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SURINAME

HEALTH SERVICES IMPROVEMENT PROJECT

(SU-L1054)

EX ANTE ECONOMIC ANALYSIS

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1 Introduction

1.1 Background and health system challenges

In 2015, Suriname experienced a deep recession due to price shocks in all of its three main commodities, which pushed its economy into a new phase, characterized by lower growth and rapidly rising debt: in 2016, real GDP growth contracted by 10.5%, the fiscal deficit increased to 7.1% of GDP and the current account balance worsened to 2.8% of GDP. The short to medium-term outlook remains challenging. The Government of Suriname (GoS) is implementing macroeconomic reforms, and launched an adjustment plan in late 2015 with cuts to government expenditure, which will limit state to generate fiscal space for future investments.

Suriname is currently in the advanced stages of an epidemiological transition, marked by a sharp rise in the prevalence of Chronic Non-Communicable Diseases (NCDs) in the general population, while high rates of Communicable Diseases (CDs) persist in specific population subgroups. This context, referred to in the specialized literature as the double burden of disease, requires that the health authorities reorient and strengthen their approach to integrate existing CDs-targeted interventions into a renewed primary health care system that can offer comprehensive care for both NCDs and CDs (Geneau R, 2010).

In 2016, for all ages, NCDs such as heart and Chronic Kidney Disease (CKD), stroke, diabetes, and cancer were the top causes of deaths (75.7% of the total), loss in disability-adjusted life years-DALYs (66.9% of the total), and accounted for 50% of premature deaths (Global Burden of Disease, 2016). Nineteen percent of the total population aged 15-64 has been diagnosed with a NCD (Departament of Public Health. Anton de Kom University of Suriname , 2016). NCDs result from and are driven by population ageing and social determinants, such as urbanization, globalization, poverty and education, which create unhealthy living environments that facilitate an increase in the behavioral risk factors for NCDs. According to the 2013 Suriname STEPS Survey[1] two thirds of the population ages 15-64 (about 232,000 persons) has 1-2 risk factors for NCDs and the remaining third between 3-5. Nearly 30% of adults, and 40-50% of those over age 55 suffer from high blood pressure; overweight and obesity affects 18% of men, 31% of women and 26% of children aged 13-15. Only 56% of the overall population met the World Health Organization (WHO) recommended exercise levels (Baldew, 2015).Smoking and alcohol consumption is higher among men than women (35% vs 6.5% and 73% vs 43%).

[1] Results from the STEPS study, a nationally representative stratified multistage cluster household survey on NCDs and risk factors. Department of Public Health. Anton de Kom University of Suriname 2016. Chronic Disease Risk Factor Surveillance. Data Book for Suriname..Comparable data from STEPS survey in other Caribbean countries (Trinidad and Tobago and Barbados) overall show similar levels of exposure to NCD risk factors.

In addition to health impacts, worldwide and Caribbean region evidence shows that NCDs have significant economic consequences. Economic impacts of NCDs at the household level range from income loss and increased out-of-pocket expenses, and at the national level, from loss of skilled labor and productivity, lower competitiveness and higher government health and social expenditures (World bank, 2013). Unless current trends in Suriname are reversed, NCDs are likely to provide additional burden on healthcare services, increase pressure on healthcare costs, and further deteriorate health outcomes, given the existing high levels of population exposure to NCD risk factors in the country. Compared to the rest of the Caribbean, DALYs caused by diabetes and CKD are almost twice the regional average and have been growing at a faster rate[2]. Between 2005 and 2016 the incidence (new cases) of diabetes, ischemic heart disease and CKD in Suriname grew by 39%, 19% and 24% respectively (Institute of Health Metrics and Evaluation, 2016). A high level of blood sugar is the risk factor driving the most death and disability combined.

On the other end of the double burden of disease, progress in control of CDs has been more marked, with malaria being best example. Suriname has moved from being the country with the highest annual parasite index in the Americas to one on the threshold of elimination. The coastal area has been free of malaria since 1968 and between 2001 and 2016 the Malaria Program (MP) achieved near total elimination of the disease in residential villages of the interior (Van Eer E., 2018). Suriname has reached the Roll Back Malaria and the Millennium Development Goals for Malaria and went from 12,197 malaria cases in 2001 to a low of 352 cases in 2016, of which 86 were autochthonous (locally transmitted) (Hiwat H). However, progress has stagnated due to foci of infection that originate from cross-border movement of mobile, illegal workers from small-scale gold mining communities located in the Guyana Shield area[3] (Hiwat H). Of the 11,381-people seen at the national health facilities in 2016 538 (4.7%) were positive for malaria infection, and of these, 92.6% were imported malaria cases[4]. Hence, although DALYs due to Malaria have decreased (0.05% of all DALYS), there is both an opportunity to eliminate the disease and a risk of resurgence in poor populations if proper elimination activities are not implemented.

1.2 Program strategy

In a context of fiscal constraints, the GoS seeks cost-effective strategies to manage this complex epidemiologic profile and establish a sustainable path to improving its health system. To reduce the rate of NCD's, and address remaining pockets of high prevalence of CD's, international experience recommends focusing on strong primary health care services that offer comprehensive care (Geneau R, 2010). Supporting the strategy with information

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[2] DALYs caused by diabetes and CKD = 1,828 and 1,033 respectively, vs regional average of 938 and 591.

[3] The area includes Suriname, Guyana and French Guyana. It was responsible for the highest annual parasite incidence (API) and concentration of *P. falciparum* malaria cases in the Americas in 2004.

[4] A total of 476 of the diagnosed imported cases (95.6%) were the result of malaria infection obtained in neighboring French Guiana (department of France), which has a high incidence of malaria in the Interior mining areas.

technologies and digital solutions on both the supply and demand side can enable and accelerate its successful implementation.

The objective of the program is to contribute to the reduction of the burden of disease in Suriname by improving access to high quality, integrated primary care services and enhancing the effectiveness of the health sector to address priority epidemiological challenges. The program will focus on financing strategies for NCD prevention and control for malaria elimination and integration of services for other priority CDs within the MP through the activities described in the components below.

Component 1: Institutional strengthening of the MOH for evidenced-based policy-making (estimated US$12.37 million). This component seeks to improve the ICT and physical working environment platforms for the MOH to exercise core policy and technical functions.

Subcomponent 1.1. Improved Health Information System (estimated US$4.3 million). This component seeks to improve the Health Information System in Suriname. Based on findings from the needs assessment, this subcomponent will finance: (i) technical assistance for updates to policies, standards and interoperability; (ii) design and implementation of data warehouse and dashboards; (iii) improved ICT infrastructure including servers, connectivity and hardware; (iv) design and implementation of the integrated clinical information system for expansion of the CCM and its respective costed maintenance plan; (v) Implementation and analysis of two rounds of the STEPS survey; and (vi) design and implementation of disease registries for CKD and cancer.

Subcomponent 1.2. MOH headquarters and central services infrastructure (estimated US$8.072 million). This will consist of improvement to the physical working environment for the MOH to perform its core business functions, enhancing productivity and hence a more effective management of the health sector´s priorities. All the MOH facilities will be concentrated in one site, located in Rode Kruislaan[5] which will be modernized to accommodate administrative and public health central services (i.e. vaccines, children with special needs, breastfeeding, health library). The works will include the reuse of abandoned/underused buildings and the construction of a new one, all incorporating green design criteria and climate change mitigation measures. [6] The subcomponent will finance: (i) the construction design of approximately 6,000m^2 and the landscape design of approximately 2.5 Ha; (ii) the retrofit of the existing buildings, new construction works and landscaping of the compound; (iii) the procurement of office furniture and equipment; (iv) the supervision of the construction works; and (v) the design of a costed maintenance plan.

Component 2. Expansion of the CCM (estimated US$3.84 million). The objective of this component is to improve accessibility and quality of clinical pathways for non-communicable diseases. It will support improvement and expansion of an integrated, patient-centered healthcare model for diabetes in the OSS of Paramaribo and Nickerie, and within approximately 18 RGD primary care facilities that already

[5] The selected site is property of the GOS, currently used for MOH facilities and located in an urbanized area.

[6] Technical Analysis. Provides details on the infrastructure project, including assessment of existing conditions, architectural brief, program of space requirements and design criteria.

operate in these areas. Facilities will be selected based on results of a health care network demand and supply analysis. Financing will be provided for: (i) infrastructure upgrades and physical repairs; (ii) procurement of medical and non-medical equipment and supplies; (iii) design and implementation of a continuous quality improvement (CQI) strategy to optimize clinical and management processes related to the CCM; (iv) training of clinical personnel in core CCM protocols (i.e. footcare); (v) design and implementation of innovative patient education and activation strategies; and (vi) initial operating costs of equipment improvements to the CCM.

Component 3. Increase access to priority services for communicable diseases in at risk population (estimated US$1.5 million). The objective is to sustain and improve the response to communicable diseases. This component will finance the following activities targeting the gold mining population: (i) design and implementation of culturally appropriate BCC strategies to reduce exposure to risk factors for malaria and HIV (i.e. promoting use of bed nets, increasing health seeking behavior) and improve adherence to treatment by at-risk population; (ii) specialized training for the MP and National Reference Laboratory personnel; (iii) training of MP personnel in BCC; (iv) equipment upgrades for the national reference laboratory and TropClinic surveillance; (v) technical studies; and (vi) training and laboratory and field equipment for HIV screening.

Program Administration and Evaluation (estimated US$1.465). This budget line will support the operation of the PIU and project administration and evaluation activities, including the design and implementation of an impact evaluation.

1.3 Expected results

The program is expected to contribute to the reduction of NCDs and CDs, therefore at the impact level, the main indicators included in the Results Matrix are: Annual rates of Ambulatory Care Sensitive Conditions hospitalizations due to diabetes and annual number of autochthonous Malaria cases. With respect to program outcomes the Matrix includes indicators that measure generation and use of health information, improvements in MOH HQ infrastructure, indicators of processes, quality and effectiveness of diabetes care, detection and counseling for HIV and changes in knowledge and practices regarding malaria.

2 Assumptions and Alternatives

2.1 Economic Analysis

2.1.1 Type of economic analysis

Economic evaluations are classified in two types: Cost Benefit Assessments (CBA) and Cost-Effectiveness Assessments (CEA). For both, costs and outcomes of two or more interventions are compared. In the CBA the analyzed outcome is the net profit measured in monetary units, while in the CEA the analyzed outcome is the net effect that is measured in nonmonetary units (Office of Strategic Planning and Development Effectiveness. Inter-American Development Bank, 2012).

For this program, a CEA was chosen given that the expected impact of the program is the reduction of autochthonous Malaria cases and hospitalizations for ambulatory care sensitive conditions (HACSC) due to diabetes. This selection was supported by the fact that the years of life gained adjusted by disability (DALYs) can be used as the effect measure that expresses both the reduction of autochthonous Malaria cases and HACSCs, and because the DALYs can explicitly indicate if the societal threshold of willingness to pay per DALY, or cost effectiveness, is surpassed.

2.1.2 General assumptions

2.1.2.1 Alternatives

At the time of this evaluation there are no other alternatives competing for the resources of the project, as these have been discarded during design, based on the priorities of the country and on their feasibility. Thus, the relevant alternatives to consider are two: (1) execute the program (from now on PROGRAM) with the proposed components with the goals expressed in the results matrix; and (2) not execute the program (from now on NO PROGRAM), ie, maintaining the current situation (counter-factual).

2.1.2.2 Perspective

The perspective used in the model is the social perspective following the guidelines of the Inter-American Development Bank(IDB) methodology guide. In this approach, the direct costs of the operation were considered, as well as other costs of the externalities generated by the implementation of the program; which are assumed by the government and families.

2.1.2.3 Time horizon

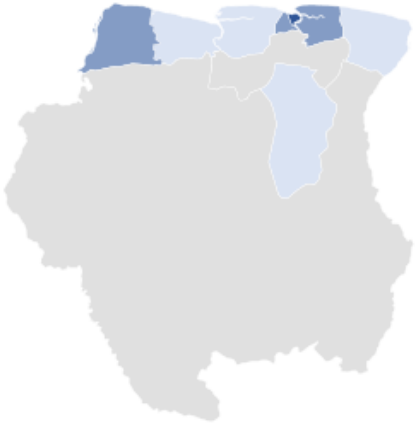
The project has an execution perior of 6 years, in which investments that aim to reduce the burden of disease will be implemented. These investments should bring benefits beyond the time of the program implementation. To account equitably both costs and benefits of the program, a time horizon of 6 years has been selected for this evaluation; however, this is a conservative approach as the operation is an investment that expects results beyond those 6 years.

2.1.2.4 Program beneficiaries

The target beneficiaries for the entirety of the loan program are the citizens of Suriname for which the total population is 558,368 (as of 2016). The potential beneficiaries of the NCD interventions are 41,999 subjects with diabetes living in the regions where the One Stop Shops (OSS) operate and where the CCM will be expanded (see Figure 1 and Table 1).

The potential number of patients benefitting from expansion was obtained applying the percentage of the patients in treatment as found in STEPS to the number of patients of the influence area, calculated as the number of people in the area multiplied by the incidence of diabetes reported by STEPS.

Figure 1 Regions of Stop Shop Centers and expansion of CCM



Source: Author elaboration

Table 1 Area of influence of the OSS and CCM-F

	Wanica	Sipaliwini	Saramacca	Paramaribo	Para	Nickerie	Marowijne	Coronie	Commewijne	Brokopondo	Total
Male											
15-24	169	12	18	263	25	59	12	2	47	4	611
25-34	609	44	66	947	90	213	45	8	169	15	2204
35-44	971	70	105	1509	143	339	71	13	269	23	3514
45-54	1416	102	154	2201	208	495	104	19	393	34	5125
55-64	764	55	83	1187	112	267	56	10	212	18	2764
65-80+	1160	83	126	1803	170	405	85	16	322	28	4198
Male Total	**5087**	**366**	**552**	**7910**	**748**	**1779**	**373**	**68**	**1412**	**122**	**18416**
Female											
15-24	310	22	34	481	46	108	23	4	86	7	1121
25-34	453	33	49	705	67	158	33	6	126	11	1641
35-44	1133	82	123	1762	167	396	83	15	314	27	4101
45-54	1006	72	109	1565	148	352	74	13	279	24	3643
55-64	1138	82	123	1769	167	398	83	15	316	27	4119
65-80+	2475	178	268	3847	364	865	182	33	687	59	8958
Female Total	**6514**	**469**	**706**	**10129**	**958**	**2278**	**478**	**87**	**1808**	**156**	**23583**
Total	**11602**	**835**	**1258**	**18039**	**1706**	**4056**	**851**	**155**	**3220**	**278**	**41999**

Note: Values calculated from STEPS Report 2013 and 2012 Census

2.1.3 Impact Indicators

Considering the guidelines of the Inter-American Development Bank (IDB) CEA methodology guide, the analysis focuses on the impact indicators that incorporate the effects of results indicators. The impact indicators for the program relate to two health conditions: diabetes and malaria (see Table 2). Each of them was analyzed individually as detailed in the following paragraphs.

Table 2 Impact indicators of the results matrix

Indicators	Unit	Baseline		Goals		Means of verification
		Value	Year	Value	Year	
Autochthonous Malaria cases	Number	40	2017	0	2024	National Malaria Database
Ambulatory Care Sensitive Hospitalizations due to diabetes	Rate per 1,000 population	5.4	2016/2017	4.32	2024	National hospital discharge databases

Source: Results matrix of the program

2.1.4 Model parameters

The implementation of the program has an expected outcome of 80% patients with controlled diabetes, a 40% increase with respect to current controlled patients. From data obtained from STEPS, it was estimated that by 2019 there will be 41,999 diabetic patients in the influence area; from which 40% are treated (23,227). By 2021, 6 RGD facilities will have been upgraded to provide the CCM (these will be denominated CCM-F); this is expected to increase the number of patients with controlled diabetes in the following year by 40%[7] (see Table 3 and Table 4).

Table 3 Deployment of the program by year

Year	Patients in CCM	
	NO PROGRAM	PROGRAM
2019	40%	40%
2020	40%	40%
2021	40%	40%
2022	40%	80%
2023	40%	80%
2024	40%	80%

Source: Model assumptions following POD.

Table 4 Treated diabetic patients by year

	2019	2020	2021	2022	2023	2024
Not perform the operation	23227	23227	23227	23227	23227	23227
Perform the operation	23227	23227	23227	33600	33600	33600

[7] This value is taken from the RM of expected outcomes and is evaluated in the sensitivity analysis in section 6.

3 Economic Costs

All costs are presented in constant US dollars of 2019 (first year of program implementation) and are discounted at an effective rate of 12% per year, following the methodological recommendations of the Inter-American Development Bank (Office of Strategic Planning and Development Effectiveness. Inter-American Development Bank, 2012).

Costs are taken from the program budget, see Table 5, and the operational costs of the activities in the Results Matrix. Other costs, not directly assumed by the operation, also were considered (ie, the cost of consumables of the CCM-F and the variable costs for the treatment of hospitalizations and amputations), see Table 6. These costs had local prices and international benchmarks as reference; for the latter, prices were adjusted for purchasing power parity or inflation.

To weight the costs of the program with its effect, the avoided DALYs were discounted at the same rate (12%); therefore, the value given to the averted deaths decreases as the time span from the beginning of the program increases.

Table 7 shows the annualized costs in 2019 US dollars obtained from the model with a discount factor of 12% for the alternatives of not performing the operation and performing the operation; the incremental value, which is the difference in costs of the two alternatives, is also displayed (Office of Strategic Planning and Development Effectiveness. Inter-American Development Bank, 2012). Table 9 shows the same information with undiscounted costs.

As shown in Tables 7-10 other than the direct costs of the operation, the costs of consumables and maintenance of the CCM-F, see Table 6 were taken into account. The consumable cost was obtained from the annual report of the CCM-F and the maintenance as a percentage of the cost of the One Stop Shop; besides, the cost of the treatment for diabetes by patient as obtained in a Latin American study (Alberto Barcelo, 2017), see Table 6.

The costs of hospitalizations was also taken into account; for simplicity it was assumed that each complication event of diabetes ended in hospitalization. The average cost of hospitalization was calculated from the records of the Paramaribo Academic Hospital and was converted to dollars considering the exchange rate and inflation as reported by the international monetary fund. Other than the direct cost of hospitalization, the average productivity time lost was taken as reported in STEPS per patient and for caregivers (considering the percentage of patients with caregivers). Each day lost by the patient or the caregiver was valued as GDP divided by 365 per day. Additionally, for the PROGRAM alternative, out of pocket expenses were considered as reported in the STEPS, as well as the the additional costs for diabetic patient treatment., see Table 4.

Table 5 Breakdown of the costs incurred by PROGRAM

Component	US$	%
1. Institutional strengthening of the MOH for evidenced-based policy-making	**12,372,000**	62
Subcomponent 1.1. Improved Health Information System	4,300,000	
Subcomponent 1.2. MOH headquarters and central services infrastructure	8,072,000	
2. Expansion of the CCM	**3,840,000**	19
3. Increase access to priority services for communicable diseases in at risk population	**1,500,000**	8
Program administration and evaluation	**1,665,000**	8
PIU basic staff salaries	1,170,000	
Monitoring & Evaluation	365,000	
Financial audits	100,000	
Mid term evaluation	40,000	
Final Evaluation (PCR report)	50,000	
Impact Evaluation	175,000	
Logistics and minor management costs	130,000	
Contingency reserve	**623,000**	3
TOTAL	**20,000,000**	**100**

Source: Program Budget

Table 6 Annual direct cost not included in the PROGRAM

Operation per OSS	
Consumables[1]	$17,938
Maintenance[2]	$18,037
Direct cost attention	
Diabetes medication cost[4]	$501
Surgery and hospitalization diabetes cost[5]	$2,824
Patient and indirect cost attention[6]	
Loss of productivity in days	5.50
Support during health care visits	19.5%
GDP daily	$20
Loss of productivity patient and caregiver	$135
Other cost	$25
Total per hospitalization	**$160**

Source: 1: Investment regional OSS concept-budget; 2: (T., 1982); 3: (Laptiste, 2004); 4: (Alberto Barcelo, 2017); 5:CVZ Hospital Records; 6: (Departament of Public Health. Anton de Kom University of Suriname , 2016)[8]

Table 7 Annualized costs by activity in USD 2019 discounted at 12% NO PROGRAM

		Year					
	Total	2019	2020	$2,021	2022	2023	2024
New OSS Operation Cost							
Consumables	$247,804.46	$53,814.66	$48,048.80	$42,901	$38,304.21	$34,200.19	$30,535.88
Maintenance	$249,175.84	$54,112.48	$48,314.71	$43,138	$38,516.19	$34,389.46	$30,704.87
Total	**$565,570**	**$107,927**	**$96,364**	**$86,039**	**$76,820**	**$137,179**	**$61,241**

[8] Monetary values in Suriname Dollars were converted to USD 2019 dollars according to the exchange rate and inflation of the International Monetary Fund, World Economic Outlook Database, October 2017.

Diabetes Treatment							
Cost of medication (Insulin, Oral)	$53,584,425	$11,636,706	$10,389,916	$9,276,710	$8,282,777	$7,395,337	$6,602,979
Total	**$60,979,761**	**$11,636,706**	**$10,389,916**	**$9,276,710**	**$8,282,777**	**$14,790,673**	**$6,602,979**
Diabetes Hospital Costs							
Amputations	$8,530,560	$942,085	$1,110,033	$1,302,502	$1,511,633	$1,726,827	$1,937,481
Blindness	$4,090,668	$652,090	$673,846	$688,852	$696,220	$694,969	$684,691
Congestive failure	$4,707,274	$181,247	$275,993	$437,589	$716,465	$1,164,711	$1,931,268
Ischemic heart disease	$7,352,187	$716,134	$922,997	$1,138,299	$1,348,809	$1,537,377	$1,688,570
Myocardial infarction	$210,545	$24,967	$28,311	$32,016	$35,969	$40,958	$48,325
Renal	$5,140,816	$687,665	$749,041	$826,011	$898,140	$962,467	$1,017,492
Stroke	$210,545	$24,967	$28,311	$32,016	$35,969	$40,958	$48,325
Out of pocket expenditure and loss of productivity	$1,852,142	$197,763	$232,020	$272,977	$321,109	$377,762	$450,511
Total	**$40,838,196**	**$3,426,917**	**$4,020,553**	**$4,730,261**	**$5,564,313**	**$15,289,490**	**$7,806,662**
Grand Total	**$102,383,528**	**$15,171,550**	**$14,506,832**	**$14,093,010**	**$13,923,911**	**$30,217,343**	**$14,470,882**

Source: Model result

Table 8 Annualized costs by activity in USD 2019 discounted at 12% PROGRAM

		Year					
	Total	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Component 1: Institutional strengthening of the MoH for evidenced based policy making							
Health Information System operational in MOH and CCM centers	$2,865,424	$0	$0	$1,594,388	$0	$1,271,036	$0
Steps survey carried out	$229,256	$0	$133,929	$0	$0	$95,328	$0
Infrastructure of MOH improved	$5,557,623	$0	$2,065,992	$1,844,635	$1,646,996	$0	$0
MOH and CCM units trained to process and analyze data from National Health Information System	$343,254	$0	$0	$75,087	$268,168	$0	$0
Ministry of health equipped	$469,293	$0	$0	$0	$469,293	$0	$0
Component total	$9,464,851	$0	$2,199,920	$3,514,110	$2,384,457	$1,366,364	$0
Component 2: Expansion of the chronic care model							
Continuous Quality Improvement strategy designed and implemented in CCM centers	$471,248	$0	$0	$0	$471,248	$0	$0
CCM model guidelines updated	$154,483	$154,483	$0	$0	$0	$0	$0
CCM centers with behavioral change and patient activation strategy implemented	$238,429	$0	$0	$0	$0	$238,429	$0
Infrastructure at CCM facilities upgraded	$921,794	$0	$0	$395,848	$0	$525,946	$0
Clinical Equipment at CCM facilities upgraded	$460,897	$0	$0	$197,924	$0	$262,973	$0
Non-clinical equipment at CCM facilities upgraded	$153,632	$0	$0	$65,975	$0	$87,658	$0
Staff at CCM trained on guidelines application	$221,599	$0	$0	$0	$104,722	$116,877	$0
Medical supplies for chronic care centers start up available	$78,055	$0	$0	$39,096	$0	$38,959	$0
Component total	$2,700,136	$154,483	$0	$698,843	$575,969	$1,270,841	$0
Component 3: Increase the access to priority CD preventive services for targeted population							
Basic Language Training (Portuguese) provided to Medical Mission clinics personnel located near mining areas	$29,800	$0	$8,760	$7,821	$6,983	$6,235	$0
Communication and behavior change strategy implemented	$638,208	$0	$187,607	$167,506	$149,559	$133,535	$0
Specialized trainings for data collection, processing and analysis at the national reference laboratory delivered	$235,001	$29,215	$78,255	$46,580	$62,384	$18,567	$0
Quality Assurance and Quality Control Guide developed	$70,858	$70,858	$0	$0	$0	$0	$0
Parasitological microscopes available	$19,466	$0	$19,466	$0	$0	$0	$0
National strategy for provision of health services for priority infectious diseases to (mobile) migrant populations elaborated	$16,352	$16,352	$0	$0	$0	$0	$0
Baseline prevalence study in migrant populations (HIV/Leishmaniasis, TB/Leprosy) elaborated	$61,319	$0	$61,319	$0	$0	$0	$0
Migrant study on population size, migration, turnover and health priorities elaborated	$29,200	$0	$29,200	$0	$0	$0	$0
HIV staff in TropClinical and national counterparts annually trained	$33,376	$9,811	$8,760	$7,821	$6,983	$0	$0
Laboratory and field equipment for HIV screening in gold mining areas available for field visits	$31,688	$7,849	$7,008	$6,257	$5,587	$4,988	$0
National Reference Laboratory equipped	$35,265	$19,622	$0	$15,643	$0	$0	$0
Component total	$1,200,531	$153,706	$400,374	$251,629	$231,497	$163,325	$0
Component 4. Program Administration and Evaluation							
Component total	$1,182,943	$293,000	$261,607	$233,578	$208,552	$186,207	$0
Other Cost	$664,548	$164,600	$146,964	$131,218	$117,159	$104,606	$0
Total components	**$15,213,009**	**$765,789**	**$3,008,866**	**$4,829,377**	**$3,517,633**	**$3,091,343**	**$0**
New OSS Operation Cost							
Consumables	$604,423	$53,815	$48,049	$128,702	$114,913	$136,801	$122,144
Maintenance	$607,767	$54,112	$48,315	$129,414	$115,549	$137,558	$122,819
Total	**$1,486,549**	**$107,927**	**$96,364**	**$258,117**	**$230,461**	**$548,717**	**$244,963**
Diabetes Treatment							
Cost of medication (Insulin, Oral)	$63,534,612	$11,636,706	$10,389,916	$9,276,710	$11,981,661	$10,697,912	$9,551,707
Total	**$74,232,523**	**$11,636,706**	**$10,389,916**	**$9,276,710**	**$11,981,661**	**$21,395,824**	**$9,551,707**
Diabetes Hospital Costs							
Amputations	$5,580,696	$942,085	$1,110,033	$1,302,502	$715,411	$739,117	$771,548
Blindness	$3,335,225	$652,090	$673,846	$688,852	$479,290	$439,925	$401,221
Congestive failure	$2,365,052	$181,247	$275,993	$437,589	$313,141	$454,923	$702,159
Ischemic heart disease	$5,291,250	$716,134	$922,997	$1,138,299	$829,168	$843,489	$841,163
Myocardial infarction	$167,819	$24,967	$28,311	$32,016	$27,291	$27,328	$27,907
Renal	$3,870,637	$687,665	$749,041	$826,011	$557,566	$535,846	$514,509
Stroke	$167,819	$24,967	$28,311	$32,016	$27,291	$27,328	$27,907
Out of pocket expenditure and loss of productivity	$1,272,534	$197,763	$232,020	$272,977	$180,615	$187,890	$201,269
Total	**$25,957,239**	**$3,426,917**	**$4,020,553**	**$4,730,261**	**$3,129,772**	**$7,162,052**	**$3,487,683**
Grand Total	**$116,889,320**	**$15,937,339**	**$17,515,698**	**$19,094,465**	**$18,859,527**	**$32,197,936**	**$13,284,353**

Source: Model result

Table 9 Annualized costs by activity in USD 2019 undiscounted NO PROGRAM

	Year						
	Total	**2019**	**2020**	**2021**	**2022**	**2023**	**2,024**
New OSS Operation Cost							
Consumables	$322,887.95	$53,814.66	$53,814.66	$53,815	$53,814.66	$53,814.66	$53,814.66
Maintenance	$324,674.85	$54,112.48	$54,112.48	$54,112	$54,112.48	$54,112.48	$54,112.48
Total	**$755,490**	**$107,927**	**$107,927**	**$107,927**	**$107,927**	**$215,854**	**$107,927**
Diabetes Treatment							
Cost of medication (Insulin, Oral)	$69,820,233	$ 11,636,705.54	$ 11,636,705.54	$11,636,706	$ 11,636,705.54	$ 11,636,705.54	$ 11,636,705.54
Total	**$81,456,939**	**$11,636,706**	**$11,636,706**	**$11,636,706**	**$11,636,706**	**$23,273,411**	**$11,636,706**
Diabetes Hospital Costs							
Amputations	$12,074,614	$942,085	$1,243,237	$1,633,858	$2,123,735	$2,717,195	$3,414,504
Blindness	$5,549,239	$652,090	$754,708	$864,096	$978,140	$1,093,547	$1,206,659
Congestive failure	$7,282,103	$181,247	$309,112	$548,911	$1,006,582	$1,832,696	$3,403,554
Ischemic heart disease	$10,467,683	$716,134	$1,033,757	$1,427,882	$1,894,980	$2,419,093	$2,975,836
Myocardial infarction	$296,981	$24,967	$31,709	$40,160	$50,533	$64,448	$85,165
Renal	$7,132,190	$687,665	$838,925	$1,036,148	$1,261,821	$1,514,460	$1,793,169
Stroke	$296,981	$24,967	$31,709	$40,160	$50,533	$64,448	$85,165
Out of pocket expenditure and loss of productivity	$2,639,553	$197,763	$259,863	$342,422	$451,135	$594,416	$793,955
Total	**$59,497,350**	**$3,426,917**	**$4,503,019**	**$5,933,639**	**$7,817,460**	**$24,058,308**	**$13,758,006**
Grand Total	**$141,709,778**	**$15,171,550**	**$16,247,652**	**$17,678,272**	**$19,562,092**	**$47,547,574**	**$25,502,638**

Source: Model result

Table 10 Annualized costs by activity in USD 2019 undiscounted PROGRAM

		Year					
	Total	2019	2020	$2,021	2022	2023	2024
Component 1: Institutional strengthening of the MoH for evidenced based policy making							
Health Information System operational in MOH and CCM centers	$4,000,000	$0	$0	$2,000,000	$0	$2,000,000	$0
Steps survey carried out	$300,000	$0	$150,000	$0	$0	$150,000	$0
Infrastructure of MOH improved	$7,370,000	$0	$2,456,667	$2,456,667	$2,456,667	$0	$0
MOH and CCM units trained to process and analyze data from National Health Information System	$500,000	$0	$0	$100,000	$400,000	$0	$0
Ministry of health equipped	$700,000	$0	$0	$0	$700,000	$0	$0
Component total	$12,870,000	$0	$2,606,667	$4,556,667	$3,556,667	$2,150,000	$0
Component 2: Expansion of the chronic care model							
Continuous Quality Improvement strategy designed and implemented in CCM centers	$300,000	$0	$0	$0	$300,000	$0	$0
CCM model guidelines updated	$70,000	$70,000	$0	$0	$0	$0	$0
CCM centers with behavioral change and patient activation strategy implemented	$170,000	$0	$0	$0	$0	$170,000	$0
Infrastructure at CCM facilities upgraded	$600,000	$0	$0	$225,000	$0	$375,000	$0
Clinical Equipment at CCM facilities upgraded	$300,000	$0	$0	$112,500	$0	$187,500	$0
Non-clinical equipment at CCM facilities upgraded	$100,000	$0	$0	$37,500	$0	$62,500	$0
Staff at CCM trained on guidelines application	$150,000	$0	$0	$0	$66,667	$83,333	$0
Medical supplies for chronic care centers start up available	$50,000	$0	$0	$22,222	$0	$27,778	$0
Component total	$1,740,000	$70,000	$0	$397,222	$366,667	$906,111	$0
Component 3: Increase the access to priority CD preventive services for targeted population							
Basic Language Training (Portuguese) provided to Medical Mission clinics personnel located near mining areas	$36,000	$0	$9,000	$9,000	$9,000	$9,000	$0
Communication and behavior change strategy implemented	$771,000	$0	$192,750	$192,750	$192,750	$192,750	$0
Specialized trainings for data collection, processing and analysis at the national reference laboratory delivered	$268,000	$26,800	$80,400	$53,600	$80,400	$26,800	$0
Quality Assurance and Quality Control Guide developed	$65,000	$65,000	$0	$0	$0	$0	$0
Parasitological microscopes available	$20,000	$0	$20,000	$0	$0	$0	$0
National strategy for provision of health services for priority infectious diseases to (mobile) migrant populations elaborated	$15,000	$15,000	$0	$0	$0	$0	$0
Baseline prevalence study in migrant populations (HIV/Leishmaniasis, TB/Leprosy) elaborated	$63,000	$0	$63,000	$0	$0	$0	$0
Migrant study on population size, migration, turnover and health priorities elaborated	$30,000	$0	$30,000	$0	$0	$0	$0
HIV staff in TropClinical and national counterparts annually trained	$36,000	$9,000	$9,000	$9,000	$9,000	$0	$0
Laboratory and field equipment for HIV screening in gold mining areas available for field visits	$36,000	$7,200	$7,200	$7,200	$7,200	$7,200	$0
National Reference Laboratory equipped	$36,000	$18,000	$0	$18,000	$0	$0	$0
Component total	$1,376,000	$141,000	$411,350	$289,550	$298,350	$235,750	$0
Component 4. Program Administration and Evaluation							
Component total	$3,000,000	$600,000	$600,000	$600,000	$600,000	$600,000	$0
Other Cost	$1,014,000	$202,800	$202,800	$202,800	$202,800	$202,800	$0
Total components	**$4,014,000**	**$802,800**	**$802,800**	**$802,800**	**$802,800**	**$802,800**	**$0**
New OSS Operation Cost							
Consumables	$861,035	$53,815	$53,815	$161,444	$161,444	$215,259	$215,259
Maintenance	$865,800	$54,112	$54,112	$162,337	$162,337	$216,450	$216,450
Total	**$2,158,543**	**$107,927**	**$107,927**	**$323,781**	**$323,781**	**$863,417**	**$431,709**
Diabetes Treatment							
Cost of medication (Insulin, Oral)	$85,410,230	$11,636,706	$11,636,706	$11,636,706	$16,833,371	$16,833,371	$16,833,371
Total	**$102,243,602**	**$11,636,706**	**$11,636,706**	**$11,636,706**	**$16,833,371**	**$33,666,743**	**$16,833,371**
Diabetes Hospital Costs							
Blindness	$7,347,028	$942,085	$1,243,237	$1,633,858	$1,005,102	$1,163,015	$1,359,732
Ischemic heart disease	$4,343,582	$652,090	$754,708	$864,096	$673,368	$692,231	$707,089
Amputations	$3,432,486	$181,247	$309,112	$548,911	$439,940	$715,831	$1,237,445
Congestive failure	$7,152,357	$716,134	$1,033,757	$1,427,882	$1,164,922	$1,327,246	$1,482,416
Renal	$227,360	$24,967	$31,709	$40,160	$38,341	$43,001	$49,181
Myocardial infarction	$5,095,983	$687,665	$838,925	$1,036,148	$783,340	$843,164	$906,741
Stroke	$227,360	$24,967	$31,709	$40,160	$38,341	$43,001	$49,181
Out of pocket expenditure and loss of productivity	$1,704,152	197762.5693	259862.8764	$342,422	253750.6639	295649.0912	$354,705
Total	**$35,676,798**	**$3,426,917**	**$4,503,019**	**$5,933,639**	**$4,397,104**	**$11,269,628**	**$6,146,490**
Grand Total	**$160,078,942**	**$16,185,350**	**$20,068,468**	**$23,940,365**	**$26,578,740**	**$49,894,449**	**$23,411,569**

Source: Model result

4 Cost-effectiveness Measures

4.1 Intervention outcomes

Taking into account the Inter-American Development Bank (IDB) CEA methodology guide, the outcomes of interest of this analysis are the impact indicators as they capture the ultimate effect of a better control of blood glucose, and the reduction of risky behaviors for malaria and HIV.. The indicators of impact for the program are formulated for two main topics: diabetes and malaria (see Table 2). Each of them was analyzed individually as detailed in the following paragraphs. It is worth pointing out that the goals of these indicators can be considered conservative if they are contrasted against similar experiences.

4.1.1 Diabetes

The effect of an adequate control of diabetic patients was estimated through a simulation model. The deployment of the program, see Table 9, and the areas of influence of the interventions to expand the CCM, see Table 8 were considered to model the effect of a better glycemic control. This simulation used the UKPDS model proposed by Clarke, et al, 2004, to estimate the likely occurrence of death and of major diabetes related complications which are causes of avoidable hospitalizations, over a life time: amputations, blindness, nonfatal myocardial infarction (MI), ischemic heart disease (IHD) and congestive heart failure (CHF), renal disease and stroke. The original model is designed to calculate QALYs; however, the model was adapted to calculate DALYs, using the values of GLOBAL BURDEN OF DISEASE 2004 (World Health Organization, 2014).

The model, which was parametrized in Excel, uses 3 equations, see Table 11, to forecast the occurrence of death and diabetes-related complications. Each equation uses data for patient's variables for each of the years of the time horizon of this economic evaluation (ie, age, sex, race, smoking history, BMI, HbA1C, systolic blood pressure (SBP), HDL, peripheral vascular disease (PVD), atrial fibrillation, ischemic heart disease (IHD), congestive heart failure (CHF) and blindness), the weight of each of those parameters in the probability of death and diabetes-related complications (see Table 12 and Table 13 respectively), and constant values of the model

For this simulation model, the average values are included in Table 14 .For the patients' variables for the time horizon of this economic evaluation, except of the HbAC1 (years 1 to 6) and SBP (years 2 to 6), were obtained by gender and age from the STEPS study[9]. The

[9] These values were considered from the average population, not only for diabetic patients; therefore, this may lead to a sub estimation of the effect of the intervention.

average values for HbAC1 (years 1 to 6) and SBP (years 2 to 6) were calculated from the data presented in the 2016 conference by ACSION at the university of University of West Indies. This data showed the effect of the glycemic control as a 0.95 percentage of change by year in the glycemic levels when the patient was being controlled during 3 years in the CCM-F; additionally, there is an assumption that the reduction of HbAC1 levels for the following years is accompanied with a reduction in SBP. Therefore, for years 2 to 5, if the patient had controlled glycemic levels, the HbAC1 and SBP were calculated applying the reduction values calculated from the ACSION data for the previous years (0.95). If the patient was not controlled, the inverse of the reduction was applied following the natural progression of the disease (0.95^{-1}).

These equations were simulated for 852 cases, each for 6 years (the time horizon of the model); each case corresponds to one age in simple years (between 15 and 85), one gender, and a year to initiate the glycemic control, between one and five, or the option of being uncontrolled all the time. The probability of events by complications, death, and the time living with complication was recorded for each simulation. This information was used to calculate the years living with disability (YLD) (calculated from the number of persons with the disease, the years with the disease, and the disability weight as obtained from GLOBAL BURDEN OF DISEASE 2004 (World Health Organization, 2014), see Table 15), and the years of life lost (YLL) considering the life expectancy at the time of death (age + year of simulation), which was linearly interpolated from the one published by Murray 1994 for grouped aged, in order to have the life expectancy by simple age and gender. The YLD and YLL were discounted at the same rate of the costs (12% annual). The YLD and YLL for each simulation were added to obtain the DALYs, see Table 16. The DALYs for each year of the intervention were obtained by multiplying all the DALYs obtained per simulation (by year and gender), see weighted average in Table 16.

The number of treated patients was then multiplied by the DALYs per year of the intervention to obtain DALYs for each of the alternatives as shown in Table 19.

The hospitalizations for complications of diabetes in the two alternatives were obtained from the number of events that could cause a hospitalization and their probability for each year, see Table 17.

Table 11 Regressions and equations used to estimate the probability of diabetes-related complications and diabetes-related mortality

	Regression	Equation
Probability of a diabetes-related complication	**Weibull**	The integrated hazard at time t is: $H(t\|x_j) = e^{(\lambda+\beta_j x_j)} t^{\rho}$ The unconditional probability in the interval t to t+1 is $1 - e^{H(t\|x_j) - H(t+1\|x_j)}$

	Regression	Equation
Probability of survival	**Logistic**	The probability of survival is given by: $S = \frac{e^{-\lambda+\beta_j x_j}}{\left(1+e^{-\lambda+\beta_j x_j}\right)}$
Probability of death	**Gompertz**	The integrated hazard at time t is: $H\left(t\middle\|x_j\right) = \phi^{-1}e^{(\lambda+\beta_j x_j)}\left(e^{\phi t}-1\right)$ And the unconditional probability of death in the interval t to t+1 is: $1-e^{H\left(t\middle\|x_j\right)-H\left(t+1\middle\|x_j\right)}$

x_j : vector of covariates that includes the data for each of the patient's variables at the time of diabetes diagnosis: age, sex, race, smoking history, BMI, HbA1C, systolic blood pressure (SBP), HDL, peripheral vascular disease (PVD), atrial fibrillation, ischemic heart disease (IHD), congestive heart failure (CHF) and blindness.
β_j : coefficient that denotes the weight of each of the patients' parameters for the diabetes-related complications see
Table 12, and diabetes-related mortality see Table 13.
λ, ρ and ϕ are constants of the model used for each of the diabetes-related complications and mortality, see
Table 12 and Table 13, respectively.

Source: (Clarke, y otros, 2004) and (Hayes, Leal, Gray, Holman, & Clarke, 2013)

Table 12 Parameters and coefficients for the equations used to estimate the probability of diabetes-related complications

	AMP	BLIND	CHF	IHD	MI	RENAL	STROKE
Functional form	Weibull	Weibull	Weibull	Weibull	Weibull	Weibull	Weibull
λ	-8.718	-6.464	-8.018	-5.310	-4.977	-10.016	-7.163
ρ	1.451	1.154	1.711	1.150	1.257	1.865	1.497
AGE	0.000	0.069	0.093	0.031	0.055	0.000	0.085
FEMALE	0.000	0.000	0.000	-0.471	-0.826	0.000	-0.516
AC	0.000	0.000	0.000	0.000	-1.312	0.000	0.000
SMOK	0.000	0.000	0.000	0.000	0.346	0.000	0.355
BMI	0.000	0.000	0.066	0.125	0.000	0.000	0.000
HBA1C	0.435	0.221	0.157	0.098	0.118	0.000	0.128
SBP	0.228	0.000	0.114	0.000	0.101	0.404	0.276
TOTAL:HDL	0.000	0.000	0.000	1.498	0.000	0.000	0.113
Ln(TOTAL:HDL)	2.436	0.000	0.000	0.000	1.190	0.000	0.000
PVD	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ATRFIB	0.000	0.000	0.000	0.000	0.914	0.000	1.428
IHD	0.000	0.000	0.000	0.000	1.558	0.000	0.000
CHF	0.000	0.000	0.000	0.000	0.000	0.000	1.742
BLIND	1.812	0.000	0.000	0.000	0.000	2.082	0.000

Source: (Clarke, y otros, 2004)

Table 13 Parameters and coefficients for the equations used to estimate the probability of diabetes-related mortality

	DIABETES MORTALITY	EVENT FATALITY	OTHER DEATH
Functional form	Logistic	Gompertz	Gompertz
λ	-5.124	-3.251	-6.373
φ	0.003	0	0.154
Ln(AGE_EVENT)	4.731	2.772	0
AGE×(FEMALE)	0	0	0.081
AGE×(1-FEMALE)	0	0	0.104
SMOK	0	0	0.307
HBA1C	0	0.114	0
TOTAL: HDL	0.109	0	0
MI_EVENT	3.939	2.64	0
MI_POST	1.119	0	0
STROKE_EVENT	2.807	1.048	0
RENAL	1.585	0	0
AMP	1.032	0	0

Source: (Clarke, y otros, 2004)

Table 14. Relevant patient values used to estimate the probability of diabetes-related complications and diabetes-related deaths, and their source

Parameter	Value	Parameter source
% diabetic patients with uncontrolled blood glucose	55%	STEPS
% diabetic patients that achieve glucose targets with CCM (Year 3, HbAC1 ≤ 7.4)	68%	(ACSION, 26 October 2016)
Average yearly HbAC1 reduction with CCM	0.937	(ACSION, 26 October 2016)
Average yearly SBP reduction with CCM	0.991	(ACSION, 26 October 2016)
Complications in function of glycosylated glucose HbAC1 and systolic blood pressure Hazard/odds HbAC1		(Clarke, y otros, 2004)
DALYS from CCM application	1,390	Results of the model

	HbAC1	SBP
Congestive Heart Failure	1.17	1.12
Stroke	1.14	1.32
Myocardial infarction	1.13	1.11
Ischemic heart disease	1.13	1.10
Blindness	1.25	
Renal failure		1.50
Amputation	1.55	1.26
Event fatality	1.12	

Table 15 Disability Weight by diabetes related condition

Condition	Disability Weight by Event	Disability Weight
Diabetes without complications		0.012
AMP		0.102
BLIND		0.552
CHF		0.201
IHD		0.124
MI		0.439
RENAL		0.104
STROKE	0.92	0.266

Source: (World Health Organization, 2014)

Table 16 DALYs by age, gender and year of glycemic control, discounted by 12%

Age	Male weight	Female Weight	Male						Female					
			Control on yr1	Control on yr2	Control on yr3	Control on yr4	Control on yr5	Uncontrolled	Control on yr1	Control on yr2	Control on yr3	Control on yr4	Control on yr5	Uncontrolled
15	0.052%	0.1%	0.0702	0.0720	0.0742	0.0769	0.0803	0.0852	0.0671	0.0684	0.0700	0.0720	0.0744	0.0781
16	0.066%	0.146%	0.0707	0.0725	0.0749	0.0777	0.0812	0.0863	0.0674	0.0688	0.0704	0.0725	0.0751	0.0788
17	0.084%	0.174%	0.0712	0.0731	0.0756	0.0786	0.0822	0.0875	0.0678	0.0692	0.0709	0.0731	0.0757	0.0797
18	0.104%	0.205%	0.0717	0.0738	0.0763	0.0795	0.0832	0.0888	0.0681	0.0696	0.0714	0.0737	0.0765	0.0806
19	0.127%	0.240%	0.0723	0.0744	0.0771	0.0804	0.0843	0.0902	0.0685	0.0700	0.0720	0.0744	0.0772	0.0816
20	0.155%	0.277%	0.0732	0.0755	0.0784	0.0819	0.0860	0.0924	0.0691	0.0707	0.0728	0.0753	0.0783	0.0830
21	0.186%	0.319%	0.0742	0.0766	0.0797	0.0834	0.0879	0.0946	0.0697	0.0714	0.0736	0.0763	0.0795	0.0845
22	0.221%	0.364%	0.0752	0.0778	0.0811	0.0851	0.0898	0.0969	0.0703	0.0722	0.0745	0.0774	0.0808	0.0860
23	0.261%	0.412%	0.0762	0.0791	0.0826	0.0868	0.0917	0.0992	0.0710	0.0730	0.0755	0.0785	0.0821	0.0876
24	0.305%	0.464%	0.0773	0.0804	0.0841	0.0886	0.0937	0.1015	0.0717	0.0738	0.0765	0.0797	0.0834	0.0892
25	0.355%	0.520%	0.0791	0.0825	0.0866	0.0915	0.0972	0.1059	0.0727	0.0751	0.0780	0.0816	0.0857	0.0921
26	0.410%	0.579%	0.0801	0.0837	0.0880	0.0932	0.0992	0.1083	0.0734	0.0759	0.0790	0.0827	0.0871	0.0938
27	0.470%	0.641%	0.0812	0.0849	0.0895	0.0950	0.1012	0.1108	0.0741	0.0767	0.0800	0.0839	0.0885	0.0956
28	0.537%	0.708%	0.0823	0.0863	0.0911	0.0969	0.1034	0.1135	0.0748	0.0776	0.0810	0.0852	0.0900	0.0975
29	0.608%	0.777%	0.0835	0.0877	0.0929	0.0989	0.1058	0.1164	0.0756	0.0785	0.0822	0.0865	0.0916	0.0995
30	0.686%	0.850%	0.0852	0.0898	0.0952	0.1017	0.1090	0.1205	0.0766	0.0798	0.0836	0.0883	0.0936	0.1021
31	0.770%	0.925%	0.0871	0.0920	0.0978	0.1047	0.1125	0.1249	0.0777	0.0810	0.0852	0.0901	0.0958	0.1048
32	0.859%	1.003%	0.0891	0.0943	0.1005	0.1079	0.1163	0.1293	0.0788	0.0824	0.0868	0.0921	0.0981	0.1076
33	0.954%	1.084%	0.0911	0.0967	0.1034	0.1113	0.1201	0.1338	0.0800	0.0839	0.0886	0.0941	0.1005	0.1106
34	1.055%	1.167%	0.0932	0.0992	0.1064	0.1147	0.1240	0.1385	0.0813	0.0854	0.0904	0.0963	0.1030	0.1136
35	1.160%	1.252%	0.0963	0.1028	0.1107	0.1197	0.1299	0.1457	0.0836	0.0882	0.0938	0.1004	0.1080	0.1199
36	1.270%	1.338%	0.0983	0.1052	0.1135	0.1231	0.1338	0.1506	0.0849	0.0898	0.0957	0.1027	0.1107	0.1234
37	1.385%	1.425%	0.1005	0.1078	0.1166	0.1267	0.1380	0.1557	0.0863	0.0915	0.0978	0.1052	0.1136	0.1270
38	1.503%	1.513%	0.1027	0.1105	0.1198	0.1306	0.1425	0.1612	0.0878	0.0933	0.1000	0.1079	0.1168	0.1310
39	1.623%	1.601%	0.1052	0.1134	0.1233	0.1346	0.1472	0.1671	0.0894	0.0953	0.1024	0.1107	0.1201	0.1352
40	1.745%	1.688%	0.1078	0.1165	0.1270	0.1391	0.1524	0.1735	0.0916	0.0979	0.1055	0.1144	0.1244	0.1407
41	1.869%	1.774%	0.1105	0.1198	0.1310	0.1438	0.1579	0.1803	0.0939	0.1007	0.1088	0.1183	0.1291	0.1465
42	1.991%	1.859%	0.1135	0.1234	0.1352	0.1488	0.1637	0.1874	0.0964	0.1036	0.1123	0.1225	0.1340	0.1525
43	2.113%	1.941%	0.1166	0.1271	0.1397	0.1541	0.1699	0.1950	0.0990	0.1067	0.1160	0.1270	0.1391	0.1587
44	2.231%	2.020%	0.1199	0.1311	0.1444	0.1597	0.1764	0.2031	0.1017	0.1099	0.1199	0.1315	0.1444	0.1652
45	2.345%	2.096%	0.1256	0.1380	0.1528	0.1697	0.1882	0.2177	0.1065	0.1157	0.1269	0.1399	0.1544	0.1777
46	2.454%	2.168%	0.1295	0.1426	0.1583	0.1762	0.1958	0.2271	0.1092	0.1191	0.1310	0.1448	0.1601	0.1849
47	2.555%	2.234%	0.1336	0.1476	0.1642	0.1832	0.2040	0.2371	0.1121	0.1226	0.1353	0.1500	0.1662	0.1925
48	2.647%	2.296%	0.1379	0.1528	0.1705	0.1907	0.2126	0.2478	0.1153	0.1265	0.1399	0.1555	0.1727	0.2006
49	2.730%	2.351%	0.1425	0.1583	0.1771	0.1985	0.2218	0.2590	0.1186	0.1305	0.1448	0.1614	0.1797	0.2093
50	2.801%	2.399%	0.1476	0.1644	0.1844	0.2072	0.2318	0.2714	0.1232	0.1360	0.1514	0.1691	0.1888	0.2209
51	2.860%	2.440%	0.1530	0.1709	0.1922	0.2164	0.2426	0.2847	0.1282	0.1419	0.1584	0.1775	0.1986	0.2332
52	2.905%	2.474%	0.1588	0.1778	0.2005	0.2263	0.2541	0.2987	0.1335	0.1482	0.1659	0.1865	0.2092	0.2459
53	2.935%	2.499%	0.1648	0.1851	0.2092	0.2366	0.2662	0.3133	0.1390	0.1548	0.1738	0.1959	0.2200	0.2590
54	2.949%	2.516%	0.1712	0.1928	0.2184	0.2475	0.2788	0.3287	0.1447	0.1617	0.1821	0.2056	0.2312	0.2726
55	2.948%	2.524%	0.1876	0.2126	0.2422	0.2759	0.3122	0.3698	0.1554	0.1746	0.1976	0.2242	0.2531	0.2998
56	2.931%	2.523%	0.1950	0.2216	0.2531	0.2888	0.3272	0.3881	0.1611	0.1816	0.2062	0.2344	0.2651	0.3147
57	2.898%	2.513%	0.2028	0.2311	0.2645	0.3024	0.3430	0.4073	0.1673	0.1891	0.2152	0.2452	0.2778	0.3305
58	2.849%	2.493%	0.2110	0.2410	0.2765	0.3167	0.3596	0.4274	0.1738	0.1970	0.2248	0.2568	0.2914	0.3473
59	2.785%	2.464%	0.2196	0.2515	0.2891	0.3317	0.3770	0.4484	0.1807	0.2055	0.2351	0.2690	0.3058	0.3652
60	2.707%	2.427%	0.2286	0.2625	0.3024	0.3474	0.3952	0.4703	0.1880	0.2144	0.2460	0.2821	0.3212	0.3841
61	2.615%	2.381%	0.2380	0.2739	0.3162	0.3638	0.4142	0.4931	0.1958	0.2240	0.2575	0.2960	0.3374	0.4042
62	2.512%	2.326%	0.2477	0.2858	0.3306	0.3809	0.4340	0.5166	0.2041	0.2340	0.2698	0.3107	0.3547	0.4255
63	2.399%	2.263%	0.2578	0.2981	0.3455	0.3986	0.4545	0.5409	0.2128	0.2447	0.2828	0.3263	0.3730	0.4480
64	2.277%	2.193%	0.2683	0.3109	0.3610	0.4170	0.4756	0.5657	0.2220	0.2561	0.2966	0.3428	0.3925	0.4718
65	2.149%	2.117%	0.2790	0.3241	0.3769	0.4358	0.4973	0.5910	0.2318	0.2681	0.3112	0.3604	0.4130	0.4970

Age	Male weight	Female Weight	Male						Female					
			Control on yr1	Control on yr2	Control on yr3	Control on yr4	Control on yr5	Uncontrolled	Control on yr1	Control on yr2	Control on yr3	Control on yr4	Control on yr5	Uncontrolled
66	2.016%	2.034%	0.2899	0.3375	0.3932	0.4552	0.5195	0.6166	0.2421	0.2807	0.3266	0.3789	0.4347	0.5235
67	1.879%	1.946%	0.3010	0.3513	0.4099	0.4749	0.5420	0.6422	0.2530	0.2941	0.3430	0.3984	0.4576	0.5514
68	1.742%	1.854%	0.3123	0.3652	0.4268	0.4948	0.5647	0.6677	0.2645	0.3082	0.3602	0.4191	0.4818	0.5808
69	1.604%	1.758%	0.3235	0.3792	0.4438	0.5148	0.5873	0.6926	0.2765	0.3231	0.3783	0.4408	0.5073	0.6116
70	1.469%	1.659%	0.3347	0.3931	0.4608	0.5347	0.6096	0.7167	0.2892	0.3387	0.3974	0.4637	0.5340	0.6439
71	1.337%	1.559%	0.3457	0.4069	0.4775	0.5543	0.6314	0.7396	0.3024	0.3551	0.4174	0.4877	0.5621	0.6776
72	1.210%	1.457%	0.3563	0.4204	0.4939	0.5733	0.6524	0.7607	0.3163	0.3722	0.4384	0.5129	0.5915	0.7128
73	1.089%	1.356%	0.3665	0.4333	0.5097	0.5915	0.6723	0.7797	0.3308	0.3902	0.4603	0.5393	0.6222	0.7495
74	0.974%	1.255%	0.3761	0.4456	0.5246	0.6086	0.6907	0.7959	0.3458	0.4089	0.4833	0.5668	0.6542	0.7875
75	0.866%	1.156%	0.3849	0.4570	0.5385	0.6243	0.7072	0.8088	0.3614	0.4283	0.5071	0.5954	0.6877	0.8268
76	0.766%	1.059%	0.3928	0.4674	0.5511	0.6383	0.7213	0.8180	0.3776	0.4485	0.5319	0.6251	0.7227	0.8674
77	0.673%	0.965%	0.3996	0.4765	0.5622	0.6503	0.7327	0.8228	0.3943	0.4694	0.5576	0.6559	0.7590	0.9091
78	0.589%	0.875%	0.4051	0.4843	0.5716	0.6600	0.7409	0.8228	0.4115	0.4909	0.5841	0.6878	0.7967	0.9519
79	0.512%	0.789%	0.4094	0.4905	0.5790	0.6671	0.7455	0.8177	0.4290	0.5130	0.6114	0.7208	0.8354	0.9955
80	0.443%	0.707%	0.4124	0.4952	0.5845	0.6715	0.7460	0.8075	0.4469	0.5356	0.6393	0.7546	0.8755	1.0398
81	0.382%	0.631%	0.4140	0.4984	0.5879	0.6731	0.7424	0.7922	0.4651	0.5587	0.6680	0.7895	0.9164	1.0845
82	0.327%	0.559%	0.4143	0.5000	0.5893	0.6717	0.7349	0.7725	0.4834	0.5821	0.6973	0.8249	0.9578	1.1296
83	0.279%	0.492%	0.4136	0.5003	0.5890	0.6678	0.7238	0.7492	0.5018	0.6058	0.7270	0.8611	0.9996	1.1746
84	0.237%	0.431%	0.4121	0.4997	0.5872	0.6618	0.7100	0.7238	0.5202	0.6297	0.7571	0.8976	1.0416	1.2193
85	0.200%	0.375%	0.4101	0.4983	0.5843	0.6541	0.6941	0.6981	0.5385	0.6535	0.7871	0.9340	1.0833	1.2633
Weighted Average			**0.196**	**0.224**	**0.257**	**0.293**	**0.330**	**0.385**	**0.179**	**0.204**	**0.235**	**0.269**	**0.306**	**0.363**

Source: Model results

Table 17 Hospitalizations for complications of diabetes in the two alternatives

	2019	2020	2021	2022	2023	2024
NO PROGRAM						
Blindness	362	477	627	815	1043	1311
Ischemic heart disease	250	290	332	375	420	463
Amputations	70	119	211	386	703	1306
Congestive failure	275	397	548	727	929	1142
Renal	10	12	15	19	25	33
Myocardial infarction	264	322	398	484	581	688
Stroke	10	12	15	19	25	33
Total	**1240**	**1629**	**2146**	**2828**	**3726**	**4976**
PROGRAM						
Blindness	362	477	627	386	446	522
Ischemic heart disease	250	290	332	258	266	271
Amputations	70	119	211	169	275	475
Congestive failure	275	397	548	447	509	569
Renal	10	12	15	15	17	19
Myocardial infarction	264	322	398	301	324	348
Stroke	10	12	15	15	17	19
Total	**1240**	**1629**	**2146**	**1590**	**1853**	**2223**

Source: Model results

4.1.2 Malaria

The goal stated in the Results Matrix is to reduce the autochthonous Malaria cases from a current estimated baseline of 40 to 0, through the implementation of interventions that aim to modify risky behaviors and increase access to priority malaria interventions targeted population; thus, reinforcing the efforts already put into practice by the country to control this disease.

For the PROGRAM alternative, a linear reduction of Malaria cases was assumed to reach the elimination goal by 2024. For the number of cases per year, DALYs were estimated considering a disability during the episode of 0.191, as reported by the Global Burden of Disease 2004, and an average duration of the episode of 20 days. For NO PROGRAM a constant value of 40 cases per year was assumed for the years of the time horizon of the evaluation (6 years) (see Equation 1).

Equation 1

$$DALYs\ performing\ the\ operation = \sum_{t=2019}^{2024} cases_t \times episode\ disability \times duration\ of\ the\ episode$$

$$DALYs\ not\ performing\ the\ operation = 5\ years \times 40\ cases \times episode\ disability \times duration\ of\ the\ episode$$

5 Assessment of cost effectiveness

Table 18 shows the results of the assessment of incremental cost effectiveness between the two alternatives for the time horizon of 6 years with a discount rate of 12%. AtHE results is that the incremental cost effectiveness ratio (ICER) of the PROGRAM alternative is 2019 US$9,266per DALY avoided. Following the benchmarks of WHO, the value of GDP per capita per year of full health to was taken as the criterion to classify an intervention as highly cost effective (World Health Organization - CHOosing Interventions that are Cost-Effective, s.f.). Also, considering that the GDP per capita of Suriname for 2019 is projected at US$7.471[10], the ICER estimated per DALY avoided can be considered as cost effective.

[10] International Monetary Fund, World Economic Outlook Database, October 2017.

Table 18 Results of the assessment of cost effectiveness, discounted by 12%

	Cost USD 2019	DALYs	Incremental Cost	DALYs avoided	ICER DALYs avoided/USD 2019
NO PROGRAM	$ 102,383,528	12,556	$ 14,505,792	**1,566**	**9,266**
PROGRAM	$ 116,889,320	10,991			

Source: Model results.

Table 19 provides a breakdown of DALYs avoided by Component 3 for the two alternatives.Theincremental value, which is the difference between the two alternatives, is also displayed.

Table 19 Breakdown of DALYs by impact

	NO PROGRAM							PROGRAM							Incremental
	Uncontrolled	Controlled Yr0	Controlled Yr1	Controlled Yr2	Controlled Yr3	Controlled Yr4	Total	Uncontrolled	Controlled Yr0	Controlled Yr1	Controlled Yr2	Controlled Yr3	Controlled Yr4	Total	
Male	60%	40%	0%	0%	0%	$0	**100%**	20%	40%	0%	0%	40%	0%	**100%**	
Female	60%	40%	0%	0%	0%	$0	**100%**	20%	40%	0%	0%	40%	0%	**100%**	
Male	11897	7931	0	0	0	$0	**19828**	3966	7931	0	0	7931	0	**19828**	
Female	13303	8869	0	0	0	$0	**22171**	4434	8869	0	0	8869	0	**22171**	
Diabetes Without Complications	547	416	0	0	0	$0	**963**	182	416	0	0	388	0	**987**	**-24**
Blindness	103	7	0	0	0	$0	**110**	34	7	0	0	30	0	**72**	**39**
Ischemic heart disease	1513	367	0	0	0	$0	**1880**	504	367	0	0	690	0	**1561**	**318**
Amputations	318	89	0	0	0	$0	**407**	106	89	0	0	151	0	**346**	**61**
Congestive failure	181	77	0	0	0	$0	**259**	60	77	0	0	102	0	**240**	**18**
Renal	1153	401	0	0	0	$0	**1554**	384	401	0	0	605	0	**1390**	**164**
Myocardial infarction	20	5	0	0	0	$0	**25**	7	5	0	0	8	0	**19**	**6**
Stroke	744	196	0	0	0	$0	**940**	248	196	0	0	348	0	**792**	**148**
Total	4579	1558	0	0	0	$0	**6137**	3085	1558	0	0	2323	0	**5407**	**730**
Diabetes Without Complications	631	476	0	0	0	$0	**1107**	210	476	0	0	446	0	**1132**	**-25**
Blindness	113	7	0	0	0	$0	**120**	38	7	0	0	32	0	**77**	**43**
Ischemic heart disease	2026	482	0	0	0	$0	**2508**	675	482	0	0	909	0	**2066**	**442**
Amputations	562	154	0	0	0	$0	**715**	187	154	0	0	262	0	**603**	**112**
Congestive failure	290	123	0	0	0	$0	**413**	97	123	0	0	163	0	**383**	**30**
Renal	579	197	0	0	0	$0	**776**	193	197	0	0	299	0	**689**	**87**
Myocardial infarction	14	4	0	0	0	$0	**18**	5	4	0	0	6	0	**14**	**4**
Stroke	614	146	0	0	0	$0	**759**	205	146	0	0	268	0	**618**	**142**
Female	5460	2064	0	0	0	$0	**7524**	1820	2064	0	0	2831	0	**6715**	**809**
Diabetes Without Complications	1178	892	0	0	0	$0	**2070**	393	892	0	0	834	0	**2119**	**-49**
Blindness	216	14	0	0	0	$0	**230**	72	14	0	0	62	0	**149**	**81**
Ischemic heart disease	3539	849	0	0	0	$0	**4388**	1180	849	0	0	1599	0	**3628**	**760**
Amputations	880	242	0	0	0	$0	**1122**	293	242	0	0	413	0	**949**	**173**
Congestive failure	471	200	0	0	0	$0	**672**	157	200	0	0	266	0	**623**	**49**
Renal	1733	598	0	0	0	$0	**2331**	578	598	0	0	904	0	**2079**	**251**
Myocardial infarction	34	8	0	0	0	$0	**43**	11	8	0	0	13	0	**33**	**10**
Stroke	1358	342	0	0	0	$0	**1699**	453	342	0	0	616	0	**1410**	**289**
Malaria			0	0	0	$0	**2**							**1**	**1**
Total	**9408**	**3146**	**0**	**0**	**0**	**$0**	**12556**	**6282**	**3146**	**0**	**0**	**4708**	**0**	**10991**	**1566**

Source: Model results

6 Additional Analysis

6.1 HIV

The Results Matrix does not include an impact result regarding HIV, since the intervention focuses on detection and counselling, and therefore treatment rates are not controlled. Nevertheless, assuming detection may lead to treatment, an analysis was performed to identify the impact of passing from 58% HIV-positive people receiving antiretroviral treatment (ART) after 12 months (according UNAIDS GAM Report 2017), to 90% in 2024, as expected in the UNAIDS 90-90-90 targets.

The new cases, actual cases and death cases in 2016 (respectively 126, 1856 and 35 for male and 101, 1476 and 26 for female) were used from the data obtained from GBD Compare Viz Hub.The incidence, prevalence and mortality were calculated using that number of cases and the projection of the population obtained from the General Bureau of Statistics.

The mortality was calculated for the patients with and without treatment using the total mortality for 2016 and the proportion of HIV-positive persons in treatment for that year (58%). It was assumed that the reduction of mortality in the population with treatment was of 0.17-0.19 (Chen, y otros, 2017).

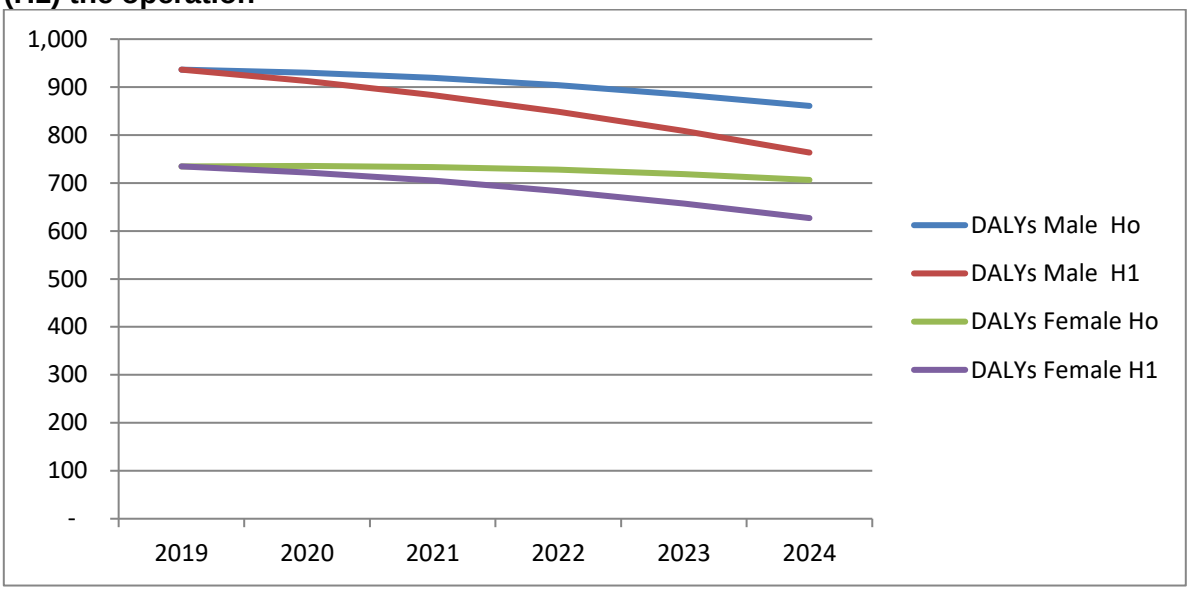
In both alternatives, *PROGAM AND NO PROGRAM*, the incidence and mortality of HIV-positive patients, with and without treatment, are the same; but, for the PROGRAM alternative, the proportion of people with ART treatment is higher.

For the NO PROGRAM alternative it was estimated that the reduction in mortality remained with the same historical tendency, and it was assumed that this reduction was due to a higher proportion of patients with treatment. When this historical tendency was projected, it was found that for 2024 there would be 84% HIV-positive people receiving ART. This is a conservative approach as it assumes that even if the operation is not performed, an improvement in this indicator is obtained.

For PROGRAM alternative, it was assumed that the goal of 90% HIV-positive people receiving ART, as found in the results matrix, was reached assuming a linear increase.

For each alternative the number of HIV-positive people with and without treatment were calculated, by gender and group age. The YLLs, by gender and group age, were calculated from the deaths and the life-expectancy by Murray 1994. The DALYs, also by gender and group age, were calculated using the disability weight as reported by the GBD: 0.167 for HIV-positive with ART and 0.505 for HIV-positive without ART (see Table 20).

Table 20 DALYs by gender and alternative: not performing (Ho) and performing (H1) the operation



Source: Model results

The annual costs per person in HIV treatment are $303 US dollars for testing and follow-up and $730USD for ART (Laptiste, 2004); using the number of HIV-positive people with and without treatment, the undiscounted and discounted costs were calculated for each alternative (Table 21).

Due to the reduction in mortality, there was a consequent increase in prevalent cases, which were accounted in the calculation of costs, where there is a slight increase in the costs in the *PROGRAM* alternative.

Table 21 Undiscounted and discounted annualized costs for HIV treatment in USD 2019 for NO PROGRAM (Ho) and PROGRAM (H1) the operation

HIV			Total	2019	2020	2021	2022	2023	2024
Undiscounted	Cost Ho	ARV	$14,191,229	$1,895,947	$2,074,830	$2,260,423	$2,452,601	$2,651,225	$2,856,204
	Cost Ho	Testing	$5,889,360	$786,818	$861,054	$938,075	$1,017,830	$1,100,258	$1,185,325
	Cost Ho	Total undiscounted	$20,080,589	$2,682,764	$2,935,884	$3,198,498	$3,470,431	$3,751,483	$4,041,528
	Cost H1	ARV	$14,806,813	$1,895,947	$2,111,052	$2,336,427	$2,572,014	$2,817,747	$3,073,625
	Cost H1	Testing	$6,144,827	$786,818	$876,087	$969,617	$1,067,386	$1,169,365	$1,275,555
	Cost H1	Total undiscounted	$20,951,640	$2,682,764	$2,987,139	$3,306,045	$3,639,400	$3,987,112	$4,349,180
Discounted	Cost Ho	ARV	$10,601,769	$1,895,947	$1,852,527	$1,801,995	$1,745,713	$1,684,901	$1,620,687
	Cost Ho	Testing	$4,399,734	$786,818	$768,799	$747,828	$724,471	$699,234	$672,585
	Cost Ho	Total discounted	$15,001,504	$2,682,764	$2,621,325	$2,549,823	$2,470,184	$2,384,135	$2,293,272
	Cost H1	ARV	$11,008,896	$1,895,947	$1,884,868	$1,862,586	$1,830,709	$1,790,729	$1,744,058
	Cost H1	Testing	$4,568,692	$786,818	$782,220	$772,973	$759,744	$743,153	$723,784
	Cost H1	Total discounted	$15,577,588	$2,682,764	$2,667,088	$2,635,559	$2,590,453	$2,533,882	$2,467,842

Source: Model results

It was observed that when HIV was included in the evaluation, the cost-effectiveness of the operation (Table 22) is improved, as compared with the results of the assessment of cost effectiveness without HIV (Table 18).

Table 22 Results of the assessment of cost effectiveness with HIV, discounted by 12%

	Cost USD 2019	DALYs	Incremental Cost	DALYs avoided	ICER
					DALYs avoided/USD 2019
NO PROGRAM	$ 117,385,031	20,101	$ 15,081,876	**1902**	**7,929**
PROGRAM	$ 132,466,907	18,199			

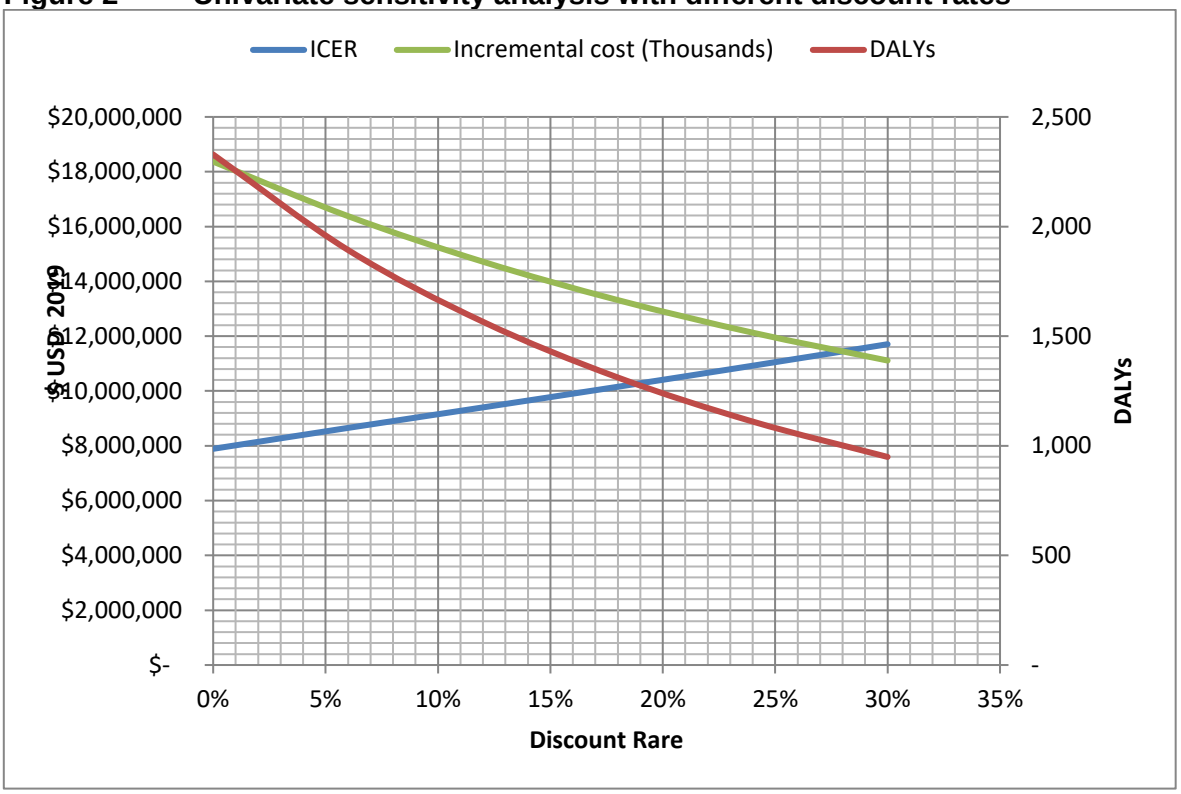
Source: Model results

7 Sensitivity Analysis

7.1 Discount Rate

A univariate sensitivity analysis was performed to analyze the impact of the variation of the discount rate in the results obtained in the model. The discount rate was evaluated from 0% to 30%; the effect on the ICER, incremental cost and averted DALYs is shown in Figure 2. From this data it can be concluded that the model is robust to variations in the discount rate, where the ICER is maintained below 3 GDPs per capita. For a discount rate of 3% the ICER would be $ 17,262,608.

Figure 2 Univariate sensitivity analysis with different discount rates



Source: Model results

7.2 Percentage of diabetic patients controlled per year

In Table 23 a sensitivity analysis was performed to evaluate one of the most relevant assumptions of the model regarding the percentage of patients with controlled diabetes per year (see Table 3). The results obtained indicate that the model is robust in changes in the percentages used for the deployment of the operation, given that in all the evaluated scenarios the implementation is still cost effective.

Table 23 Sensitivity analysis with 8 scenarios with different percentages of patients controlled per year

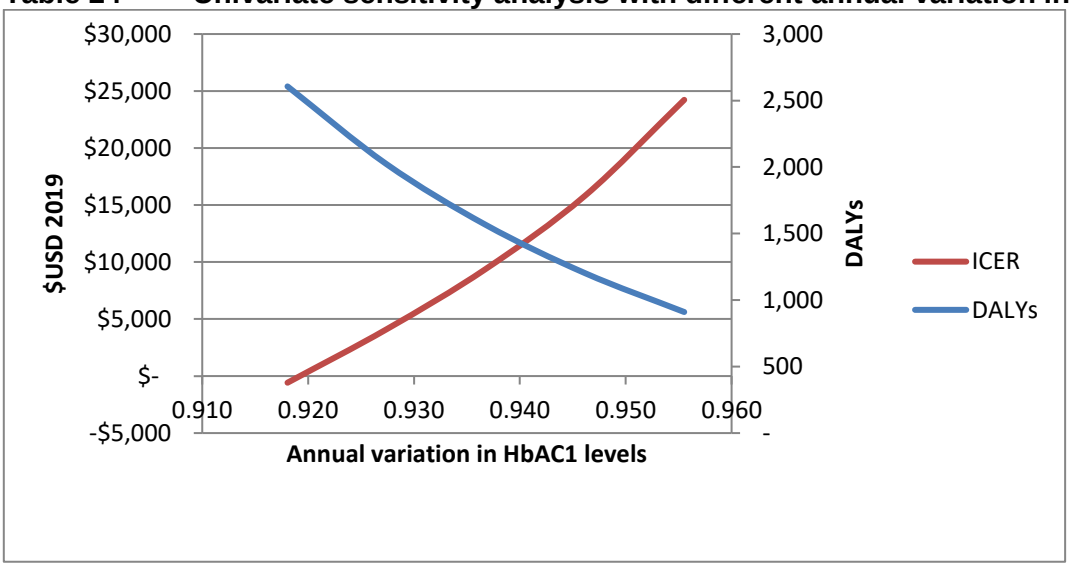
Case	2019	2020	2021	2022	2023	2024	ICER	DALYs Averted
Case 1	0%	10%	10%	10%	10%	10%	$6,949	1,836
Base Case	0%	0%	0%	40%	0%	0%	$9,266	1,565
Case 3	0%	0%	0%	0%	40%	40%	$13,014	946
Case 4	0%	0%	0%	27%	13%	13%	$9,669	1,364
Case 5	0%	5%	15%	15%	5%	5%	$7,340	1,847
Case 6	0%	4%	8%	12%	16%	16%	$7,747	1,546
Case 7	0%	16%	12%	8%	4%	4%	$6,690	2,125

Source: Model results

7.3 Annual variation in HbAC1

A univariate sensitivity analysis was performed to analyze the impact of the annual variation in HbAC1 in the results obtained in the model. The annual variation in HbAC1 was evaluated from 0.92 to 0.96; the effect on the ICER and averted DALYs is shown in Figure 2Table 24.

Table 24 Univariate sensitivity analysis with different annual variation in HbAC1

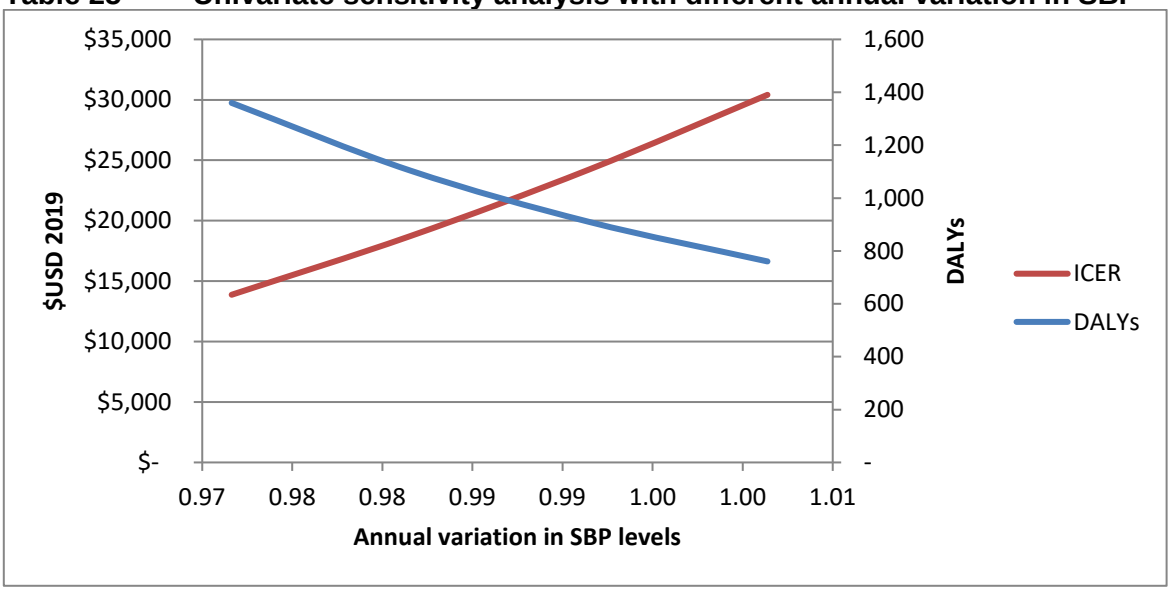


Source: Model results, Note: The negative ICER value corresponds to the program becoming dominant (cost saving)

7.4 Annual variation in Systolic Blood Pressure (SBP)

A univariate sensitivity analysis was performed to analyze the impact of the annual variation in SBP in the results obtained in the model. The annual variation in SBP was evaluated from 0.97 to 1; the effect on the ICER and averted DALYs is shown in Figure 2Table 25.

Table 25 Univariate sensitivity analysis with different annual variation in SBP



Source: Model results

8 Conclusions

- An ex ante economic assessment was performed of the cost-effectiveness type for the components of the operation "Health Services Support Project" (SU-L1054). This analysis was performed from the perspective of society with a discount rate of 12% and following other guidelines for the economic assessment of programs financed by the IDB. A case basis was analyzed with a time horizon of 6 years. The effectiveness data were obtained from the goals of the results matrix and were confronted with the effectiveness results reported for similar interventions in comparable contexts. The costs were obtained from the national cost and international benchmark. For costs not directly assumed by the program, the national cost and the references published in the literature were used. Throughout the analysis we chose to overestimate the costs of operation and underestimate the effect achieved to have a conservative approach to the cost-effectiveness of the operation.

- For the base case was estimated an ICER of $9,266USD 2019 per DALYs avoided. The comparison of this value per DALYs avoided with the GDP per capita of 2019 ($7,471USD) allows to consider the operation as cost effective according to the commonly accepted standards.

- If HIV is included in the analysis, an ICER of $7,292USD 2019 per DALYs avoided is obtained; therefore, even if assuming the additional costs for ART treatment needed to reach the 90-90-90 UNAIDS target, the operation can be considered cost effective according to the commonly accepted standards (GDP per capita of 2019 of $7,471USD).

- In addition, a sensitivity analysis with different discount rates and deployment of the program was conducted. Different values were evaluated on the main variables of the results matrix and with several changes in effect size. The model results are robust to changes in these variables. For a discount rate of 3% the ICER would be $ 17,262,608.

- Considering the results of the base case, the results from the sensitivity analysis and rcognizing the limitations and assumptions of this assessment, the proposed program is cost effective and its implementation would generate an increase in net welfare of the people of Suriname.

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