brazilian Dialysis Census reports that approximately 57% of the patients with chronic kidney disease were men and 42% were women.[2] Data from a Brazilian study and an international one corroborate these findings.[15,16]

Another relevant piece of information is that most of the interviewees live in other cities and use public transportation to commute to the hemodialysis unit. One study addressing 200 patients found that the quality of the commute and distance from the dialysis unit interferes in hemodialysis treatment.[17]

Intending to determine what factors contribute to obtaining better results for hemodialysis regimes, researchers conducted a non-randomized clinical trial by controlling the intake of fluids in interdialytic periods and verified that an educational and motivational intervention positively impacted modification of habits among patients with chronic kidney disease.[18] Most of this study's patients reported compliance with fluid and food restrictions.

One study analyzing the understanding of 210 chronic kidney disease patients regarding self-care verified that 56.2% were aware of dietetic restrictions and 62.4% had received guidance regarding fluid restrictions.[19]

In regard to Kt/V, only 28% of the participants presented adequate results. Different findings are reported by a study conducted in the south of Brazil, in which 99 out of the 110 patients interviewed presented adequate results.[20]

Clinical Practice Guidelines for Dialysis Adequacy emphasize the importance of keeping hemodialysis at appropriate Kt/V values, that is, above 1.2, in order to decrease the occurrence of complications during sessions.[21]

The participants had an average interdialytic weight gain of 2.34kg ± 1.4 kg, a finding that corroborates other Brazilian studies.[22,23]

When excessive interdialytic weight is gained, patients are more likely to experience hypotension and complications during hemodialysis with ultrafiltration, which indicates the need for nurses to provide health education to avoid such an effect.[24]

Excessive interdialytic weight gain has been associated with increased risk of left ventricular hypertrophy, hypotension, and cardiovascular comorbidities and mortality. In the United States, patients undergoing hemodialysis presented high hospitalization

rates due to fluid overload, which entails significant healthcare costs.[25]

The laboratory exams of most patients showed changes: creatinine, urea and phosphorus results were above normal, while hematocrit and hemoglobin were lower than normal. This study's results corroborate those reported in other studies.[26-28]

A total of 74% of the interviewees were anemic, as their hematocrit and hemoglobin levels were below normal parameters. This condition directly influences the lives of patients undergoing hemodialysis, making everyday tasks more difficult due to the debilitating state resulting from anemia.[29]

Despite the physical and social limitations faced by patients in hemodialysis, their health perceptions improve over time. Studies show improved quality of life when individuals compare their current condition with prior health conditions.[29-31]

Creatinine (p=0.038) appears statistically significant in the linear regression analysis when compared to the effects of kidney disease. Creatinine is an index of kidney function and is considered to be an important predictor of muscle tissue and survival in addition to be related to quality of life.[32]

This study's results show that most patients in hemodialysis presented creatinine above 7.6mg/dl, which agrees with the results of a study addressing 354 individuals in hemodialysis (creatinine equal to 7.72mg/dl), which reports a positive correlation between serum creatinine and mental health.[33]

Researchers found that arterial stiffness precedes cardiovascular disease, that is, 39.6% of this study population is at an increased risk.[34] One study reports a progressive increase of arterial stiffness as a predictor of mortality and cardiovascular events among patients with end-stage kidney failure, regardless of anemia, nutrition levels and hemoglobin variability.[35] Patients with CKD may experience arterial stiffness due to decreased arterial compliance and glomerular filtration.[34]

When comparing clinical variables with arterial stiffness, systolic blood pressure (SBP) was found to be statistically significant. A study addressing 150 patients undergoing hemodialysis report that SBP above normal levels was associated with a two-fold risk of cardiovascular mortality in comparison to lower SBP levels.[36]

The identification of patients at a high risk of CVD who require preventive and educational strategies is essential to managing patients in hemodialysis. It is known that high blood pressure variability during hemodialysis sessions contributes to the risk of cardiovascular complications.[9]

Nurses play a key role on the multidisciplinary team in sensitizing chronic kidney patients to the importance of modifying habits and adhering to their treatment to ensure improved quality of life and survival.[37]

This study's limitations include the fact that the database in the electronic system used by the hemodialysis unit is incomplete and that we had a limited amount of time to conduct this study. The results, however, can support educational interventions intended to properly complete databases of patients undergoing hemodialysis.

CONCLUSION

This study enabled assessing the adequacy of hemodialysis treatment among patients with arterial stiffness and correlate sociodemographic and clinical factors with the effects of CKD. The conclusion is that the sociodemographic and clinical profiles of the patients addressed here is in agreement with what is reported in the Brazilian literature and that the effects of kidney disease, creatinine, length of treatment, and being on the kidney transplant waitlist presented a positive impact. Systolic blood pressure was the only variable that was significantly correlated with arterial stiffness.

This study's results provide support for multiprofessional teams in the implementation of educational therapy interventions intended to prevent and fight cardiovascular morbidity.

AUTHORS' CONTRIBUTIONS

Study design. Data acquisition and analysis. Finding discussion. Writing and critical revision of the manuscript. Final version approval of the article. Responsibility for all contents issues and the integrity of the published article: Letícia Carvalho, Claudia Bernardi Cesarino, Leiza Franco Garcia. Writing and critical revision of the manuscript. Final version approval of the article. Responsibility for all contents issues and the integrity of the published article: Rita de Cassia Helu Mendonça Ribeiro, Fabiana de Souza Orlandi, Luciana Kusumota.

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