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Cost-Effectiveness of a Care Program for HIV/AIDS Patients Affiliated with a Health Insurer in Colombia, Comparing Three Health Care Providers Nationwide

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ABSTRACT

Background: In Colombia, HIV and AIDS constitute one of the major diseases of high cost to the health system, making necessary health risk management of patients with this disease through comprehensive health care programs with their respective evaluation of results. **Objective:** To evaluate the relative cost-effectiveness of a care program for patients with HIV/AIDS affiliated to a health insurer in Colombia, comparing their results in three Health care provider (HCP). **Methods:** The study population corresponded to a cohort of patients older than 18 years with HIV/AIDS and affiliated to a health insurer in Colombia during 2011 and 2012. A cost-effectiveness and cost-utility analysis of a health care program for this population was performed on the basis of a Markov model, in which quality-adjusted life-years (QALYs) and life-years gained were assessed. This analysis was conducted from the insurer perspective. The time horizon was life expectancy. A discount rate of 3% was applied. **Results:** Drugs accounted for 80.54% of care costs. The average annual cost of patients in health state 5 was 3 times higher than that of patients in state 1. HCP A compared with HCP B generated an additional 1.53 QALYs, with a rate of incremental cost-effectiveness of $2400 per QALY gained. HCP C showed a dominated behavior. The variables that most influence the uncertainty were the cost of HCP A in health state 5 (55.52%) and the cost of HCP B in state 3 (27.51%). **Conclusions:** HCP A is a very cost-effective option considering a threshold of 1 time the per-capita gross domestic product.

Keywords: AIDS, cost-benefit analysis, impact assessment health, program evaluation.

Introduction

Globally, reducing the incidence of HIV and AIDS has been defined as a priority in health, and one of the main objectives of the Millennium Development Goals, given their impact on morbidity, mortality and quality of life, and sociocultural and economic aspects of the affected population [1,2]. The prevalence of HIV/AIDS in adults aged 15 to 49 years worldwide was estimated at 0.5% in 2012 [3], at 0.4% in the Latin American context in 2012 [4], and at 0.16% in Colombia in 2013 [5].

In Colombia, HIV and AIDS constitute one of the main high-cost diseases, given its chronicity, disease burden, impact on the demand for services and health technology, and high financial burden for patients, their families, society, and the General System of Social Security in Health [6,7]. It was estimated that about $ 138 million (USD) health resources were invested in Colombia by 2011 in response to HIV and AIDS. Of these, 84.13% were involved in the care and treatment of those suffering from the disease. This is equivalent to an average cost of $803 per person per year with the disease, and nearly 3 times the annual premium per capita for the period (Capitation Payment Unit $273.58 for 2011) [8].

Therapeutic advances in the treatment of this disease have improved patient outcomes and have extended their life expectancy to the extent that it is considered today as a chronic disease that can be managed with the intervention of avoidable outcomes [9,10]. Against this background and in an environment of health insurance, risk management has become necessary for the health of members with HIV/AIDS through the design and implementation of models of care with holistic and clinical disease management, including program development routes and clinical practice guidelines. These programs should, in turn, articulate both health professionals and service providers, promoting prevention and early diagnosis of comorbidities.

Conflicts of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

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Under these considerations, in 2011, a new model of care for these patients was implemented by the insurer using which this study was conducted, which preliminarily showed decreased hospitalization rates and associated costs for this pathology. To facilitate decision making, it was considered necessary to evaluate health outcomes of these interventions beyond analysis and monitoring of the behavior of costs and incidence of comorbidities, including differences among providers. Therefore, the aim of this study was to evaluate the cost-effectiveness of the program of care for patients with HIV/AIDS affiliated with a health insurer in Colombia, comparing the results of its management in three health care providers (HCP).

Methods

Field of Study and Target Population

In Colombia, the health insurance model called the General System of Social Security in Health seeks universal population coverage, with the state delegating insurers to pay a fixed annual premium per user (annual premium per capita), which seeks to ensure access through health care providers to a positive list of benefits defined by the government.

The system is divided administratively and financially into the contributory scheme and the subsidized scheme. The first addresses the population linked at work or retired and those who have the ability to pay, whereas the latter caters to people who do not have sufficient income and therefore need to be subsidized by the state [11].

The target population for this study was a cohort of 884 patients affiliated with a health insurer in Colombia in the contributory system, with confirmed HIV infection and/or AIDS diagnosis, age older than 18 years, and at least an annual measurement of CD4 count during the years 2011 and 2012. The cohort members were distributed for the attention and follow up of their pathology among three health care providers who evaluated in this analysis. These institutions were contracted by the insurer for the development of the model of care in seven cities of the country. The three institutions are distributed in different cities of the country as follows: HCP A in Bogotá; HCP B in Barranquilla, Bucaramanga, and Santa Marta; and HCP C in Cartagena, Monteria, and Sincelejo. According to the objectives of the study, they are considered the relevant alternatives to compare.

Program Description

Patients were admitted to the program of care in HIV/AIDS once the diagnosis was confirmed in primary care institutions. The program was designed by a model of standard care and develops equally in the three specialized health care providers (HCP A, HCP B and HCP C) through an interdisciplinary team of medical specialists in infectious diseases, general practitioners, nurses, nutritionists, psychologists, social workers, and dentists [12].

On admission, the patients are seen by the general practitioner who requests a pack of blood tests and refers the patients to their respective interventions and follow-up to each of the health service providers. Then, medical supervision is performed and according to laboratory results, the plan of care and the need for initiation of antiretroviral therapy (ART) is defined, wherein the patient receives medication immediately after medical consultation and before leaving the institution.

The patient is seen by the infectious disease specialist at least four times a year and receives additional specialist care when inadequate virologic or immunologic response to treatment is observed, or when the patient is a pregnant woman. Follow-up consultation is performed monthly by general practitioners and telephone tracking by technical support staff who perform both searching, catchment and induction to the demand for health services, as well as strengthening adherence to treatment. The relevant laboratories are performed once per semester. Patient and family education is led by the nurse, with the active participation of other team professionals.

Cost Description

The cost-effectiveness analysis assessed only direct medical costs. Drug treatment, diagnostic and therapeutic procedures, as well as hospital, outpatient, emergency, and home care costs were taken into account. Indirect costs were not considered. The cost of each care and service provided to every patient in the

Table 1 – Annual average cost and transition probabilities by HCP and health state, from 2011 to 2012.

Strategy	Cost (per state) ($)	Initial health state 2011	Final health state 2012				
			5	4	3	2	1
HCP A	6359.45	5	0.30	0.37	0.33	0.00	0.00
	4031.92	4	0.07	0.42	0.43	0.04	0.04
	2538.70	3	0.02	0.03	0.41	0.41	0.13
	1792.30	2	0.00	0.01	0.07	0.39	0.52
	1749.80	1	0.01	0.01	0.04	0.11	0.84
HCP B	3728.11	5	0.26	0.47	0.26	0.00	0.00
	2745.30	4	0.12	0.42	0.38	0.08	0.00
	1745.96	3	0.04	0.12	0.58	0.16	0.11
	1374.39	2	0.00	0.00	0.37	0.58	0.05
	1995.42	1	0.01	0.00	0.11	0.30	0.57
HCP C	3050.04	5	0.00	0.50	0.33	0.17	0.00
	2086.18	4	0.20	0.30	0.30	0.20	0.00
	2765.97	3	0.00	0.18	0.38	0.29	0.15
	2336.19	2	0.00	0.08	0.32	0.39	0.21
	2054.56	1	0.00	0.03	0.03	0.24	0.70

HCP, health care provider.
*Annual average first half 2015 US $1 = 2485.32 Colombian peso [13].

cohort during the follow-up period was analyzed to calculate the average annual cost of both health state and HCP, which was taken as reference in the development of economic evaluation (data description is summarized in Table 1). The information was consolidated from own records available in the information systems of health insurance and costs were adjusted to 2015 US dollars [13].

The cost of services was established from hiring and prior negotiation of the insurance company with different health service providers during the monitoring period and according to the prices fixed in the "Medical, surgical, and hospital procedures tariff manual," provided by the Ministry of Health and Social Protection [14].

Description of Clinical Data

In the model, the transition between each of the health states was calculated from the cohort follow-up study during the years 2011 and 2012 (Table 1). This information was extracted from own databases specific to the insurer. Because the population follow-up was conducted for a period of 2 years, it was not possible to determine mortality data for the cohort. Therefore, the probability of mortality to adjust the annual transitions from each of the five health states of the disease was calculated taking into account the estimated probability of death of the Colombian general population by age group [15] and the death rate in the population with HIV/AIDS according to the Longitudinal Study Collaboration of Observational HIV Epidemiological Research in Europe (COHERE) 2012 [16].

Utilities and Estimates of Quality of Life

In the present study, life-years gained (LYG) and quality-adjusted life-years (QALYs) were calculated, considering as a common unit benefit that connects both quality and quantity of life gained during an intervention to identify the gain in health outcomes associated with interventions. For the base-case analysis, utilities were taken from Simpson et al. [17], reported in various studies published in the literature [18–20]. The values come from the EuroQol questionnaire responses from 21,000 people in clinical trials of HIV. Simpson et al. [17] conducted transformations from initial questionnaire responses according to the methodology of modeling preferences developed by Dolan [17,18,21]. These values were used because they are presented ranges for CD4 T-lymphocyte count and correspond to latest available estimates. The values of the utilities included in the model were 0.946 for health state 1, 0.933 for health state 2, 0.931 for health state 3, and 0.853 to 0.781 for health state 4 and health state 5, respectively.

Overview of the Model

An analysis of cost-effectiveness and cost-utility was performed on the basis of a Markov model using TreeAge®, which is shown in Figure 1, where five transition health states for HIV / AIDS were included according to the WHO classification, based on counting CD4 lymphocytes (health state 1 CD4 $\geq$ 500, health state 2 CD4 351–500, health state 3 CD4 201–350, health state 4 CD4 51–200, and health state 5 CD4 $\leq$ 50) and an absorbing state concerning death [22,23]. The transition probabilities were estimated from the cohort's own data, by calculating the proportions and their distribution among health states from the beginning to the end of the period using a square matrix according to the methodology of Naimark et al. (Table 1) [24]. Model validation was performed by checking both equations and its programming software by two assessors, and similar studies were not found when reviewing the literature that would allow comparisons [25]. The analysis was conducted from the perspective of the insurer.

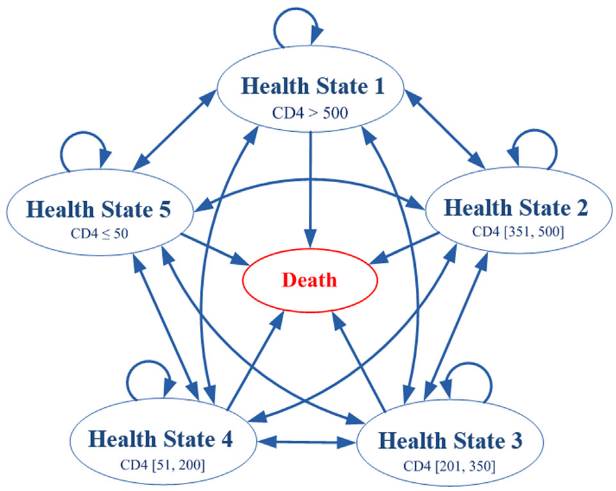

Fig. 1 – Structure of the Markov model: Illustration of transition health states in patients with HIV / AIDS according to the values of CD4 lymphocytes ranges. Health state 1 (CD4 $\geq$ 500), health state 2 (CD4 351-500), health state 3 (CD4 201-350), health state 4 (CD4 51-200), health state 5 (CD4 $\leq$ 50). All patients begin in health state 1 corresponding to the onset of infection, these can be moved between different states until the death.

Model Assumptions

The initial population considered in the three HCP was distributed equally in the five health states of the disease.

It was assumed that the clinical, demographic, and social characteristics of patients are similar among the three institutions.

Life expectancy used in the time horizon of the model corresponds to that of the general population [24].

It was assumed that all costs of care of patients are related to their underlying disease.

In the absence of studies of mortality from HIV/AIDS health states in Colombia, the annual health state transition probabilities were adjusted on the basis of mortality reported in the longitudinal study COHERE [16]. Health state utility was adopted from the study of Simpson et al. [17].

Time Horizon

Some studies report that the life expectancy of patients with HIV/AIDS is similar to that of the general population [22], making it possible to consider the life expectancy of the Colombian general population estimated by the National Administrative Department of Statistics [25] as the time frame for the development of this model. For future events, a discount rate of 3% on costs and health outcomes was applied [26].

Analysis and Results

Costs during the 2-year follow-up were found to be mainly distributed in drugs (80.54%), followed by clinical laboratory (4.71%) and other therapeutic procedures (3.51%). In the three HCP the average annual cost of patients in health state five was higher compared with patients in health state one (See Table 1), in the HCP A is three times, in the HCP B is 1.5 times and C is nearly 2 times. Under the base-case assumptions, the total cost per patient for the time horizon was $38,603, $34,935, and $43,941 for HCP A, B, and C, respectively. The QALY estimates were 17.60,

Table 2 – Cost-effectiveness analysis by HCP (costs, QALYs, LYGs, and ICERs) by HCP.

Strategy	Total cost ($)	Incremental cost ($)	QALYs	LYGs	Incremental utility	Incremental effectiveness	Utility cost ($)	Effectiveness cost $)	ICER ($)/QALYs	ICER ($)/LYGs
HCP B	34,935		16.07	18.18			2174	1921		
HCP A	38,603	3668	17.6	19.1	1.53	0.91	2194	2021	2400	4010
HCP C	43,941	5338	16.93	18.76	−0.66	−0.34	2595	2343	Dominated	Dominated

Note. Dominated = more expensive and equal or lesser number of QALYs.
HCP, health care provider; ICER, incremental cost-effectiveness ratio; LYG, life-years gained; QALY, quality-adjusted life-year.

16.07, and 16.93, respectively, showing that results of HCP B though less expensive were the least effective, whereas HCP C showed a behavior dominated by HCP A (more expensive and less effective) (see Table 2). Assuming a willingness to pay a gross domestic product (GDP) per capita in the country of $7930 for 2014 [27], according to the recommendation of the WHO [28–30], the program management's attention on IPHS A is a very cost-effective alternative. For effectiveness, similar utilities in terms of LYG behavior were observed. HCP A compared with HCP B generated an additional 0.91 LYG at an incremental cost of $2021 for an incremental cost-effectiveness ratio of $4010 per LYG, which is also below the willingness-to-pay value (Table 2).

Deterministic Sensitivity Analysis

One-way sensitivity analysis for costs, health state utilities, and health care provider was performed to determine the variables with the greatest impact on the uncertainty in model results. Tornado diagram was used to represent variables with descending greatest influence on the incremental cost-effectiveness ratio (Fig. 2).

The variables that most influenced the uncertainty were the cost of HCP A in health state 5 (55.52%), the cost of HCP in health state 3 (27.51%), the cost of HCP A in health state 4 (6.87%), the cost of HCP B in health state 4 (5.99%), the cost of HCP A in health state 3 (2.42%), the cost of HCP B in health state 1 (0.66%), the cost of HCP B in health state 2 (0.57%), the cost of HCP A in health state 2 (0.24%), the utility of health state 1 (0.096%), and the utility of health state 3 (0.076%). These together corresponded to 99.94% of the variability, and for this reason they were considered in the probabilistic analysis.

Probabilistic Sensitivity Analysis

Probabilistic sensitivity analysis was performed using a Monte-Carlo simulation with 10,000 iterations. This process took into account probability distributions associated with all interest variables included in the model. Beta distributions were used for utilities, and lognormal distributions were used for costs (Table 3) parameters were calculated according to the methodology described by Briggs et al [31].

The probabilistic analysis showed that 79.17% of the simulations were below 1 time the per-capita GDP, 18.58% between one and two times the per-capita GDP, 2.02% between two and three times the per-capita GDP, and only 0.23% above three times the per-capita GDP (Fig. 3A). The acceptability curve shows that starting from a willingness-to-pay threshold of one time the per-capita GDP, program management of care for patients with HIV/AIDS was cost-effective for HCP A in 77%, for HCP B in 21%, and for HCP C in 2% of the simulations. Assuming that the willingness-to-pay threshold recommended by the WHO is three times the per-capita GDP [28], the probability of cost-effectiveness increased to 97.5% for HCP A (Fig. 3B).

Discussion

This study shows the application of health technology tools assessment to measure the efficiency of the implementation of a risk management program for patients with HIV and/or AIDS in three HCP in different regions of Colombia.

In the extended literature review conducted in this study, no similar economic evaluations in which management of comprehensive care programs is analyzed in IPHS were found. Most published studies focused basically on comparing drug treatments and therapeutic regimens [17–20,22,32], screening [33,34], prevention of infection [35,36], and its comorbidities [37,38].

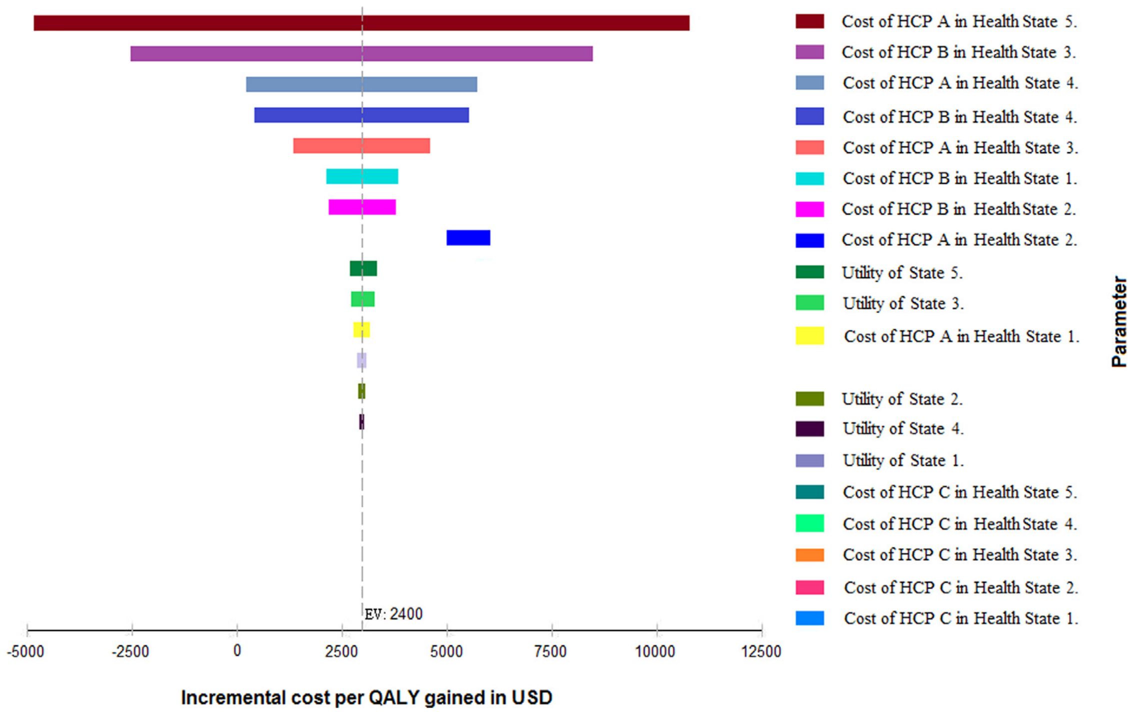

Fig. 2 – Deterministic sensitivity analysis: Diagram tornado. HCP, health care provider; QALY, quality-adjusted life-year. Each horizontal bar in the tornado diagram represents net monetary benefit values expected from a range of values evaluated for each variable.

Some studies show generally similar care programs as described in this study and argue that implementation of a comprehensive program of care with clinical management approach provides better access to care and ART and prevent and diagnose the comorbidities early [9]. Fonquernie et al. [9], in his description of improving the quality of a program of care for patients with HIV/AIDS through a computer tool, refers to a comprehensive care program provided by an interdisciplinary group that provides medical care, ART, clinical laboratory tests, and education, similar to the one presented, whereafter the

Table 3 – Input parameters in the probabilistic analysis.

Variable	Parameter		Probability distribution function
	A*	B†	
HCP A cost in health state 1	15.28	0.24	Lognormal
HCP A cost in health state 2	15.30	0.31	Lognormal
HCP A cost in health state 3	15.66	0.24	Lognormal
HCP A cost in health state 4	13.82	0.09	Lognormal
HCP A cost in health state 5	16.58	0.02	Lognormal
HCP B cost in health state 1	15.42	0.01	Lognormal
HCP B cost in health state 2	15.04	0.24	Lognormal
HCP B cost in health state 3	15.28	0.30	Lognormal
HCP B cost in health state 4	15.74	0.08	Lognormal
HCP B cost in health state 5	16.04	0.14	Lognormal
HCP C cost in health state 1	15.45	0.17	Lognormal
HCP C cost in health state 2	15.57	0.08	Lognormal
HCP C cost in health state 3	15.74	0.14	Lognormal
HCP C cost in health state 4	15.46	0.18	Lognormal
HCP C cost in health state 5	15.84	0.36	Lognormal
Utilities in health state 1	606.19	34.60	Beta
Utilities in health state 2	604.21	44.78	Beta
Utilities in health state 3	543.33	93.63	Beta
Utilities in health state 4	543.33	93.63	Beta
Utilities in health state 5	517.17	145.02	Beta
Discount rate	0.93	30.12	Beta

* Corresponds to the α parameter for beta distributions and the μ parameter in case of lognormal distributions.
† Corresponds to the β and σ parameters for beta and lognormal distributions, respectively.

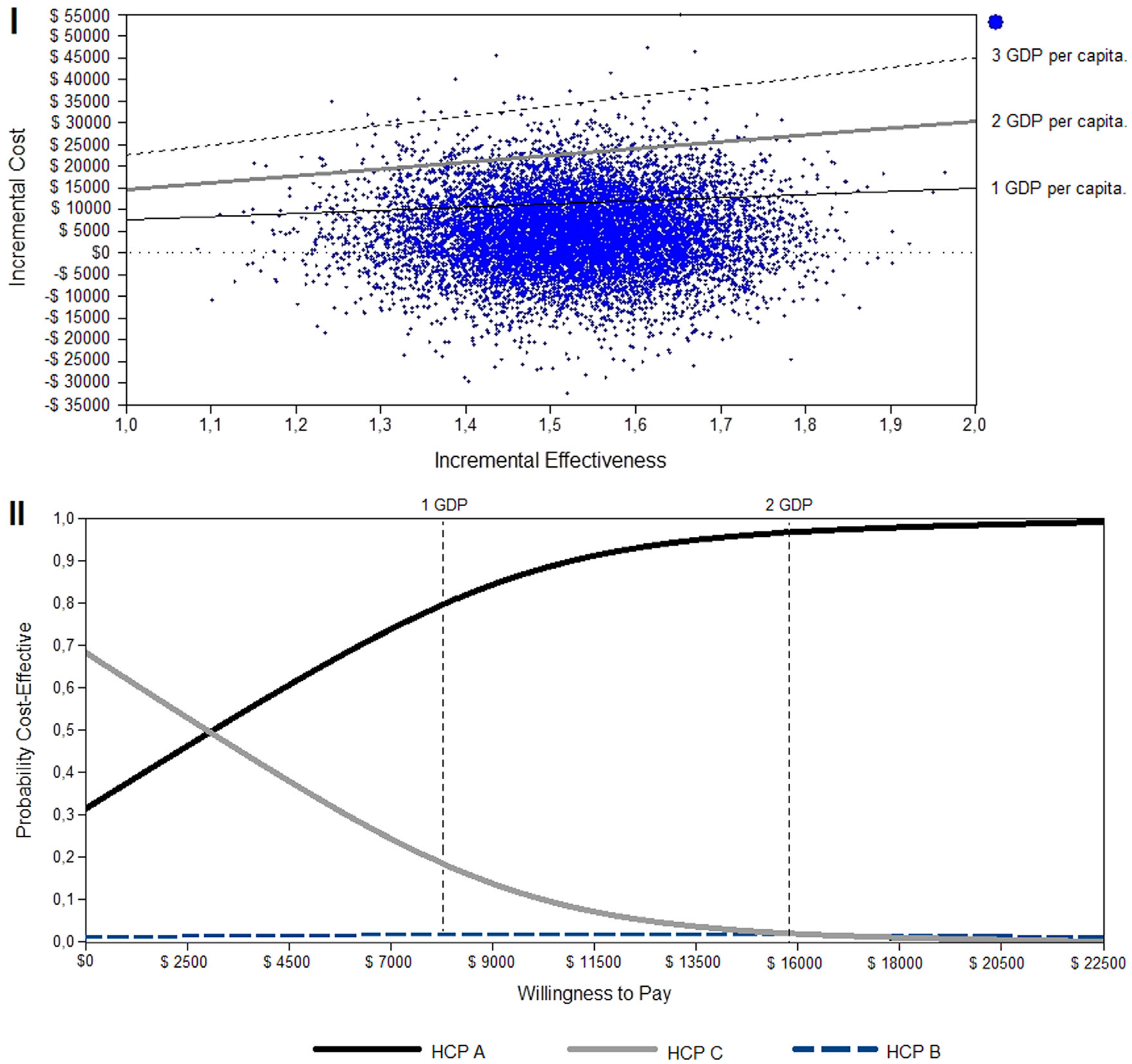

Fig. 3 – Probabilistic sensitivity analysis. (A) Cost-effectiveness ratio plane resulting in a positive incremental cost-effectiveness of IPHS A relative to IPHS B. (B) Acceptability curve. GDP, gross domestic product (GDP per capita 2014 = $ 7.930 USD); HCP, health care provider; IPHS, institution providing health service.

intervention achieved an improvement in indicators of access and care. Turnbull [39] in his work of managing HIV in general practice mentions that patient care is performed largely by general practitioners with specific training, who also monitor adherence to treatment, clinical laboratory tests, sexual health, and management of chronic and metabolic diseases resulting from ART. Turnbull concludes that as treatment of the disease has evolved, people with HIV/AIDS are living longer, so general practitioners must be trained and use their skills for handling problems associated with chronic conditions [39]. Meanwhile, Solomon et al. [10] assessed the impact of patient volumes on the quality of care for people with HIV within a program of care, to stabilize medical costs in the main health insurance company of the United States, through capitation contracting with institutions providing specialized services. The authors found that when comparing the performance of the HCP according to the volume of patients seen (low, medium, and high), those with higher volume showed a better performance in virtually all quality indicators. [10]

Some economic evaluations of programs focused mainly on dispensing drugs have found positive results for patients. For example, the assistance program for AIDS drugs in the United States (US AIDS Drug Assistance Program [ADAP]) is basically aimed at the provision of medicines in the population with the disease and has been evaluated twice. In 2002, Johri et al. [40] showed their findings in two extreme scenarios, "high efficiency and low efficiency," with the cost-effectiveness for each of these ranging between $7,000 and $28,000 per QALY gained. Meanwhile, Pinkerton et al. [24] in their assessment of the ADAP in 2008 found an incremental cost-effectiveness ratio of $11,955 per QALY gained for this program. On comparing the evidence in these assessments with the results of this study, we observed that although the programs are different, the findings are consistent regarding the benefit to patients. In relation to the calculation of transition probabilities, it was not possible to make a specific comparison because in the analyzes published at the time of literature review, the experiences that submit the calculation between health states from start to finish period were not identified as was done in this study; only two presented the occurrence probability of clinical events by the five health states [16, 22], the others pointed to the occurrence probability of opportunistic infections and mortality based on different ranges of CD4 [17, 18, 43].

With respect to the results obtained in this study, it was observed that the total cost per patient in the care program was between $34,935 and $43,941 depending on the service provider. These values were lower than those reported by Johri et al. [24] in their assessment of the ADAP in 2002 ($78,800–$149,000), despite the difference in periods and without regard to inflation adjustments. Likewise, in the assessment of the distribution of program costs, it became clear that 80.54% of the costs were for drugs, which is close to that reported by other countries such as Germany (83.4%) [41], China (85.1%) [42], Latin America (60%–80%) [43], and Colombia, which registered a value of 84.13% in 2011 [8].

Furthermore, on evaluating the impact of the severity of the disease on the total cost of care, it was observed that the cost of controlled patients (health state 1) was three times lower than that of patients found in health state 5, which is consistent with published studies in which the cost of care for patients in advanced health states is 2 to 16 times the cost of care of the controlled patients [18,20,44–46].

Given the inflection point of the curve of acceptability, if the company was willing to pay more than US $2578.29, the cost-effective alternative would be A; otherwise, it would be B.

With respect to the willingness-to-pay threshold, considering the WHO definition of one to three times the per-capita GDP in developing countries, the study results are very cost-effective. However, from the perspective of the company, this is a high threshold, being equivalent to the annual per-capita premium of 31 patients. This points out the need of defining a threshold payment from the perspective of the insurer in the future.

This study should be viewed in the context of many limitations, mainly associated with the model assumptions; for example, the possible clinical differences between patients entering each provider institution as they are in different regions, have different nutritional status, and have differences in adherence to the treatment and the program can influence both costs and the measured outcome. Unit costs and quantities of resources used for the health care of patients may have differences among institutions and regions. The three service institutions compared may differ in their organization, operation, implementation, and monitoring of the program, affecting therefore costs and health outcomes.

With regard to utilities, currently in Colombia there are no studies to determine these valuations. The analysis of quality of life with evidence from other contexts is controversial; however, it is possible to use this information to make evaluations and decisions, provided we take into account these restrictions and assumptions used. To the extent that evaluation studies about health-related quality of life appear, this analysis will have to be adjusted to the results found in this context.

This analysis allowed comparison of health care providers regarding their management in a health care program. Although the implemented program is the same, the actual management of the institutions presented differences, in this case the results promoted the generation of improvement plans for HCP B and C, which constitutes the main recommendation for those who decide to replicate a similar analysis in health care providers that adopt a standard care model for certain pathology. However in the comprehensive evaluation of a program of care, besides incorporating tools of health economics, further analysis is required to identify the specific problems of management, in which characteristics of the assigned population are verified, as well as attributes of the mandatory system of quality assurance in health (accessibility, timeliness, security, relevance, and continuity) for both insurers and providers of health services.

Nevertheless, it is noteworthy that this evaluation focuses on cost-effectiveness and is based on real information obtained from the individual behavior of patients, presenting a general and innovative vision of comprehensive health management service institutions that have contracted the same interventions. This gives a starting point for evaluating different types of care programs and helps improve the efficiency of health spending.

Conclusions

In the field of economic evaluation developed, HCP A management is a very cost-effective option considering the threshold of 1 time per-capita GDP.

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