Cost analysis of drug treatment in hypertensive patients at social security health care family medicine units

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Abstract

Objective. To estimate the increase of drug treatment costs associated with predictive factors of hypertensive patients in family medicine units. **Materials and methods.** A generalized linear model was employed to estimate costs with data from a microcosting costing study for a 1-year time horizon. Sources of dada were medical electronic files, pharmacy records and unitary prices updated to 2019. **Results.** From a total of 864 patients older than 65 years were 67% and women 65%. Factors with most influence on mean drug treatment costs were diabetes, age and complications associated with hypertension. Mean annual cost of antihypertensive treatment was 61 dollars (CI95% 55,67) and median were 32 dollars (IQR 30,35) per patient. Incremental costs for diabetes were 23 dollars (CI95% 13,33) and 25 dollars (CI95% 5, 45) in the group of ≥ 65 years. **Conclusion.** Diabetes, age and complications were the factors with largest influence on hypertension pharmacological costs.

Keywords: Hypertension; cost allocation; drug therapy

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Resumen

Objetivo. Estimar el aumento de costos de tratamiento farmacológico de hipertensión asociado con factores predictivos en pacientes de unidades de medicina familiar. **Material y métodos.** El análisis utilizó un modelo lineal generalizado alimentado con información de un estudio de microcosteo en 2016. Las fuentes de información fueron los registros médicos del expediente electrónico y de farmacia y los precios unitarios del cuadro básico de medicamentos transformados a dólares americanos correspondientes a 2019. **Resultados.** Las variables significativas con mayor influencia fueron diabetes, edad y complicaciones asociadas con hipertensión. El costo promedio anual de tratamiento antihipertensivo por paciente fue de 61 dólares (IC95% 55,67) Los resultados sugieren un costo incremental de 23 dólares (IC95% 13,33) cuando se tiene diabetes y de 25 dólares (IC95% 5, 45) en el grupo ≥ 65 años. **Conclusiones.** Diabetes, edad y complicaciones son los factores encontrados que más influyen en los costos farmacológicos de tratamiento de la hipertensión.

Palabras clave: Hipertensión; asignación de costo; tratamiento farmacológico

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Worldwide, systemic arterial hypertension is a growing public health problem affecting one third of the world adult population.[1-4] In Mexico, prevalence of hypertension was 34.1% for 2019[5] and control rate blood pressure was 13.8%.[6-8] This scenario suggest a sub optimal control of disease when compared to that of developed countries corresponding to 28.4%.[3,4] Costs of treatment and complications associated with hypertension are increasing and represent a significant economic burden for public health care system and an opportunity cost that leave other health problems underfunded.[9]

Primary care system of Mexican Social Security Institute (*Instituto Mexicano del Seguro Social*, IMSS) is integrated by a network of 1 118 family medicine units which provide health care to nearly 56% of the 127.5 million population.[10] Hypertension is the leading motive of primary care consultations since it is one of the most important causes of chronic degenerative diseases.[10] An estimate is that 7 million insured individuals were diagnosed with hypertension, and 431 new cases, on average, are detected daily by 2020. Hypertensive patients would demand 15.4 million consultations in one year.[10,11]

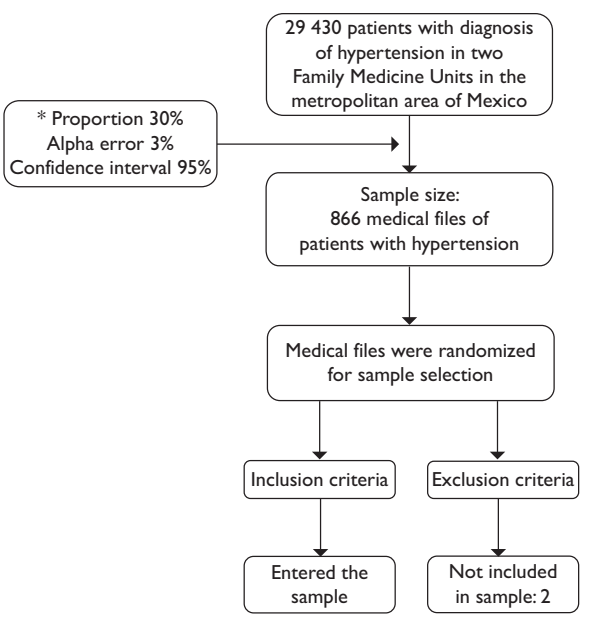
Costing studies (micro-costing or disease costing) at patient level can provide evidence on health care consumption patterns and its association with characteristics of patients with hypertension.[9,12-14] Evidence generated from these studies is fundamental for health policies prioritization and health resource allocation aimed to improve efficiency of health care delivery.[15,16]

A large number of studies on costs of chronic diseases are available,[12] however, the evidence based on published investigations on pharmacological treatment costs of hypertension is limited. Studies available are not specific on the topic, use aggregate information or were conducted outside Mexico.[9,17-20] Only two studies on the pharmacological costs of treating hypertension were identified.[21,22] In one of them authors estimated the pharmacological treatment of hypertensive patients and of those who were also diabetic controlling for other factors that can cause increase health care costs.[22] Authors found that that additional annual costs of persons with hypertension and diabetes were 85% compared with those who were only hypertensive. Authors also conducted estimates of costs by type of services. Evidence provided by this type of studies can be useful for development of interventions and program evaluation oriented to improve health care of hypertensive population under treatment. Based on these considerations the objective of the study is to conduct an estimate of the additional costs of pharmacological treatment at patient level considering as explanatory variables a set of factors using a generalized linear model.

Materials and methods

An analysis of the relationship between antihypertensive pharmacological costs and factors of patients with hypertension was conducted using data from two Family Medicine Units pertaining to IMSS for 2016 year. Costs were estimated by means of a cross-sectional, retrospective design, from the provider's perspective study with a micro-costing technique (bottom up) for a 1-year time horizon (2016). Sources of data were electronic medical files (EMF) corresponding to 29 430 individuals diagnosed with hypertension regularly attending two Family Medicine Units for health care (figure 1). Selection of cases was conducted using simple random sampling with no replacement taking similar proportion of sample from each medical facility. Inclusion criteria were: age >18 years, non-pregnant, with a minimum of three primary care visits associated to hypertension per year. The sample size considered a proportions formula, 3% alpha-error and statistical power of 90% (figure 1).

Data on sociodemographic characteristics (age, gender, marital status, and education), clinical situation (time since hypertension diagnosis, complications attributed to hypertension, type 2 diabetes, body mass



*The proportion of the cost difference between two scenarios of treatment was used for sample size calculation.
IMSS: *Instituto Mexicano del Seguro Social*

FIGURE 1. FLOW DIAGRAM OF THE STUDY SAMPLE. MEXICO, 2016

index) and resource utilization (consultations and pharmaceuticals) of patients with hypertension over one year were collected. The researcher identified required information on medical notes then extracted data to build an electronic database. IMSS-National Committee for Health Research approved the study protocol. Personal information of patients during the analysis was managed with confidentiality in order to protect patient identity.

Data on resource use of antihypertensive drug presentation box prescribed were registered in electronic database for analysis. Confirmation of prescription drug quantities was conducted with database from pharmacy department and medication not delivered was not measured. Quantities of prescription per patient were measured with information from EMF. Pharmacological treatment costs were valued with official list unitary prices.[23] Costs were updated to 2019 Mexican pesos with national index of consumer prices and converted to US dollars using an exchange rate of 19.14 pesos per dollar. A statistical analysis using a generalized linear model with family gamma distribution and logarithmic link function was conducted since it allows response variables that have error distribution models other than a normal distribution. The model considered costs of pharmaceutical treatment as dependent variable and factor variables of patients corresponding to socioeconomic attributes, clinical condition and number of consultations as explanatory variables.

Socioeconomic variables were included in the model because these can be associated with clinical condition of individuals. In addition, clinical variables were also included because these can cause increase in consumption of pharmaceuticals or consultations for treatment or control of hypertension. The following variables were included in the model: age group (<45, 45-64 and> 65), sex, marital status, educational level, presence of medical complications due to hypertension (with or without complications), type 2 diabetes, body mass index categories (normal, overweight and obesity), time since diagnosis (<5, 5 to 10 and >10 years) and medical consultations. Model coefficients by factor and associated statistics are reported. Mean and incremental costs are reported as well. Interaction effects of independent variables were not explored. Analysis was performed with Stata 14 (Stata Corp, College Station, Texas, USA).

Results

A total of 864 EMF of patients with diagnosis of hypertension were included in study. Mean age was 69.1 years (SD 11.2) with most concentrated in older than 65 years (67.5%) (table I). Women married were the majority. Education level was mostly no studies or primary and secondary (64%). A significant number of participants had type 2 diabetes (43.8%), had more than ten years of evolution of hypertension and were overweighed or obese. In addition, 27% of participants had complications like heart disease (hypertensive or mixed heart disease). The groups with higher costs were, age ≥ 65 years, being single, bachelor´s degree, diagnosis of hypertension for more than 10 years, having a history of stroke and having ≥ 9 consultations for hypertension.

Results of the model suggest that those variables with significant effect on mean costs are diabetes and number of consultations (p value <0.01) meanwhile age, single and complications are less significant (p value <0.05) and overweight is in the limit. Direct coefficients of the model are in logarithmic scale and because parameters of costs distribution are under transformation of gamma distribution, thus, the coefficient for being women mean that the factor effect is negative and very small on costs. The corresponding coefficient of diabetes in addition to hypertension suggest a positive effect and an increase of 37% of mean cost compared to not having diabetes (table II).

Prediction of the model suggest that the average cost for all individuals in the sample is 61 dollars. Diabetes in addition to hypertension is associated with an increase of 23 dollars to mean cost and an additional consultations represents 10 dollars more costs. If the individual is ≥65 years old the corresponding increase on costs is also important (25 dollars). Other less significant factors which are associated with incremental costs are complications due to hypertension, being single and overweigh (table III).

Discussion

Findings of the present study were that specific sociodemographic and clinical factors were related statistically with pharmacological costs of hypertension treatment. Among those factors with most influence on average cost of hypertension were diabetes, age and complications due to hypertension. Other variables were expected to be significant but they were not like sex and time since diagnosis. In addition, civil status was significant but was not expected to be that result.

Diabetes is a factor with most influence to increase costs of hypertension pharmacological treatment (p value <0.001) with an incremental cost of 23 dollars. This is less than the corresponding to be single but this factor is less significant (p value= 0.049). A similar result was found by authors of a study in USA.[22] They used data from medical expenditure panel survey and found that diabetics spend 85% more on pharmaceuticals compared with those who

Table I

HYPERTENSIVE-PATIENTS CHARACTERISTICS, AND ASSOCIATED PHARMACEUTICAL-TREATMENT COSTS. MEXICO, 2016

Measure	*Characteristics of sample*			*Cost determination**		
	N=864	*%*	*95%CI*	*Median*	*Mean*	*95%CI*
Age						
<45	18	2.1	1.2,3.1	12.3	18.8	11.5,26
45-64	263	30.4	27.4,33.5	23.4	47.3	38.7,55.9
>65	583	67.5	64.3,70.5	33.3	63.0	54.3,71.7
Sex						
Male	297	34.4	31.2,37.5	30.4	55.6	46.3,64.9
Female	567	65.6	62.4,68.7	29.2	58.2	49.6,66.7
Civil status						
Single	90	10.4	8.3,12.4	29.4	77.1	43.6,110.5
Married	580	67.1	63.9, 70.2	30.5	54.8	47.5,62.1
Divorced	37	4.3	2.9,5.6	30.8	49.4	30.1,63.3
Widower	157	18.2	15.6,20.8	30.6	56.9	44.9,69
Education						
No studies	42	5	3.5,6.4	31.7	56.4	37,75.8
Primary / secondary	511	59	55.7,62.2	30.6	54.9	47.5,62.3
Baccalaureate / technical	180	20.9	18.1,23.6	30.5	54.3	42.8,65.8
Bachelor's degree	113	13	10.8,15.3	26.6	73.9	43.6,104.3
Postgraduate	18	2.1	1.1,3	34.7	51.5	19.1,83.9
With type 2 diabetes‡	379	43.8	40.4,47	40.8	73.3	61.4,85.3
Time with the diagnosis of hypertension (years)						
<5	97	11.2	9.1,13.3	27.1	47.6	33.5,61.6
5-10	208	24.1	21.1,26.8	20.9	36.4	29,43.7
More than 10	559	64.7	61.5,67.9	34.1	66.7	57.5,75.9
Complications secondary to hypertension						
Hypertensive heart disease	235	27.2	24.2,30.2	39.8	77.9	61.5,94.2
Chronic kidney disease	124	14.3	11.9,16.6	43.7	85.0	56.5,113.5
Hypertensive retinopathy	61	7	5.3,8.7	41.6	67.5	45.8,89.2
Stroke	40	4.6	3.2,6	47.3	97.8	30.8,164.9
Acute myocardial infarction	23	2.7	1.6,3.8	32.8	92.8	29,156.7
Body mass index§						
Normal	203	23.4	20.61,26.2	32.2	70.5	51.9,89
Overweight	329	38	34.75,41.2	29.6	54.0	45,63.1
obesity	334	38.6	35.32,41.8	28.0	52.5	44,61
Consultations for hypertension						
<9 consultations	499	57.6	54.3,60.9	20.4	34.1	29.7,38.4
>9 consultations	367	42.4	39,45.6	48.9	88.8	75.5,102.2

* Costs are reported in US dollars (US$) of 2019 with inflation factor.
‡ Type 2 diabetes plus hypertension.
§ wt(kg)/hgt(m)2. Normal=18.5-24.99, overweight=25-29.99, obesity class 1-3= >30.

Table II

Results of GLM* for costs of antihypertensive drug treatment in patients with hypertension. Mexico, 2016

Variable	*Coefficient*	*SE*	*95%CI*	*p-value*
Constant	4.52	.352	3.8,5.2	< .001
Age				
18 - 44	Reference	Reference	Reference	Reference
45 - 64	.517	.277	-.026,1.06	.062
>65	.523	.265	.002,1.04	.049
Sex				
Female	-.007	.09	-.193, .179	-.07
Male	Reference	Reference	Reference	Reference
Civil status				
Married	.061	.083	-.103, .225	.468
Divorced	.009	.161	-.307, .325	.955
Single	.541	.121	.303, .779	<0.001
Widower	Reference	Reference	Reference	Reference
Education				
Primary / secondary	-.018	.151	-.315, .278	.905
Baccalaureate/ technical	.076	.181	-.278, .432	.671
Bachelor's degree	.055	.195	-.326, .438	.775
Postgraduate	-.197	.232	-.652, .256	.394
No studies	Reference	Reference	Reference	Reference
Complications secondary to hypertension				
With complications	.208	.090	.0311, .385	.021
Without complications	Reference	Reference	Reference	Reference
Diagnosis				
Hypertension and type 2 diabetes	.376	.081	.217, .535	<.001
Hypertension	Reference	Reference	Reference	Reference
Body mass index				
Normal	Reference	Reference	Reference	Reference
Overweight	.242	.116	.134, .197	.038
Obesity	.096	.093	-.087, .280	.306
Time since diagnosis (years)				
<5	Reference	Reference	Reference	Reference
5-10	-.140	.170	-.474, .193	.410
> 10	.081	.139	-.193, .355	.562
Consultations‡ (hypertension)	.166	.016	.134, .197	<.001

*The generalized linear model was carried out with Gamma distribution and logarithmic link function.
‡Average number of consultations in one year (2016).

Table III

Prediction of average and incremental costs for estimating costs in antihypertensive drug treatment in patients with arterial hypertension in 2016.* IMSS, Mexico, 2016

Variable	*Coefficient*	*SE*	*95%CI*	*P-value*
Constant	61	3	55- 67	<.001
Age				
18 - 44	Reference	Reference	Reference	Reference
45 - 64	25	11	3-47	.026
>65	25	10	5-45	.013
Sex				
Female	-.43	6	-12-11	.941
Male	Reference	Reference	Reference	Reference
Civil status				
Married	4	6	-9-16	.559
Divorced	.12	13	-25-25	.992
Single	41	21	.13-82	.049
Widower	Reference	Reference	Reference	Reference
Education				
Primary / secondary	-1	9	-19-17	.905
Baccalaureate / technical	5	11	-17-27	.669
Bachelor's degree	3	12	-20-27	.774
Postgraduate	-11	13	-36-14	.386
No studies	Reference	Reference	Reference	Reference
Complications secondary to hypertension				
With complications	13	5	2-23	.021
Without complications	Reference	Reference	Reference	Reference
Diagnosis				
Hypertension and type 2 diabetes	23	5	13-33	<.001
Hypertension	Reference	Reference	Reference	Reference
Body mass index				
Normal	Reference	Reference	Reference	Reference
Overweight	15	8	-.02-30	.050
Obesity	6	6	-5-16	.308
Time since diagnosis (years)				
<5	Reference	Reference	Reference	Reference
5-10	-8	10	-27-11	.417
> 10	5	8	-11-22	.552
Consultations‡ (hypertension)	10	1	8-12	<.001

* Costs are reported in US dollars (US$) of 2019 with inflation factor.
‡ Average number of consultations in one year (2016).
IMSS: *Instituto Mexicano del Seguro Social.*

are not diabetic. A second significant factor was complications due to hypertension. This variable also represents additional costs referring to mean common costs for the sample. Another factor contributing to increasing costs was age. Our results suggest that the age in the group 45-64 years and ≥ 65 are significant and increase costs by 25 dollars in each group. However, authors that used a similar statistical model in hypertensive population in USA found that the coefficient associated with 45-64 years of age is not significant though it is associated with a slight increase of costs (10%).[21] The corresponding cost increase of the 65-84 years group was 13% but neither significant. This evidence does no support the increase of costs by these age groups.

Sex is another variable which was found nonsignificant and associated with a small decrease of medical hypertensive costs. In study by Park and colleagues, authors found a similar result.[21] Regarding civil status the present study found that being single is associated with increase of average cost though not very significant. The corresponding finding of Park and colleagues was that the status of not being married (which is not the same of being single) has a small cost increase but it is not significant. In addition, levels of overweight and obesity were not significant in our estimates and this result is supported by the same study.[21]

The main advantage of the generalized linear model for analysis of pharmacological treatment costs is a more flexible approach to manage problems of costs data such as skewed distribution and heteroscedasticity. This strategy allows the selection of a link function that relates the conditional mean of dependent variable with independent variables and an exponential distribution family function that specifies the relationship between the variance and the mean of the dependent variable. Another advantage of this approach is that costs prediction are reported in the same monetary units despite the transformation used in the link function and the distribution family function used in model.[24,25]

It is worth to mention that decision of using unitary prices corresponding to internal official list of prices instead of private market prices to value costs of treatment has the consequence of reduced comparability of treatment costs reported with those of other studies that use private market prices inside or outside Mexico. In addition, a limitation of the present study refers to the framework used for sampling patients for the study. We consider that considering more medical units and other social and economic conditions of Mexican population may reduce potential biases for inference to hypertensive population. For this reason, we only can infer results to population of the two family medicine units sampled. Costs by groups of antihypertensive drugs are missing and this represents another limitation of the present study. Information on this should be included in a future report for including data on prescription patterns of pharmaceuticals used.

Findings of the present study represent a contribution to evidence on the factors that may increase pharmaceutical costs of hypertensive patients. Further development of studies in this area with improved design and sample data framework may help to improve prescription and increase efficiency of resource utilization of drugs for hypertension treatment.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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