

ECONOMIC ADVANTAGE OF A COMMUNITY-BASED MALARIA MANAGEMENT PROGRAM IN THE BRAZILIAN AMAZON

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Abstract. In the Brazilian Amazon, travel costs to centralized malaria clinics for diagnosis and treatment can approach 20% of one's monthly salary. A program was established in a mining town for community-based dipstick test diagnosis and treatment. An economic analysis was performed that compared expected costs under the old program to the observed costs of the new one. Data were obtained through interviews, government reports, clinic and hospital records, and community records. There was a 53% reduction (by 1,219 visits) of clinic visits but a doubling of malaria hospitalization admissions (to 191). The new program had an overall annual savings of \$60,900 (\$11.8K–\$160K, sensitivity limits), a 77% reduction of the old program's cost. The benefit-to-cost ratio was 9:1, where benefits were patients' savings from travel and lost wages and costs were government drug, diagnostic, training, and monitoring expenses. A community-based program incorporating dipstick tests for malaria management can have economic advantages.

INTRODUCTION

An essential but costly component of Brazil's malaria control program has been the establishment of numerous malaria clinics for microscopic diagnosis and treatment. Because of the high capital costs and training associated with establishing and maintaining microscopy services, they are restricted to central areas and do not extend to peripheral forested areas where cases of malaria are occurring. Because many patients must travel long distances at great expense for diagnosis and treatment, one would ideally like to extend diagnostic and treatment services to peripheral areas without incurring additional costs. This initiative gains in importance if it is done during times of shrinking health budgets and malaria resurgence. During interviews in some of these remote areas, we learned that community volunteers were an enthusiastic, untapped resource for case management at the village level, provided that such programs were operationally and technically feasible.

We previously reported the establishment of a successful community-based program for the management (diagnosis and treatment) of malaria in a remote community of the Amazon.¹ Bar owners of a mining village were responsible for administering dipstick tests (ParaSight-F, Becton Dickinson, Franklin Lakes, NJ) and mefloquine to patients with specified symptoms. By use of data from the year before intervention began as well as from a neighboring village that we used as historical and concomitant controls, respectively, there was a significant reduction in the number of visits to the centralized laboratory posts (FNS), and more importantly, without an overuse or abuse of services seen with previous attempts to extend case management to the periphery through mobile clinics.^{2,3} The purpose of this work is to perform an economic analysis of the previously reported study. If an economic, rather than purely humanitarian, argument can be made for community-based case management, then such programs would more likely be sustainable and attractive to budget-minded agencies.

METHODS

The methods for the noneconomic aspects of the study have been previously reported,¹ and we will only describe

methods, in accordance with published guidelines,^{4–7} for the economic analysis of this data.

Design. The general strategy was variation of a cost-minimization approach,⁴ in which one determines the most efficient (cheapest) method to obtain a given goal. The goal in this case was to provide diagnosis and treatment to the study village for 1 year, and for our study, only 2 methods (new and old) were compared. We compared the dollar value of costs and benefits expected under the old system (central laboratory visits) with those observed under the new program (which included community-based diagnosis and treatment). Changes in costs and benefits to all sectors of society were tallied. An interview of subjects was conducted at the end of the study to determine their willingness to pay for such services in the future.

Assumptions. Under a cost-minimization approach, we assumed that the main contributing factors to difference of the economic value between programs resulted from changes in costs for materials, training, and monitoring, and from benefits of a reducing the number of FNS clinic visits and malaria hospitalizations. There were too few deaths and too few patient visits to private pharmacies to measure as outcomes. No attempt was made to measure or assign economic values to the less tangible, theoretical outcomes regarding changes in the number of days of suffering from malaria illness, malaria transmission, changes in cure rates, or alterations in the development of drug resistance.

Determining cost/benefit values. The costs and economic value of benefits of study variables were determined from government purchase and accounting records (drugs, supplies, hospitalizations), interviews (patient travel costs and lost wages during travel or illness), and government salaries and per diem expenses (training and monitoring). The staff of the 6 participating bars agreed not to accept compensation for their services for the following reasons. Their actual working time was minimal (~ 3 hr per bar-month), and the bars were staffed almost on a 24-hr basis for their normal operations. They believed that providing malaria management services would attract customers and gain the respect of the community. Although the FNS laboratory performed fewer slide examinations under the new program, no savings were attributed to the reduction in labor because employees

TABLE 1

Case management under the old program in Baixão (FNS visits), under the new program in Baixão (FNS visits and dipstick tests), and for the control village of Mutum (FNS visits)*

Program	FNS visits (% PF)	
	Baixão (n = 750)	Mutum (n = 900)
First year (old program)	3,306 (15.6%)	5,005 (16.2%)
Second year (new program)	1,097 (7.5%) 626 (19.8%)†	3,507 (13.1%)

* FNS, centralized laboratory clinic; PF, *Plasmodium falciparum* malaria. The expected number of FNS visits from Baixão during the second year under the old program was $3,507/5,005 \times 3,306 = 2,316$. The following results were significant (>0) at $P < 0.0001$ by incidence density calculation⁸: (1) the reduction in the number of observed Baixão visits compared to expected numbers during the second year, by 1,219 (2,316–1,097, a 53% reduction); (2) the number of Baixão visits (1,097) continuing during the second year; (3) the number of dipstick tests applied (626); and (4) the number of reduced visits not accounted for by dipstick tests (593).

† Dipstick tests applied.

received a fixed salary regardless of the number of slides examined.

Sensitivity analysis. The sensitivity analysis of economic outcomes incorporated the uncertainty of reported costs, statistical uncertainty (95% Confidence Intervals), and the uncertainty of epidemiologic assumptions. When aggregate outcomes (differences and ratios) are reported, we used the limits of each variable to obtain the range of uncertainty of the aggregate variable. Discounting was not performed because the period of return was short (1 year) and in theory could have occurred over an even shorter period.

Economic outcomes. The absolute savings as well as a cost/benefit ratio comparing the old to new program is reported. The cost/benefit ratio was calculated on the basis of changes in government costs compared with changes in patients' benefits.⁷ Although costs and benefits to society as a whole are tallied, each item is also referenced to a specific groups (in this case, government or patients). The benefit/cost ratio was defined as the ratio of the change in economic value to patients compared with the change for the government. This can be interpreted as the added amount that patients "save" for every additional dollar spent by the government on the new program. This ratio is usually defined as the marginal change in benefits/costs for all sectors of society, but in this case, it is analyzed along government versus patient categories because the majority of the benefits are accrued by patients and costs by the government. For sensitivity analysis, the upper limit of this ratio was calculated by the maximum of patients' savings/the minimum of government spending (from the corresponding uncertainty intervals). Analogously, the lower limit of this ratio was calculated by use of the minimum patients' savings/maximum government spending.

RESULTS

A summary of previously reported results¹ is presented in Tables 1 and 2, followed by the data used for the economic analysis in Table 3. The first few columns of Table 3 lists the program components, their unit costs, and who pays for each element. Next are listed the amount and total cost of each component one would expect to use during the second year if the old program had been operating. Next are listed the amount and total component costs for the second year

TABLE 2

Plasmodium and vivax malaria hospital admissions under the old program in Baixão, under the new program in Baixão, and for the control village of Mutum*

Program	Baixão (n = 750), by interviews of community sample	Mutum (n = 900), by sample of hospital records
First year (old program)	11 admissions, 75 person-years	33
Second year (new program)	50 admissions, 196 person-years	27

* There was a significantly higher (about twice) incidence of malaria hospitalizations in Baixão observed during the new program compared with the old program ($P = 0.026$; for H_0 , identified first year/identified second year = 33/27), with an average stay of 3.7 and 3.2 days for the first and second year, respectively. On the basis of the samples, the total number of malaria hospitalizations for Baixão (n = 750) during the first year was 110 (95% confidence interval, 44–176; incidence density). For the second year, the observed total would be 191 (95% confidence interval, 150–241; incidence density), and the expected total for the second year would be $110 \times (27/33) = 90$.

under the new program. The next columns list the change in the amount of each component used and the change in total cost for the second year comparing the new program to the old. Because the results of sensitivity analysis will vary depending on the calculations used, the formulas and assumptions for each calculation are described in the footnote of Table 3.

Summarizing the results of Table 3, there was a net savings per year for Baixão of \$60,900 (\$60.9K) with an uncertainty interval (sensitivity analysis) of (\$11.8K–\$160K). There was a 77% reduction in the old program costs if one considers no travel expenses for those with initial symptoms presenting in Apiacas (see explanation in Table 3; the old program cost is \$78.8K and \$18.3K is the new). This represents an \$81 savings per person-year, where the average monthly income is \$250. The benefit/cost ratio, calculated as benefit to patients/cost to government, is 9:1, with an uncertainty interval of (2–50):1. This represents the return per unit invested over a 1-year period. However, if one chooses to reinvest profits into the program more frequently—say, every 4 months—then the point estimate of the benefit/cost ratio can be as high as 729:1 per year.

By interview of 196 subjects at the end of the study, we established that the average willingness to pay for dipsticks (excluding mefloquine treatment cost) was \$5.60. Multiplied by the number of dipstick tests used, this represents ~ 6% of the total saving.

DISCUSSION

Cost efficiency and cost/benefit analyses have recently become important considerations as we recognize the need to economize health resources and use them more efficiently. Nowhere is the need for economic analysis more pressing than in developing countries where health needs far outweigh health resources. For tropical diseases, the issues are complex,⁹ with many nonquantifiable variables that must be accounted for. Still, when the potential for improving efficiency is great, even a crude attempt at economic analysis may be robust enough to show potential for enormous savings. We believe we have shown this for our community-based program.

The approach we chose was a cost minimization method,

TABLE 3
Cost comparison of old and new methods for management of second-year patients, Baixão*

Item	Unit cost (US\$)	Who pays	Expected under old method		Observed under new method		Change	
			No. units	Total cost (thousands of US\$)	No. units	Total cost (thousands of US\$)	No. units	Total cost (thousands of US\$)
FNS laboratory visit:								
Travel	40 (30–50)							
Plus lost wages	15 (10–20)							
Equals total	55 (40–70) (a)	Patient	2,316	127	1,097	60.3	–1,219	–67.0
			(1,723–3,306) (b and c)	(69–231) (d)	(1,032–1,162) (e)	(41–81) (d)	(561–2,274) (f)	(22–159) (g)
Diagnostic smear	0.33	Government	2,316	0.76	1,097	0.36	–1,219	–0.40
			(1,723–3,306) (b and c)	(0.57–1.10)	(1,032–1,162) (e)	(0.34–0.39)	(561–2,274) (f)	(0.19–0.75) (h)
Dipstick	2.14	Government	0	0	636	1.34	+626	+1.34
					(576–676)	(1.23–1.45)	(576–676)	(1.23–1.45) (h)
Therapy Q ₃ T ₇	1.00	Government	301 = 2,316 × 13%	0.30	82	0.08	–219	–0.22
			(224–430) (i)	(0.22–0.43) (h)	(64–100) (e)	(0.064–0.10) (h)	(124–366) (f)	(0.12–0.37)
Chloroquine	0.60	Government	509 = 2,316 × 22%	0.31	714	0.43	+205	+0.12
			(379–727) (j)	(0.23–0.44)	(640–788) (k)	(0.38–0.47)	(–87–409) (f)	(–0.05–0.25)
Mefloquine	2.00	Government	0	0	124	0.25	+124	+0.25
					(102–146) (e)	(0.2–0.3)	(102–146)	(0.20–0.30)
Training costs of provider	10.00 per person-day	Government	0	0	15 people × 2 days	(0.30)	+30	+0.30 (l)
Monitoring cost	20.00 per person-day	Government	0	0	20 person-days	(0.40)	+20	+0.40 (l)
Days hospitalized for malaria	20.00 per day	Government	407 days	8.1	612 days	12.2	+205	+4.1
			(280–534) (m)	(5.6–10.6)	(515–707) (m)	(10.1–15.0)	(117–293) (n)	(2.3–5.9)
Totals				136.5		75.6		–60.9
				(75.6–243.6) (o)		(54.0–8.7) (o)		(11–160) (o)

* Sensitivity analysis in parentheses. CI = confidence interval; FNS = centralized laboratory clinics; PV = *Plasmodium vivax* malaria. By interview, 1,042 of the observed 1,097 FNS visits during the second year occurred because patients were already in Apiacas (the town in which the FNS is located) for other reasons at the time of onset of symptoms. Similarly, of the 2,316 FNS visits expected, we would expect a similar number to have experienced onset of symptoms in Apiacas. If no travel costs are associated with these visits, \$70.1K and \$3K are the costs of expected and observed visits, respectively. Factors incorporated into the sensitivity analysis include the following: (a) population interviews ($n = 30$), range of reported average cost per visit; (b) Baixão without Mutum adjustment, where the number of expected visits equals the number of observed visits + number of dipstick tests applied; (c) Baixão without Mutum adjustment, which uses previous year's visits as expected number of visits; (d) lower limit = lower limit unit × lower limit cost; upper limit = upper limit unit × upper limit cost; (e) statistical analysis, 95% CI of incidence density*; (f) uncertainty interval calculated as (minimum observed – maximum expected, maximum observed – minimum expected); (g) uncertainty interval calculated as (minimum change in number of units × minimum unit cost, maximum change in number of units × maximum unit cost); (h) uncertainty interval calculated as (minimum change of number of units × unit cost, maximum change in number of units × unit cost); (i) low and high expected number of visits × percentage of *Plasmodium falciparum* malaria expected in Baixão in the second year = (b × 13%, c × 13%); (j) low and high expected number of visits × percentage of PV malaria expected in Baixão in the second year = (b × 22%, c × 22%); data for the PV proportions have not been shown but are equal to (%PV Baixão first year) × (%PV Mutum second year)/(%PV Mutum first year); (k) dipstick negative + PV by smear. The uncertainty interval is statistical: 95% CI for the sum of the observed incidence densities*; (l) no uncertainty, amount paid directly; (m) statistical, 95% CI of incidence density (hospital days/person-years)*; (n) statistical, 95% CI of difference of incidence densities (hospital days/person-years)*; (o) uncertainty interval calculated as (sum of lower limits of terms, sum of upper limit of terms) with consideration of positive or negative change.

but one that restricted the comparison to only 2 alternatives, the old and the new programs. This strategy assumes that the outcomes that cannot be accounted for in monetary terms are either similar for the 2 alternatives or not perceived by users to be important or directly related to the intervention. Because this perception in part determines sustainability of an intervention, we did not attempt to measure these less tangible economic outcomes. There are certain effects that we have not accounted for that fit these above categories. Changes in malaria transmission, from presumably earlier treatment, are reflected in the number of cases and thus are indirectly measured. The drug toxicity associated with the 2 alternatives (both involving standard regimens) we assume to be similar. Reduced duration of suffering resulting from prompt treatment we assume to be relatively unimportant. However, we did not attempt to account for the degree of suffering associated with increased hospitalizations of malaria cases.

Finally, the new program might have resulted in a delay in diagnosis and treatment in Apiacas of nonmalaria cases. This would be reflected in the number of nonmalaria hospitalizations, which were not measured in this study. In other situations, the above factors may be very important considerations for deciding between various alternative interventions, providing the more tangible effects are first described.

Although the sensitivity analysis yielded large uncertainty intervals, it is based on more than just statistical uncertainty; more importantly, it covers the range of epidemiologic assumptions as well. Other reports present comparable ranges of uncertainty of cost/benefit ratios for new programs¹⁰ or the comparison of alternative interventions.¹¹

Although cost/benefit ratios vary depending on methods of calculation,⁴ the concept of reinvestment is not generally accepted by health economists. The argument is that health budgets are funded annually without the chance for more frequent reinvestment of profits. However, from a business perspective, the potential for reinvestment and exponential growth of profits is a valid argument. And herein lies the dilemma. Whether the government or the private or community sectors of society establishes a community-based program will depend on its perceived economic advantage. If the private sector is more efficient through reinvesting, then they will take the initiative. Unfortunately, although maximum profit per unit of investment can be obtained by the private sector, little will be returned to the community. It will be a challenge to establish community-based programs in the face of such lucrative potential for the private sector. But our study has shown that in the absence of a significant private sector, a community with minimal gov-

ernment supervision and investment can conduct its own program under sustainable economic conditions.

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