

Economic analysis of blood pressure control in patients undergoing hemodialysis, ambulatory cyclical peritoneal dialysis, and automated peritoneal dialysis

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Abstract

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Introduction: Blood pressure (BP) control is a fundamental objective in patients with stage 5D chronic kidney disease since hypertension and hypotension cause adverse effects on the patient's quality of life and predispose them to increased cardiovascular risk. This study aimed to carry out an economic analysis of the prescription of antihypertensives in a group of patients undergoing renal function replacement therapy.

Methods: This is a cross-sectional study of the hemodialysis service of the "José Carrasco Arteaga" hospital. The variables were: type of dialysis, sex, use of antihypertensives, type of antihypertensives, and cost. The sample was nonprobabilistic.

Results: 174 patients were analyzed, 73 (41.95%) in a hemodialysis (HD) program, 80 (45.98%) in automated peritoneal dialysis (APD), and 21 (12.07%) in manual peritoneal dialysis (PD) program. 74% of men were on HD, 39 cases (48.7%) on PD, and 12 cases (57.14%) on DPA. The use of antihypertensives in HD was 84%; in PD, it was 86%; in DPA, it was 86%. The cost of antihypertensives was 12.5 ± 8.7 USD in HD, 15.7 ± 22.4 in PD, and 16.4 ± 18.6 USD $P > 0.05$ in CAPD.

Conclusion: the use of antihypertensives in this study group was more than 84% in the different dialysis modalities, without significant difference in the cost analysis.

Keywords:

MESH: Renal Dialysis; Renal Insufficiency, Chronic; Essential Hypertension; Cost-Effectiveness Analysis.

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Hypertension among hemodialysis patients is common and often inadequately controlled. Meta-analyses of randomized trials showed that deliberate lowering of blood pressure (BP) with antihypertensive medications improves clinical outcomes in hemodialysis patients [1]. Restriction of dietary sodium intake, elimination of intradialytic sodium gain through individualized dialysate sodium prescription, optimal assessment and management of dry weight, and sufficient duration of dialysis are considerations as first-line treatments to control BP [2]. If BP remains uncontrolled despite adequate volume management, the next consideration is antihypertensive therapy.

Randomized trials with angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs) do not provide consistent cardioprotection in hemodialysis patients. β -Blockers may provide a more consistent CV benefit. Although some preliminary clinical trials have shown that mineralocorticoid receptor antagonists (MRAs) reduce CV mortality, the associated risk of hyperkalemia raises significant safety concerns about using MRAs as adjunctive therapy [3, 4].

The objective of this study was to conduct a descriptive analysis of the antihypertensive drugs used and to analyze the costs in a group of patients in hemodialysis programs who were hospitalized due to decompensation or complications compared with patients in peritoneal dialysis programs.

Materials and methods

Study design

The present study is cross-sectional. The source is prospective.

Scenery

The study was conducted in the hemodialysis service of the "José Carrasco Arteaga" Specialty Hospital of the Ecuadorian Social Security Institute of Cuenca-Ecuador. The study period was from October 1, 2022, to October 30, 2022.

Participants

Patients of legal age were included, with stage 5-d chronic kidney disease who received renal function replacement therapy in hemodialysis programs in the different health service provider units of the Ecuadorian Institute of Social Security and who required hospitalization due to medical complications, hypervolemia or decompensation. Cases with surgical complications were excluded. Claims of patients with acute or chronic infection, liver cirrhosis, hematological diseases, and active malignancy were excluded. Medical charts with incomplete data were removed for analysis.

Variables

The variables were type of dialysis, sex, use of antihypertensives, class of antihypertensives, and cost. The sample was nonprobabilistic.

Data sources/measurements

The source was direct; surveys and measurements were carried out on the patients upon admission to the study before the hemodialysis session. The peritoneal dialysis group was selected from nonhospitalized outpatients. A review of clinical and hemodialysis records was performed. The information was treated confidentially; no personal data were included to allow the identification of the study subjects.

Biases

To avoid possible interviewer, information, and memory biases, the data were kept at all times by the principal investigator with a guide and records approved in the research protocol. Observation and selection bias was avoided by applying the participant selection criteria. All the clinical and paraclinical variables of the period above were recorded. Two researchers independently analyzed each of the records in duplicate, and the variables were recorded in the database once their concordance was verified.

Study size

The sample was nonprobabilistic, census type, where all possible cases of the study period were included.

Quantitative variables

Descriptive and inferential statistics were used. The results were expressed on a scale of means and standard deviation. Categorical data such as sex are presented in proportions.

Statistical analysis

Noninferential and inferential statistics are used. For the descriptive analysis, measures of central tendency and dispersion were calculated according to the measurement scale of each variable. Qualitative variables are presented as absolute numbers and percentages; quantitative variables are presented as medians and standard deviations.

Inferential analysis: comparing values on the scale between the groups was carried out with Student's *t* test; the importance and proportion were compared with the chi-square test. The statistical significance level was $P < 0.05$. The statistical package used was SPSS 28.0 (IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp.

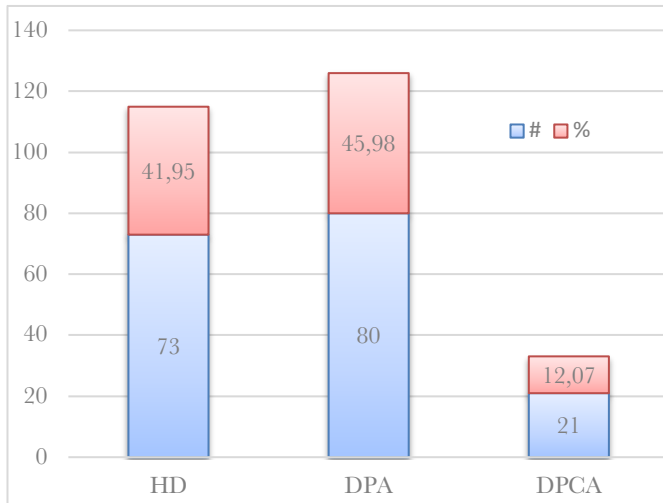
Results

Participants

A total of 174 analyzable patients entered the study. There were 73 patients on hemodialysis (41.95%), 80 patients (45.98%) on automated peritoneal dialysis (APD), and 21 patients (12.07%) on continuous ambulatory peritoneal dialysis (CAPD) (Figure 1).



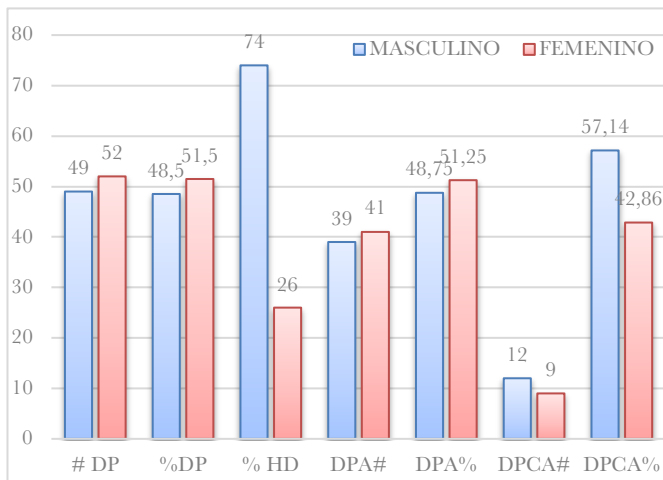
Figure 1. Study participants.



General characteristics of the sample

The male sex prevailed in hemodialysis at 74% and in ambulatory peritoneal dialysis at 57.14%. Compared to automated peritoneal dialysis with very little difference, the female sex prevailed at 51.25% (Figure 2).

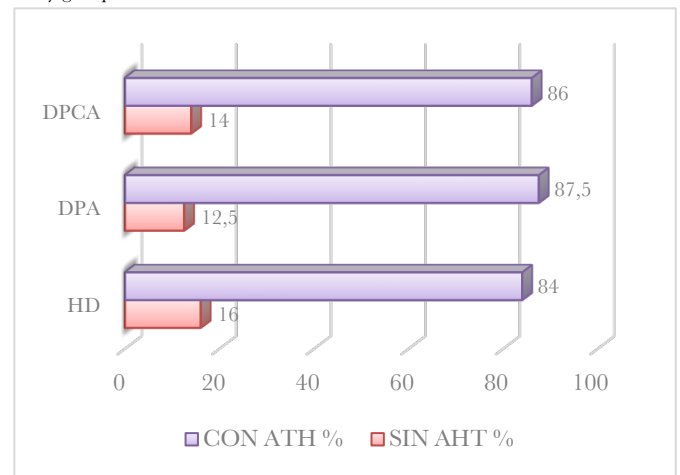
Figure 2. Sex of study participants and treatment modality.



Use of antihypertension medications

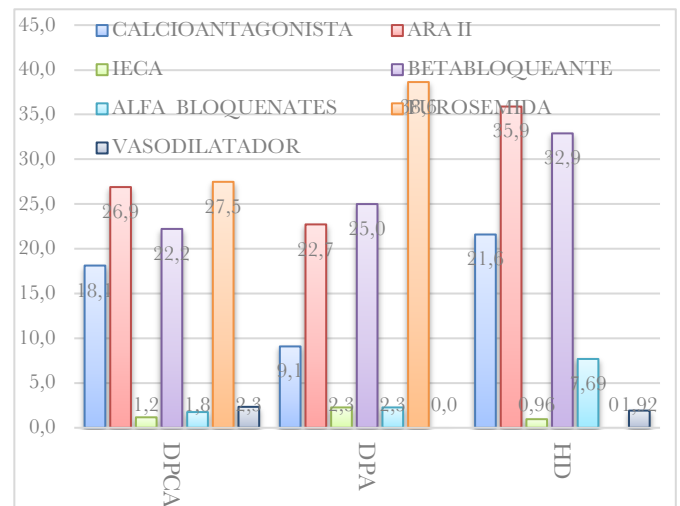
The use of antihypertensives was more than 84% in each treatment group. Complementary patients without antihypertensive medication were 14% in CAPD, 12.5% in DPA, and 16% in HD (Figure 3).

Figure 3. Presence of hypertension with the use of antihypertensives in the study groups.

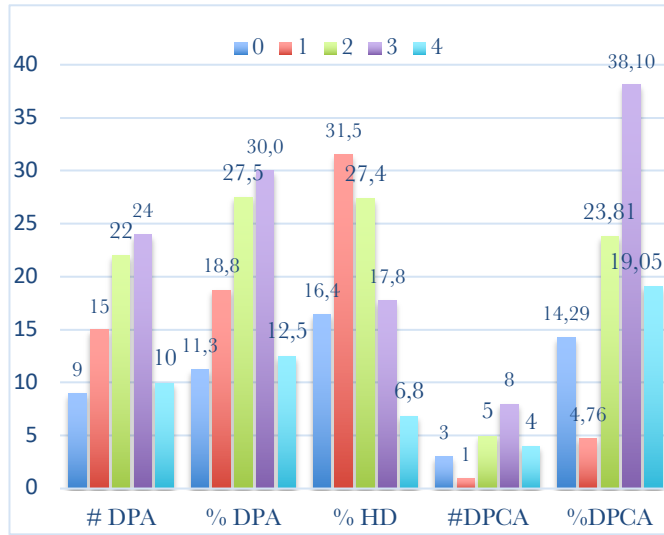


In DPA, furosemide, at 38.6%, was the most commonly used antihypertensive, followed by beta-blockers and ARA 2 at 25% and 22.7%, respectively; in CAPD, furosemide at 27.5%, ARA2 at 26.9% and beta-blockers at 22.2%; and in HD, ARA 2 at 35.9% and beta-blockers at 32.9% (Figure 4).

Figure 4. Type of antihypertensives prescribed in dialysis programs.



Three antihypertensives were used in CAPD in 38.1% of cases and DPA in 30%, while in HD, 1 type of antihypertensive was used in 31.5% of patients (Figure 5).

**Figure 5.** Numbers of antihypertensives prescribed in dialysis programs.**Economic analysis**

Having performed the economic analysis on antihypertensive medication in 30 days, we found that 61 patients on hemodialysis spent \$761.81, 70 patients on DPA spent \$1099.88, and 18 patients on DPA paid \$295.75, giving us a total of 149 patients who are on the different renal substitution therapies, which corresponds to a monthly expense of \$2157.44. The average cost of HD per patient is \$12.49, with a median of \$11.4, compared to DPA, which spends \$15.71 per patient, with a median of \$12.27, and CAPD per patient spends \$16.43, with a median of \$9.57. The average of all therapies is \$14.5, with a median of \$11.52 (Table 1).

Table 1. Analysis of the cost of antihypertensives in patients undergoing dialysis.

		HD	APD	CAPD	HD vs APD
No.	Valid	61	70	18	P=0.273
	lost	9	0	52	
Half		12.5	15.7	16.4	
Standard error of the mean		1.1	2.7	4.4	
Median		11.4	12.3	9.6	
Standard deviation		8.7	22.4	18.6	
Asymmetry		0.75	4.6	2.1	
Standard error of asymmetry		0.31	0.29	0.54	
kurtosis		0.19	26.0	3.99	
Standard error of kurtosis		0.604	0.57	1.04	
Range		37.7	159.5	70.6	
Minimum		0.78	0.66	1.32	
Maximum		38.5	160.2	71.96	
percentiles	25	4.8	4.1	4.6	
	fifty	11.4	12.3	9.6	
	75	18.9	17.5	19.8	

Discussion

Hypertension affects most hemodialysis patients and is often poorly controlled [3]. In the present study, the majority of patients had arterial hypertension requiring an antihypertensive. Adequate blood pressure control is difficult with conventional hemodialysis alone, but it is essential to improve cardiovascular outcomes. Nonpharmacological interventions to improve blood pressure include educating patients about limiting sodium intake, ensuring adequate removal of sodium solutes during hemodialysis, and achieving target 'dry weight' [4-6].

Most patients require a series of antihypertensive medications to achieve adequate blood pressure. The most widely used antihypertensive agents in this report were furosemide in peritoneal dialysis and

ARA 2 in the hemodialysis program. Several first-line pieces have included angiotensin-converting enzyme inhibitors and angiotensin receptor blockers. Beta-blockers and combined alpha and beta blockers can also be used in patients with cardiovascular disease or congestive heart failure and may improve outcomes in these populations. Calcium channel blockers and direct vasodilators are also effective in controlling blood pressure. Many antihypertensives can be dosed once daily and should preferably be administered at night to prevent nocturnal hypertension and minimize intradialytic hypotension. In non-compliant patients, renally eliminated agents (such as lisinopril and atenolol) can be administered thrice weekly after hemodialysis.

The economic analysis of the present study did not report any difference between the use of antihypertensives between the three dialysis modalities, even though the use of antihypertensives was markedly lower in the group of hemodialysis patients. New studies should



study the relationship between antihypertensives, control of hypervolemia, and mortality.

Conclusion

The most widely used antihypertensives in all therapies are ARA 2 and beta-blockers, and only in PD are they surpassed by furosemide. There is better control of BP with hemodialysis compared to peritoneal dialysis. Regarding the economic analysis, we could assume that hemodialysis, in terms of prices for antihypertensive medication, is cheaper, followed by APD, and finally, CAPD is more expensive. However, it is a statistically insignificant difference.

Abbreviations

HD: hemodialysis.

APD: automated peritoneal dialysis.

CAPD: continuous ambulatory peritoneal dialysis.

BP: blood pressure.

Supplementary information

Supplementary materials have not been declared.

Acknowledgments

Does not apply.

Author contributions

Wilmer Stalin Sanango Reinoso: Data curation, Formal analysis, Fundraising, Research, Methodology, Project management, Resources, Software, Writing – original draft.

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The studies, hemodialysis treatments, peritoneal dialysis, and laboratory tests constituted regular hospital activity and did not constitute a cost for the patients. The authors funded this research.

Availability of data or materials

The data sets generated and analyzed during the current study are not publicly available due to the confidentiality of the participants.

Statements

Ethics committee approval and consent to participate

It does not apply to observational studies.

Consent for publication

Not required for studies that do not publish patient photographs, CT scans, or X-ray studies.

Conflicts of interest

The authors report no conflicts of interest.

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