

A Controlled Study of Funding for Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome as Resource Capacity Building in the Health System in Rwanda

Donald S. Shepard,* Wu Zeng, Peter Amico, Angelique K. Rwiyereka, and Carlos Avila-Figueroa
Schneider Institutes for Health Policy, Heller School, Brandeis University, Waltham, Massachusetts; Abt Associates, Bethesda, Maryland

Abstract. Because human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) receives more donor funding globally than that for all other diseases combined, some critics allege this support undermines general health care. This empirical study evaluates the impact of HIV/AIDS funding on the primary health care system in Rwanda. Using a quasi-experimental design, we randomly selected 25 rural health centers (HCs) that started comprehensive HIV/AIDS services from 2002 through 2006 as the intervention group. Matched HCs with no HIV/AIDS services formed the control group. The analysis compared growth in inputs and services between intervention and control HCs with a difference-in-difference analysis in a random-effects model. Intervention HCs performed better than control HCs in most services (seven of nine), although only one of these improvements (Bacille Calmette-Guérin vaccination) reached or approached statistical significance. In conclusion, this six-year controlled study found no adverse effects of the expansion of HIV/AIDS services on non-HIV services among rural health centers in Rwanda.

INTRODUCTION

The pandemic of human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) has spread rapidly since the 1980s. In 2010, 2.7 million new HIV infections occurred, 1.8 million people died, and 34 million people were living with HIV infections worldwide.¹ To combat HIV/AIDS, the international community has provided unprecedented financial assistance.²

This funding for HIV/AIDS has re-opened a long-standing debate on whether HIV/AIDS funding has strengthened the health care system of recipient countries to manage other diseases. Advocates of an enhancement effect of HIV/AIDS funding believe that the country's AIDS program has improved the infrastructure, management, communications, laboratories, information systems, and human resources. Additionally, they claim that HIV/AIDS funding has contributed to standardization of services, strengthened monitoring and surveillance systems, better integration of HIV/AIDS service and primary health care, fewer funding gaps for health care, and the provision of services that the existing system had been unable to provide.^{3–7}

Conversely, critics argue that the infusion of HIV/AIDS funding weakens the health care system. HIV/AIDS receives disproportionately more resources than its share of disease burden, thereby drawing qualified staff from the rest of the country's health system and displacing resources that could have been used for other diseases.^{8–10} The investment in HIV/AIDS may have shifted strategies and commitments of governments to manage other diseases in a country.¹¹ These concerns are bolstered by the fact that approximately one-third of donor funding on health and population programs was committed to HIV/AIDS during 2002–2006.¹²

Empirical studies of this topic have at least two limitations. First, they generally focus on inputs to the health care system, such as human resources and capital resources, but neglect outputs. Outputs are generally preferable to inputs as a mea-

sure of health system performance.⁵ Second, most facility-level studies use a pre-post design without a control group to account for secular changes.

Using a quasi-experimental design with a matched control group, we aim in this study to overcome these two limitations with empirical data for six consecutive years (2002–2007) in Rwanda to analyze the impact of HIV funding on the health system. Rwanda provides a particularly informative research context because the country has received substantial funding from international donors to address HIV/AIDS and has been used to support arguments on both sides.^{7,13} This study also contributes to the evaluation of other concurrent initiatives in Rwanda, community-based health insurance (CBHI) and performance-based financing (PBF).

METHODS

Study design. The analysis unit of the study was the health center (HC). The overall study design was a pre-post comparison between HIV/AIDS HCs (those in which HIV/AIDS services began during the study period [2002–2007], excluding the first and last years) and matched non-HIV/AIDS HCs (which never offered HIV/AIDS services during the study period). We assessed the impact of HIV/AIDS services by comparing the evolution of non-AIDS inputs (personnel) and outputs (services) between the two groups of HCs and controlling for other covariates.

We used the date of starting antiretroviral therapy (ART) service to mark the inception of comprehensive AIDS funding in the HC. Twenty-five rural HCs starting ART services during 2002–2006 were randomly selected as the intervention group. Based on the three matching factors (ownership, PBF [none, flat or varied], and income of the district in which the HC is located in 2002), we identified 25 perfectly matched HCs that had not started HIV/AIDS services by the end of 2007. We excluded urban HCs because all urban HCs provided HIV/AIDS services by 2007. Thus, no urban HCs could serve as controls.

During June–September 2008, a trained research team collected data from each HC. Most data were obtained during a one-day site visit, but gaps were filled by follow-up phone

*Address correspondence to Donald S. Shepard, Schneider Institutes for Health Policy, Heller School, MS 035, Brandeis University, Waltham, MA 02454-9110. E-mail: shepard@brandeis.edu

calls, and the records on vaccinations were obtained centrally at the Ministry of Health (MoH).

Variables. We included two input and nine output indicators in the evaluation. The inputs consisted of the number of the full-time equivalent staff (FTE) on HIV/AIDS services, termed HIV-personnel (HP), and on non-HIV/AIDS services, called non-HIV personnel (NHP). The outputs covered preventive and curative non-HIV/AIDS services. The indicators for preventive services included the number of doses of bacillus Calmette-Guérin (BCG), diphtheria, pertussis, and tetanus (DPT) vaccine, polio vaccine, and measles vaccine that were distributed, and the number of visits for child growth monitoring. The indicators for curative services were the number of curative visits for persons < 5, 5–14, and > 14 years of age and the number of admissions for hospitalizations. To provide more stable measures of performance on non-HIV services, we created summary indices for preventive services and curative activities. Each index for a HC was the geometric mean of the ratios of all included services within the HC divided by the respective geometric means across all HCs. For example, a preventive index of 2.0 meant that the HC delivered on average twice the number of preventive services as an average HC.

In addition to three matching variables (ownership, PBF, income), we also included three contextual variables as covariates to minimize the risk of confounding bias: 1) a proxy for coverage of CBHI, 2) accessibility of the HC by bus (busaccess), and 3) the background of the director in HCs (background). The proxy for CBHI coverage was based on the premium revenue from CBHI, the premium per person, and the estimated population of the catchment area.¹⁴ The covariates and their coding are shown in Table 1.

Some data items remained missing (2.58%) despite follow-up with the HCs and MoH offices, and some data were categorized as outliers (beyond 1.5 times the interquartile, 2.43% of data). We imputed missing items by replacing them by the mean of corresponding values from the two observations for which all other known information matched most closely to the values for the observation with missing values, a hot deck procedure.¹⁵

Analysis. After calculating crude means of the evaluation indicators by groups and years, we first conducted a simple

TABLE 1

Coding of categorical variables in the analysis, Rwanda*

Variable	Coding
Int	0 = Control group, 1 = Intervention group
AfterART	0 = Before antiretroviral treatment started, 1 = After antiretroviral treatment started
Ownership	0 = Publicly owned, 1 = Privately owned
PBF†	0 = No PBF (no extra payment), 1 = Phase 1 (pay by results), 2 = Phase 2 (flat payment)
CBHI	Continuous variable (0–100)
Income‡	0 = Low income, 1 = Median income, 2 = High income
Busaccess	0 = No bus access, 1 = Bus access
Background§	0 = A2 nurse, 1 = A1 nurse or medical doctor

*PBF = performance-based financing; CBHI = community-based health insurance.
 †In the regression, dummy variables were generated. Health centers without PBF were used as the reference group. Health centers in phases 1 and 2 received detailed monitoring of services, those in phase 1 received conditional funding based on the volume of designated services, and those in phase 2 received supplemental lump-sum funding.
 ‡In the regression, dummy variables were generated. Health centers located in the median-income province were used as the reference group.
 §A1 nurses have 3 years of nursing training post high school. A2 nurses have only high school level nursing education.

regression of the preventive and curative indexes as a function purely of time to examine crude secular trends. We then developed fixed-effects and random-effects models to examine the impact of HIV/AIDS funding, as shown in equation (1):

$$\log(\text{indicator}_{it} + 1) = \beta_0 + \beta_1 \text{int}_i + \beta_2 \text{afterART}_{it} + \beta_3 \text{int}_i * \text{afterART}_{it} + B_4 \text{controls}_{it} + \alpha_i + \varepsilon_{it} \tag{1}$$

In this equation, all the dependent variables except for preventive and curative care indices are in started logarithm form. Started logarithms are the natural logarithms of the indicator plus 1, a transformation that permits relative comparisons while enabling zero values. The subscripts *i* and *t* represent *i*th HC at year *t*, *int*afterART* is the interaction term of *int* and *afterART*, and *controls* represents all other control variables. The coefficient for *int*afterART*, β_3 , is the target coefficient that informs the impact of the introduction of ART services on the examined indicator. A statistically significant positive coefficient of β_3 would indicate an enhancement effect of ART treatment on service delivery. Conversely, a statistically significant negative coefficient of β_3 would imply the diversion effect of the ART service. To minimize the risk of multiple comparisons, we focus attention on the coefficients for the output variables related to the interaction term (*Int*afterART*) and the two policy initiatives in Rwanda, CBHI and PBF varied payment.

We conducted Hausman tests to determine whether fixed or random effects fit the data better. To increase our ability to examine patterns on the nine service outputs, we checked consistency in direction in the results by applying Fisher’s exact test to the signs of coefficients. To examine the impact of time on service delivery, we estimated models with three alternative specifications of the variable time in the formula: a continuous variable, a dummy variable, or no time variable.

RESULTS

Descriptive analysis and comparison of trends. Detailed descriptive statistics for all variables in the control and intervention groups and the difference of growth rates between the two groups using the data in the earliest and latest two years are shown in Table 2. Over this four-year period (mid 2002–mid 2006), AIDS HCs on average added five more staff providing AIDS services than non-AIDS HCs. However, the number of personnel providing non-AIDS services increased 16% less in AIDS HCs than in non-AIDS HCs. For all the output indicators, AIDS HCs tended to increase at a faster rate than non-AIDS HCs.

To compare trends between AIDS HCs and non-AIDS HCs, average scores of the preventive care index and trend lines by group are shown in Figure 1. The trends were derived from a simplified regression model using year (year), group (int) and their interaction term (year*int) as the independent variables. The graph shows a decrease in the control group and an increase in the intervention group, indicating that AIDS funding may promote the preventive services. However, the coefficient for the interaction term of 0.050 was not statistically significant (*P* = 0.15).

Average scores of curative care index by group are shown in Figure 2. In both groups, the provision of curative care

TABLE 2
Mean values of indicators by type of health center and time period, Rwanda*

Variable	Non-AIDS HC		AIDS HC		Growth rate (%)		Difference in growth rates (%)
	2002–2003	2006–2007	2002–2003	2006–2007	Non-AIDS	AIDS	
HIV personnel	0.0	0.0	0.5	5.5	–	–	–
Non-HIV personnel	9.5	13.5	13.7	17.0	42	26	–16
BCG doses	736	613	959	919	–17	–4	13
DPT doses	2,020	1,814	2,644	2,630	–10	–1	9
Polio doses	2,542	2,239	3,412	3,310	–12	–3	9
Measles doses	588	615	793	859	5	8	3
Curative care visits, < 5 years of age	1,794	3,040	2,179	4,023	69	85	16
Curative care visits, 5–14 years of age	778	1,505	917	2,140	94	133	39
Curative care visits, > 14 years of age	3,323	5,985	4,516	9,619	80	113	33
Growth monitoring visits	4,156	4,189	2,652	5,044	1	90	89
Hospitalization admissions	598	548	828	807	–8	–2	6
Preventive care index	0.827	0.763	0.903	1.036	–8	15	23
Curative care index	0.629	0.955	0.8	1.35	52	69	17

*Non-HIV denotes HCs without HIV services; HIV denotes HCs with HIV services, and difference is HIV-Non-HIV. AIDS = acquired immunodeficiency syndrome; HC = health center; HIV = human immunodeficiency virus; BCG = Bacille Calmette-Guérin; DPT = diphtheria, pertussis, and tetanus.

increased over time. AIDS HCs increased slightly faster than the control group, suggesting that inception of AIDS funding potentially improved the delivery of curative care. Again, however, the coefficient for the interaction term of 0.055 was not statistically significant ($P = 0.14$).

Multiple regression analysis. After controlling for the covariates, we found that the results were robust in all three model specifications regarding whether and how secular trend (time) was included in the model. Over the six years, no unanimous secular trend in service delivery was observed. Therefore, the preferred model, reported here, used a reference year of 2002 and a dummy variable for each subsequent year. We also chose random effects over fixed effects models because Hausman tests showed insignificant differences between the random effects and fixed effects models ($P > 0.05$) for more than half of indicators examined (6 of 11 indicators) and no inconsistencies of signs and significance of the coefficients on the key research variables (e.g., HIV*afterART and CBHI) between the two types of models. Results from the models are summarized in Table 3.

In Table 3, the interaction coefficients (int*afterART) for 7 of 9 services were positive. Using Fisher’s exact test, we found

that the probability of having such imbalanced results caused by chance was only 8%, suggesting a trend towards AIDS HCs experiencing faster growth on general health services. The only service indicator that reached even borderline statistical significance ($P = 0.06$) was BCG vaccination. The coefficient of 0.105 suggested that initiation of ART treatment increased BCG vaccination by 10.5%. Although we found negative coefficients for the interaction term in two regression analyses (those on rates of services of curative care of children < 5 years of age and on rates of hospitalizations), neither coefficient was statistically significant. The results from the two comprehensive indices were similar: introduction of HIV/AIDS care appeared to improve the delivery of services related to preventive care and had no effect on those related to curative care.

Regarding the number of full-time equivalent (FTE) personnel at the HCs, we found a significant difference between the AIDS HCs and the control HCs: HIV programs reduced non-HIV staff by 22%, but increased HIV staff by 85%. The large percentage increase was an artifact of the small denominators (small numbers of HIV staff) in the initial years. We ran another model using the absolute number of HP and NHP

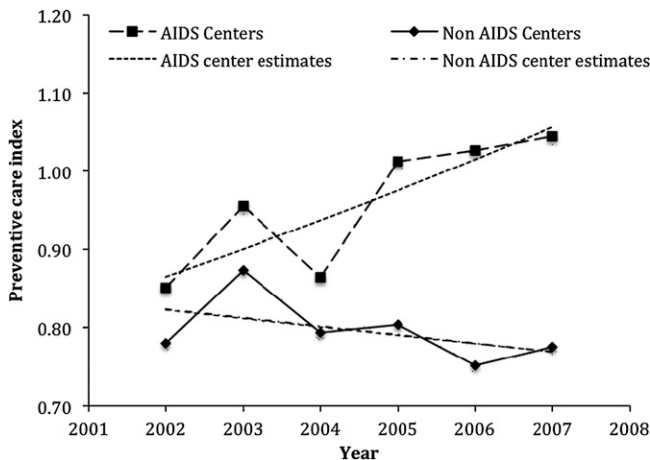


FIGURE 1. Average score of preventive care index between acquired immunodeficiency syndrome (AIDS) AIDS centers and Non-AIDS centers in Rwanda, 2002–2007.

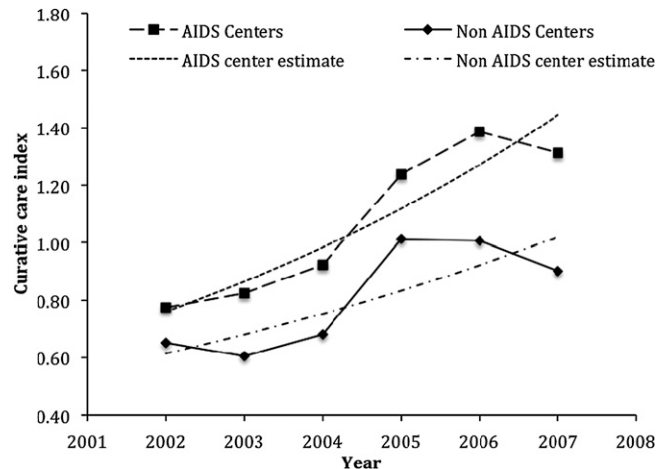


FIGURE 2. Average score of curative care index between acquired immunodeficiency syndrome (AIDS) AIDS centers and Non-AIDS centers in Rwanda, 2002–2007.

TABLE 3
Estimated coefficients in regression models, Rwanda*

Independent variable	HIV personnel	Non-HIV personnel	BCG	DPT	Polio	Measles	Curative care visits < 5	Curative care visits 5–14	Curative care visits > 14	Growth monitoring	Hospitalization	Preventive care index	Curative care index
Int	0.736†	0.304†	0.279‡	0.335†	0.339†	0.293†	0.209	0.196	0.264‡	0.035	0.850	0.153	0.291‡
AfterART	-0.414‡	0.042	-0.154‡	0.003	-0.024	-0.045	0.017	0.023	-0.066	-0.142	-0.442§	-0.044	-0.164
Int*afterART	0.858†	-0.222†	0.105§	0.005	0.036	0.045	-0.009	0.077	0.118	0.049	-0.278	0.109§	0.084
Ownership	0.146	0.153	-0.030	-0.024	-0.037	-0.069	-0.047	-0.116	0.059	0.815	0.671	0.087	0.121
No PBF (reference)													
PBF varied payment	-0.145	-0.034	0.008	0.114‡	0.106§	0.068	0.191§	0.205	0.135	0.603	0.345§	0.084	0.198‡
PBF flat Payment	0.004	-0.003	-0.027	0.005	-0.013	-0.028	0.060	0.084	0.040	0.168	-0.017	0.008	0.126‡
CBHI	0.002	0.003§	-0.001	-0.001	-0.001	-0.003†	0.005†	0.007†	0.007†	0.005	-0.002	-0.002	0.006†
Middle income (reference)													
Low income	-0.184§	-0.173	0.064	0.05	0.033	0.021	-0.051	0.026	-0.034	-0.377	-0.257	0.06	0.006
High income	0.056	-0.204§	0.047	-0.040	-0.043	-0.127	-0.140	-0.276§	-0.242	-1.136	-0.129	-0.064	-0.218
Busaccess	0.096	0.018	0.102	0.102	0.081	0.059	0.130	0.215	0.230	-0.376	-0.585	0.012	-0.049
Background	0.140	0.322‡	0.205§	0.073	0.112	0.272†	0.241	0.140	0.233	1.363§	0.211	0.355†	0.119

*Dependent variables were the started logarithm of number of services per year in each health center except preventive and curative care index. Each regression model also included a constant term and dummy variables for each year after the reference year (2002). HIV = human immunodeficiency virus; BCG = Bacille Calmette-Guérin; DPT = diphtheria, pertussis, and tetanus; PBF = performance-based financing; CBHI = community-based health insurance. We used $\alpha = 0.10$ because we had only 50 health centers in the study.

† $P < 0.01$.

‡ $P < 0.05$.

§ $P < 0.10$.

as dependent variables and found that the net impact of HIV/AIDS program was a 2.7 FTE reduction of NHP ($P < 0.01$) and a 3.3 FTE addition of HP ($P < 0.001$). The net result of 0.6 FTE staff indicated that overall health personnel increased in AIDS HCs compared with control HCs.

From the additional covariates, we found that CBHI uniformly improved use of curative care across all age groups ($P < 0.05$). Similarly, we observed a statistically significant favorable impact of CBHI on the curative care index. A 1% point increase of CBHI use rate improved curative care for population < 5, 5–14, and > 14 years of age by 0.5%, 0.7% and 0.7%, respectively. Surprisingly, CBHI was associated with a slight reduction in the number of measles vaccinations (coefficient = -0.003, $P < 0.05$).

Performance-based financing was another important factor in improving service delivery, particularly the version with payment according to numbers of services being provided. Compared with HCs without PBF schemes, HCs in PBF phase 1 delivered 11.4% more DPT vaccines ($P < 0.05$), 10.6% more polio vaccines ($P < 0.10$), 19.1% more curative care for children < 5 years of age ($P < 0.10$) and 34.5% more hospitalization care ($P < 0.10$).

DISCUSSION

This study shows that for most indicators examined, there were neither prominent diversion nor enhancement effects after AIDS services were inaugurated in HCs in Rwanda. The results are consistent with those from studies in several other countries in Africa, where substantial infusions of AIDS-related funding did not adversely affect non-AIDS services. For example, in Ethiopia, although the influx of funding for HIV/AIDS might have encouraged physician migration from the public to the non-governmental organization sectors, there is no evidence of adverse effects for the health system overall: mortality decreased, coverage of immunization increased, and antenatal care coverage increased over the four-year period of HIV expansion (2003–2007).¹⁶ In the U.S. President's Emergency

Plan for AIDS Relief (PEPFAR) focus countries, non-HIV-specific national health indicators compared with non-PEPFAR focus countries showed no evidence that PEPFAR funding had negative impacts on non-HIV health parameters.^{17,18}

Our study shows that BCG vaccination is the only one of all the services examined with a statistically significant interaction term. Surprisingly, the number of BCG vaccinations decreased in both control and intervention HCs in our sample, albeit with smaller reduction in AIDS-HCs than control HCs. The downward trend from our sample of rural HCs in numbers of vaccinations contrasts with national reports by the World Health Organization and the United Nations Children's Fund, which indicated a 2.5% increase per year in BCG vaccination rates in Rwanda in 2006 and 2007.¹⁹ For vaccinations with high coverage in Rwanda, such as DPT, measles, and polio,¹⁹ we expected no significant improvement because these services are saturated. We did not observe such a decrease for vaccinations in this study in AIDS HCs. Integration of HIV/AIDS services with other HC activities may have helped follow-up of missed vaccinations in AIDS HCs. Absolute numbers of vaccinations were likely reduced by decreases in numbers of infants born after substantial growth in Rwanda of use modern methods of family planning and decreases in its total fertility rate during this study period and subsequently.^{20,21}

The study showed less use of curative ambulatory care for children < 5 years of age and in hospitalizations in the intervention group, although neither coefficient approached statistical significance. Given the high prevalence of infectious diseases and increased mortality rate among children in Rwanda in 2003,²² and subsequent reduction in the child mortality rate from 153 to 103 per 1,000 live births from 2005 to 2007 and 76 in 2010,^{20,21} these patterns could reflect lesser need for curative care from the combined effects of AIDS funding and other government policies such as CBHI, PBF, and development of an effective network of community health workers.

From the descriptive analysis, we observed that the behavior of seeking care for children < 5 years of age in the intervention and control groups increased from the pre-period to

post-period. Rwanda faces many challenges in reducing children's mortality rate, of which the major causes are malaria, measles, being underweight, and HIV/AIDS. The slightly lower increase in curative services for children < 5 years of age in the intervention group observed in multiple regressions might be attributed to the higher coverage of preventive services in intervention HCs because the demand for curative care decreased, whereas preventive primary care is strengthened. For example, with malaria as the major reason for hospitalization, the decrease likely represents better prevention and management of malaria.

Infusion of HIV/AIDS funding in Rwanda comes in the context of concurrent beneficial interventions (e.g., CBHI and PBF) in the health sector. Consistent with previous reports,^{23,24} our results suggest that higher coverage of health insurance was associated with improved use of curative services by the rural population in Rwanda. Similarly, analysis by an overlapping group of researchers showed that provinces with greatest increases in CBHI enrollment experienced the greatest reductions in malaria mortality (Shepard DS, Rwiwerekka AK, Bail RN, and Kagubare J, unpublished data). Because childhood vaccinations are provided free to all children, regardless of insurance coverage, we did not expect any effect of CBHI on preventive services. The unexpected negative coefficient for CBHI on measles vaccinations was small and did not apply to any other vaccinations. Given the importance of CBHI in seeking essential care in many developing countries, international donors may consider premium subsidies and other approaches to increase enrollment by the most vulnerable populations.

Consistent with findings from studies of PBF in Rwanda,^{25–27} our results also show that PBF exerts remarkable impact on several services examined in this study, particularly on curative care. In many developing countries, lack of incentives of medical providers, scarcity of infrastructure, and shortage of medical workers are major constraints of providing essential medical services to needy populations.²⁸ Reforming physician incentives by paying for outputs to circumvent these constraints has been initiated in several resource-limited countries besides Rwanda, such as Haiti and Afghanistan, and has shown favorable results.^{28–30}

Although we used a quasi-experimental research design, our study still contains three limitations. The first is the inability to observe a counter-factual: what would have occurred for non-HIV/AIDS service in the absence of the HIV/AIDS programs.¹¹ It is possible that without HIV/AIDS programs, HCs in both groups might have received more resources for other services. In considering the experiences of the control HCs as the counter-factual, we implicitly assume that the injection of HIV/AIDS funding at a higher level in the health system (e.g., national or district level) does not affect its resource allocation to the non-HIV HCs. The second limitation lies in not including system-level inputs. HIV/AIDS programs may strengthen health care systems with improved information system, drug procurement, management, leadership, governance, and standardized health care procedures.^{3,6} However, because many elements of system performance are difficult to measure, and may offer benefits to comparison HCs, their impacts are not included. The third limitation is that this study involved only one country (Rwanda), lasted less than a decade, and overlapped in time with implementation of other beneficial interventions, especially CBHI. The policy in

Rwanda of integrating HIV/AIDS care with general health services and its generous support from donors may have contributed to widespread service improvements. It is possible that without these concurrent interventions, or in a country with different cultural factors, the effect of HIV/AIDS services on outputs could have been less favorable.

Despite these limitations, this study found that the injection of AIDS funding did not reduce provision of curative and preventive services over this six-year period in Rwanda. For most non-HIV/AIDS services, we observed improvements after HIV/AIDS funding. To address the challenges posed by HIV/AIDS in Rwanda requires maintaining the momentum to continue to increase resources for this health problem. Equally important is the integration of HIV/AIDS funding with the health care system to benefit all other diseases to maximize the positive synergies of HIV/AIDS programs and health systems.^{31–33}

Received April 6, 2011. Accepted for publication February 1, 2012.

Acknowledgments: We thank Sabine Furere, and Godelive Kashama for their lead roles in data collection; Anita Assimwe, Jules Mugabo, and A. K. Nandakumar for valuable advice; and the interviewers, HC personnel, and Ministry of Health officials for providing necessary data for this study.

Financial support: This study was supported by The Joint United Nations Programme on HIV/AIDS and Brandeis University through a cooperative agreement.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the views of the authors' institutions or the sponsors. None of the authors has any financial interest in any product discussed in this article.

Authors' addresses: Donald S. Shepard, Wu Zeng, Peter Amico, and Angelique K. Rwiwerekka, Schneider Institutes for Health Policy, Heller School, MS 035, Brandeis University, Waltham, MA 02454-9110, E-mails: shepard@brandeis.edu, wuzengcn@brandeis.edu, pamico@brandeis.edu, and gasugi@gmail.com. Carlos Avila-Figueroa, Abt Associates, 4550 Montgomery Avenue, Suite 800 North, Bethesda, MD 20814, E-mail: carlos_avila@abtassoc.com.

REFERENCES

1. Joint United Nations Programme on HIV/AIDS, World Health Organization, 2009. *AIDS Epidemic Update*. Geneva: UNAIDS, WHO.
2. Joint United Nations Programme on HIV/AIDS, 2009. *What Countries Need: Investments Needed for 2010 Targets*. Geneva: UNAIDS.
3. Samb B, Evans T, Dybul M, Atun R, Moatti JP, Nishtar S, Wright A, Celletti F, Hsu J, Kim JY, Brugha R, Russell A, Etienne C, 2009. An assessment of interactions between global health initiatives and country health systems. *Lancet* 373: 2137–2169.
4. Musango L, 2007. *Impact des Projets de Lutte contre le VIH sur le Systeme de Santé au Rwanda*. Kigali, Rwanda.
5. Price JE, Leslie JA, Welsh M, Binagwaho A, 2009. Integrating HIV clinical services into primary health care in Rwanda: a measure of quantitative effects. *AIDS Care* 21: 608–614.
6. Yu D, Souteyrand Y, Banda MA, Kaufman J, Perriens JH, 2008. Investment in HIV/AIDS programs: does it help strengthen health systems in developing countries? *Global Health* 4: 8.
7. Delph E, 2008. *Global Vertical Programmes: The Future of Aid or a Quick Fix?* Quezon City, the Philippines: EUROAD.
8. Hsiao WC, 2007. Why is a systemic view of health financing necessary? *Health Aff (Millwood)* 26: 950–961.
9. Schieber G, Gottret P, Fleisher L, Leive A, 2007. Financing global health: mission unaccomplished. *Health Aff* 26: 921.

10. Lewis M, 2005. *Addressing the Challenge of HIV/AIDS: Macroeconomic, Fiscal and Institutional Issues*. Washington, DC: Center for Global Development.
11. Shiffman J, 2008. Has donor prioritization of HIV/AIDS displaced aid for other health issues? *Health Policy Plan* 23: 95–100.
12. Piva P, Dodd R, 2009. Where did all the aid go? An in-depth analysis of increased health aid flows over the past 10 years. *Bull World Health Organ* 87: 930–939.
13. Switlick K, 2008. *HIV/AIDS Expenditure Tracking: Linking Two Frameworks to Inform Policy and Programming*. Available at: http://www.healthsystems2020.org/files/2104_file_HIVAIDS_Expenditure_Rev_6.pdf. Accessed December 1, 2009.
14. National Institute of Statistics of Rwanda, 2008. *Demographic and Social Statistics*. Available at: http://statistics.gov.rw/index.php?option=com_content&task=view&id=152&Itemid=201. Accessed December 1, 2009.
15. Elliott P, Hawthorne G, 2005. Imputing missing repeated measures data: how should we proceed? *Aust N Z J Psychiatry* 39: 575–582.
16. Assefa Y, Jerene D, Lulseged S, Ooms G, Van Damme W, 2009. Rapid scale-up of antiretroviral treatment in Ethiopia: successes and system-wide effects. *PLoS Med* 6: e1000056.
17. Brugha R, Simbaya J, Walsh A, Dicker P, Ndubani P, 2010. How HIV/AIDS scale-up has impacted on non- HIV priority services in Zambia. *BMC Public Health* 10: 540.
18. Duber HC, Coates TJ, Szekeras G, Kaji AH, Lewis RJ, 2010. Is there an association between PEPFAR funding and improvement in national health indicators in Africa? A retrospective study. *J Int AIDS Soc* 13: 21.
19. WHO/UNICEF, 2009. *Review of National Immunization Coverage 1980–2008 in Rwanda*. Available at: http://www.who.int/immunization_monitoring/data/rwa.pdf. December 1, 2009.
20. Ministry of Health (MOH) [Rwanda], National Institute of Statistics of Rwanda (NISR), 2009. *ICF Macro. Rwanda Interim Demographic and Health Survey 2007–08*. Calverton, MD: MOH, NISR and ICF Macro. Available at: <http://www.measuredhs.com/pubs/pdf/FR215/FR215.pdf>.
21. National Institute of Statistics of Rwanda (NISR), 2011. Ministry of Health (MOH) [Rwanda]. *ICF Macro. Rwanda Demographic and Health Survey 2010*. Calverton, MD: NISR, MOH and ICF Macro. Available at: <http://www.measuredhs.com/pubs/pdf/PR7/PR7.pdf>.
22. Black RE, Morris SS, Bryce J, 2003. Where and why are 10 million children dying every year? *Lancet* 361: 2226–2234.
23. Palmer N, Mueller DH, Gilson L, Mills A, Haines A, 2004. Health financing to promote access in low income settings—how much do we know? *Lancet* 364: 1365–1370.
24. Shepard DS, Zeng W, Rwiyereka AK, Amico P, Furere S, 2009. *Does the Policy Work? An Evaluation of Health Centers Providing HIV/AIDS Services in Rwanda*. Technical Report to UNAIDS.
25. Rusa L, Ngirabega Jde D, Janssen W, Van Bastelaere S, Porignon D, Vandenbulcke W, 2009. Performance-based financing for better quality of services in Rwandan health centres: 3-year experience. *Trop Med Int Health* 14: 830–837.
26. Soeters R, Habineza C, Peerenboom PB, 2006. Performance-based financing and changing the district health system: experience from Rwanda. *Bull World Health Organ* 84: 884–889.
27. Basinga P, Gertler PJ, Binagwaho A, Soucat AL, Sturdy J, Vermeersch CM, 2011. Effect on maternal and child health services in Rwanda of payment to primary health-care providers for performance: an impact evaluation. *Lancet* 377: 1421–1428.
28. Eichler R, Levine R, 2009. *Performance Incentives for Global Health: Potential and Pitfalls*. Available at: http://www.cgdev.org/doc/books/PBI/10_CGD_Eichler_Levine-Ch10.pdf. Accessed June 21, 2010.
29. Eichler R, Auxila P, Pollock J, 2001. *Output-Based Health Care: Paying for Performance in Haiti*. Available at: <http://rru.worldbank.org/documents/publicpolicyjournal/236Eichl-080201.pdf>. Accessed June 24, 2010.
30. Sabri B, Siddiqi S, Ahmed AM, Kakar FK, Perrot J, 2007. Towards sustainable delivery of health services in Afghanistan: options for the future. *World Hosp Health Serv* 43: 10–16.
31. World Health Organization, 2008. *Maximizing Positive Synergies between Health Systems and Global Health I*. Available at: <http://www.who.int/healthsystems/New-approach-leaflet-ENv2-p4p.pdf>. Accessed December 3, 2009.
32. World Health Organization, 2009. *United Nations Population Fund, International Planned Parenthood Federation, Joint United Nations Programme on HIV/AIDS, University of California SF, Global Health Sciences. Sexual and Reproductive Health and HIV Linkages: Evidence Review and Recommendations*. Available at: http://www.hivandsrh.org/newsletter/WHO_HIV_2009_eng.pdf. Accessed December 3, 2009.
33. Population Council, 2008. *Frontiers in Reproductive Health. Kenya Integration: Integrating Services for FP and HIV Improves Quality and HIV Testing*. Available at: http://www.hivandsrh.org/newsletter/Kenya_integration.pdf. Accessed December 3, 2009.