Cost-effectiveness of community health workers in tuberculosis control in Bangladesh

Md. Akramul Islam,[1] Susumu Wakai,[2] Nobukatsu Ishikawa,[3] A.M.R. Chowdhury,[4] & J. Patrick Vaughan[5]

Objective To compare the cost-effectiveness of the tuberculosis (TB) programme run by the Bangladesh Rural Advancement Committee (BRAC), which uses community health workers (CHWs), with that of the government TB programme which does not use CHWs.
Methods TB control statistics and cost data for July 1996–June 1997 were collected from both government and BRAC thanas (subdistricts) in rural Bangladesh. To measure the cost per patient cured, total costs were divided by the total number of patients cured.
Findings In the BRAC and government areas, respectively, a total of 186 and 185 TB patients were identified over one year, with cure rates among sputum-positive patients of 84% and 82%. However, the cost per patient cured was US$ 64 in the BRAC area compared to US$ 96 in the government area.
Conclusion The government programme was 50% more expensive for similar outcomes. Although both the BRAC and government TB control programmes appeared to achieve satisfactory cure rates using DOTS (a five-point strategy), the involvement of CHWs was found to be more cost-effective in rural Bangladesh. With the same budget, the BRAC programme could cure three TB patients for every two in the government programme.

Keywords Tuberculosis, Pulmonary/prevention and control; Community health aides/utilization/economics; Health personnel/utilization; National health programs/organization and administration; Rural health services/manpower; Cost-benefit analysis; Comparative study; Bangladesh (*source: MeSH, NLM*).

Mots clés Tuberculose pulmonaire/prévention et contrôle; Auxiliaire santé publique/utilisation/économie; Personnel sanitaire/utilisation Programme national santé/organisation et administration; Service santé milieu rural/main-d'œuvre; Analyse coût-bénéfice; Etude comparative; Bangladesh (*source: MeSH, INSERM*).

Palabras clave Tuberculosis pulmonar/prevención y control; Auxiliares de salud comunitaria/utilización/economía; Personal de salud/utilización; Programas nacionales de salud/organización y administración; Servicios rurales de salud/recursos humanos; Análisis de costo-beneficio; Estudio comparativo; Bangladesh (*fuente: DeCS, BIREME*).

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Introduction

Tuberculosis (TB) remains a major public health problem in Bangladesh. This is exemplified by the statistics for 1993, when the incidence was estimated to be 220 people per 100 000 population (*1*). To address this issue, the Bangladesh Rural Advancement Committee (BRAC) first initiated a pilot community-based TB control project in 1984 in Manikganj thana (subdistrict), with technical support from the Research Institute of Tuberculosis in Japan (*2, 3*). This model is currently being applied in 60 thanas covering a population of approximately 14 million (about 12% of the population of Bangladesh).

Since 1993, a national TB programme has been implemented at the thana level, based on the WHO-recommended DOTS strategy, with each thana covering a population of about 250 000 (*4*). Nongovernmental organizations (NGOs), including BRAC, are collaborating with the national TB programme. Both BRAC and national TB programmes use the same treatment regimens (*5*), but BRAC mainly relies on the use of community health workers (CHWs) to deliver directly observed therapy (DOT) while the government provides DOT mostly through thana health complexes. According to national TB programme reports, recent cure rates of between 71% and 75% have been achieved (*6–8*). In contrast, a cure rate higher than the WHO target of 85% has been achieved by BRAC, using CHWs (*2, 5*).

In the present study, we examined the cost-effectiveness of using CHWs for TB control, by comparing the costs of BRAC and government services.

Methods

TB control through government thana health complexes

The government thana health complexes had 31 beds for inpatients, and staff positions for nine medical doctors. Below the thana level, services were also available at union subcentres and family welfare centres, managed by doctors or paramedics

[1] Senior Sector Specialist (TB), BRAC (Bangladesh Rural Advancement Committee) Health Programme, BRAC, Dhaka, Bangladesh.
[2] Professor and Chairman, Department of International Community Health, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan (email: swakai@m.u-tokyo.ac.jp). Correspondence should be addressed to this author.
[3] Deputy Director, Research Institute of Tuberculosis, Kiyose-shi, Tokyo, Japan.
[4] Deputy Executive Director and Director Research, BRAC, Dhaka, Bangladesh.
[5] Professor of Epidemiology and Public Health, Health Policy Unit, London School of Hygiene and Tropical Medicine, London, England.
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(*8*). Below the union level, there was about one health worker (health assistant) for every 5000–6000 population, who provided basic health care to the villagers (*9*).

Patients suspected of having pulmonary TB submitted three sputum specimens within two days to the thana health complexes for laboratory examination, and were diagnosed as sputum positive if two specimens were positive for acid-fast bacilli (*6*). If symptoms persisted, but the sputum was negative for acid-fast bacilli, patients underwent chest radiography at the private or government health facilities. However, systematic quality control of laboratory services has not yet been established at thana health complex level.

An 8-month, short-course treatment regimen was used for treating sputum-positive patients, who underwent follow-up sputum examinations at 2–3, 5, and 8 months (*4*). In the first 2–3 months, sputum-positive individuals were given drugs weekly at the thana health complexes, while sputum-negative patients were given drugs monthly, after which patients collected drugs monthly from the thana health complexes. Government health workers traced defaulters.

TB control through CHWs

Each BRAC health centre had a medical doctor or a manager and services were mainly provided by CHWs under the supervision of paramedics (programme organizers). The CHWs were mostly illiterate women who each covered about 200 households (*2*). In the study area, BRAC had two health centres to provide health care services to the community. Sputum collection centres were widely available, to increase access.

Suspected TB patients were given sputum containers for two samples and asked to bring them to the sputum collection centre, where a third sputum sample was collected. Sputum smears were prepared and sent to the thana-level laboratory for staining and microscopy. If symptoms persisted, but the sputum was negative, patients were referred to the thana health complexes or district hospitals. For quality control, 50% of positive, 5% of negative, and 5% of follow-up sputum slides were cross-checked by another laboratory technician every month (*2, 5*).

Treatment of all TB patients and follow-up sputum examinations were carried out according to national TB programme guidelines (*4*). CHWs observed new patients swallow the drugs during the first 2–3 months, while patients undergoing retreatment were observed for the entire period. After the initial 2–3 month period, patients collected drugs once a week from the home of the CHW. BRAC staff supervised the CHWs and other activities regularly.

Patients receiving treatment were asked to deposit 200 Takas (US$ 4; about four days' wages), and to sign a bond to guarantee treatment completion. From the bond, 125 Takas were given to the CHW and the remaining 75 Takas were refunded to the patient after completing treatment (*2, 5*). Patients unable to pay the deposit received a waiver.

Data collection

The data on TB control (treatment of pulmonary and extrapulmonary TB in children and adults) and costs were collected from one BRAC thana and one government thana, located between 65 and 100 kilometres north of Dhaka, the capital. Sociodemographically, both areas were similar to each other and to the majority of other thanas (*10*).

Cost analysis

Costs of health services and CHWs, together with patient costs, were calculated for one full year (July 1996–June 1997). Shared costs, including salary, buildings, furniture, supervision, transportation, and vehicles, were estimated through observation and interviews with health staff, including CHWs (*11*). Staff at each level and CHWs were asked to list their activities and identify the proportion of time they worked on each activity.

In both BRAC and government areas, the costs of all health workers and administrative staff (including CHWs) were included in the analysis. However, basic staff training costs were excluded, since training had already been given in 1994 in both areas and costs were estimated to be similar. BRAC capital costs (including building costs) were derived from accounting books and financial reports. As government capital costs were not available, they were estimated according to the local market price, using current replacement costs. Annual values of capital items were estimated from their expected useful life: 10 years for furniture, 5 years for vehicles and equipment, and were discounted 5% per annum.

Recurrent costs were derived from accounting books and financial reports in both areas. The BRAC and government overhead costs for TB patients were calculated to be 10% and 5%, respectively, following staff discussions. An inventory of drugs and logistics used for the TB programmes was prepared according to the records, and costs were calculated from the national TB programme price list.

To determine costs incurred by patients for their diagnosis and treatment, we interviewed a total of 18 BRAC and 20 government patients. The patients were selected purposively from individuals who visited health facilities within a one-week period either for a consultation, to give sputum tests, or to collect drugs, and they volunteered to provide information. From the information we calculated time and travel costs associated with patient visits to health facilities and treatment centres (for diagnosis, drug collection, and follow-up tests for cough). Our estimates also included the cost of each visit for people accompanying the patients.

Time costs were calculated by using the average daily wage to value a unit of time, and then multiplying this by the time taken for different activities associated with TB treatment (e.g. DOT visit to CHWs; collecting drugs from thana health complexes). Costs for technical support by the Research Institute of Tuberculosis were not included in costs for the BRAC area, as they provided support during the pilot phase (1984–90). All costs were calculated in Bangladesh currency (Taka) and converted to United States dollars at the 1996–97 exchange rate of US$ 1.00 = 42.22 Taka.

Effectiveness

Programme data for July 1996–June 1997 were collected from the respective BRAC and government offices. Treatment outcomes were analysed according to the WHO-recommended cohort analysis method (*12*). Programme effectiveness was determined from data on the number of patients who were cured, who completed treatment, who were successfully treated, or who defaulted, died, failed, and transferred/referred (as defined by the national TB programme) (*4, 13*). Cure and treatment success were used as the measure of effectiveness.

Cost-effectiveness

Cost-effectiveness ratios were calculated by dividing the cost per activity by each different effectiveness measure for July 1996–June 1997. The cost per patient cured was calculated by dividing the number of patients cured into the total health system costs. Similarly, the cost per patient successfully treated was calculated by dividing the number of patients successfully treated into the health system costs. The overall total cost per patient cured was calculated by dividing the total number of patients cured into the sum of the health system and patient costs.

Results

Cost analysis

The estimated total annual costs for TB control at thana level in BRAC and government areas were US$ 7351 and US$ 10 697, respectively (Table 1). The two main expenditures in both areas were for salaries and drugs, which together accounted for 77% and 83% of total expenditures for BRAC and government areas, respectively. Overall, the BRAC programme accounted for 69% of total government costs for the national TB programme. Although drug costs were similar in the BRAC and government thanas, salary costs in the BRAC programme were only 43% of those in the national TB programme. Costs for laboratory logistics and reagents were less in thana health complexes, as they tested only 2300 sputum smears, compared to 3968 sputum smears tested in BRAC areas.

A breakdown of estimated costs incurred by a typical patient and a typical CHW for diagnosis and treatment is shown in Table 2. On average, the total patient cost was about US$ 10 in the BRAC areas and US$ 19 in government areas.

Effectiveness

Of the 186 patients identified as having TB in the BRAC area in one year, over 91% were sputum positive and more than 70% were male (Table 3). Among the sputum-positive patients, 84% were cured and 10% died. A total of 185 TB patients were identified for the same period in the government thana. Of these, over 91% were sputum positive and 80% were male. For the sputum-positive patients, over 82% were cured and nearly 12% died. Treatment completion rate in sputum-negative patients was 62.5% in the BRAC area and 87.5% in the government area. The overall treatment success rate was 83.3% in the BRAC area and 82.7% in the government area.

Cost-effectiveness

In the BRAC area, each cured patient cost the health system US$ 52, while successfully treated patients cost the system US$ 48 each. However, the total overall cost per patient cured was higher, at US$ 64 (Table 4). In the government area, the equivalent figures were US$ 77, US$ 70, and US$ 96, respectively.

Discussion

A recent WHO review estimated that only 32% of the world's population had access to DOTS (*5*), a strategy that requires health workers (or persons accountable to health services) watch patients swallow their anti-TB drugs (*13*). In view of this, it is germane to ask how DOTS can be made more widely available. One solution would be to keep patients in hospitals for long stays, but in developing countries where TB is epidemic, this would increase the burden both on patients and

Table 1. **Estimated annual expenditure for tuberculosis control programmes, BRAC[a] and government areas, July 1996–June 1997**

Item	Cost (US$)	
	BRAC programmes (with CHWs)[b]	Government programmes (without CHWs)
Furniture	53 (0.70)[c]	66 (0.60)
Equipment	95 (1.30)	335 (3.10)
Vehicle	2 (0.02)	24 (0.20)
Building	96 (1.30)	253 (2.40)
Salary	2839 (38.60)	6443 (60.20)
Transport	522 (7.10)	108 (1.00)
Staff development[d]	30 (0.40)	101 (1.00)
Training costs for one CHW	96 (1.30)	0 (0.00)
Laboratory logistics	378 (5.20)	277 (2.60)
Reagents[e]	190 (2.58)	128 (1.20)
Drugs[e]	2787 (37.90)	2580 (24.10)
Overhead costs	263 (3.60)	382 (3.60)
Total expenditures	**7351 (100.00)**	**10 697 (100.00)**

[a] BRAC = Bangladesh Rural Advancement Committee.
[b] CHWs = community health workers.
[c] Figures in parentheses are percentages. Percentages for each expenditure were calculated from the corresponding total expenditure for BRAC and government programmes.
[d] Expenses associated with meeting and retraining staff.
[e] Supplied by the Government of Bangladesh.

Table 2. **Costs for tuberculosis control in BRAC[a] and government areas**

Item	Cost (US$)	
	BRAC programmes (with CHWs)[b]	Government programmes (without CHWs)
Diagnosis		
Loss of income	0.7 (53.8)[c]	1.4 (23.3)
Transportation costs	0.5 (38.5)	2.2 (36.7)
Examination fees	0.1 (7.7)	2.4 (40.0)
Total	1.3 (100.0)	6.0 (100.0)
Intensive phase treatment		
Loss of income	2.8 (100.0)	2.7 (44.3)
Transportation costs	0.0 (0.0)	3.4 (55.7)
Total	2.8 (100.0)	6.1 (100.0)
Continuation phase treatment		
Loss of income	1.4 (100.0)	2.1 (42.0)
Transportation costs	0.0 (0.0)	2.9 (58.0)
Total	1.4 (100.0)	5.0 (100.0)
Sputum monitoring		
Loss of income	0.9 (52.9)	0.8 (42.1)
Transportation costs	0.8 (47.1)	1.1 (57.9)
Total	1.7 (100.0)	1.9 (100.0)
Bond money	3.0 –	0.0 –
Patient and CHW costs		
Total patient costs	10.2 (84.0)	19.0 (100.0)
Cost of time given by a CHW for TB control	2.0 (16.0)	NA[d] –
Total costs (patient and CHW) per patient	12.2 (100)	19.0 (100)

[a] See footnote a, Table 1.
[b] See footnote b, Table 1.
[c] Figures in parentheses are percentages. Percentages for each expenditure were calculated from the corresponding total expenditure for BRAC and government programmes.
[d] NA = not applicable.

Table 3. **Characteristics and outcomes of tuberculosis (TB) control programmes in BRAC[a] and government areas, July 1996–June 1997**

Characteristics and outcomes	BRAC programmes (with CHWs)[b]	Government programmes (without CHWs)
TB patients registered (*n*)		
Sputum positive (new cases)	148 (79.6)[c]	167 (90.3)
Sputum positive (retreatment)	22 (11.8)	2 (1.1)
Sputum negative	13 (7.0)	5 (2.7)
Extrapulmonary	3 (1.6)[c]	11 (5.9)
Total patients registered	186 (100.)0	185 (100.0)
Patient characteristics		
Mean age (years ± 1 SD[d])	40.3 ± 15.4	37.7 ± 14.2
Age range (years)	9–75	9–80
Median age (years)	37	36.4
Male (*n*)	133 (71.5)	148 (80)
Female (*n*)	53 (28.5)	37 (20)
Treatment results for sputum-positive patients (*n*)		
Cured	143 (84.1)	139 (82.2)
Completed	2 (1.2)	0 (0.0)
Died	17 (10.0)	20 (11.8)
Failure	3 (1.8)	0 (0.0)
Defaulted	4 (2.3)	4 (2.4)
Transferred/referred	1 (0.6	6 (3.6)
Treatment results for sputum-negative and extrapulmonary patients (*n*)		
Completed	10 62.5	14 (87.5)
Died	3 18.7	0 (0.0)
Defaulted	3 18.7	0 (0.0)
Referred	0 0.0	2 (12.5)

[a] See footnote a, Table 1.
[b] See footnote b, Table 1.
[c] Figures in parentheses are percentages. Percentages for each characteristic and outcome were calculated from the corresponding total (patient and outcome) for BRAC and government programmes.
[d] SD = standard deviation.

Table 4. **Cost-effectiveness of community health workers (CHWs) in tuberculosis control (July 1996–June 1997)**

Expenditure	Cost (US$)	
	BRAC[a] programmes (with CHWs)	Government programmes (without CHWs)
Health system costs		
Per patient cured	52.0 –	77.0 –
Per patient successfully treated[b]	48.0 –	70.0 –
Total	52.0 (81.0)[c]	77.0 (80.2)
Patient costs		
Per patient loss of income	5.8 –	7.1 –
Per patient monetary loss	4.4 –	11.9 –
Total	10.2 (15.9)	19.0 (19.8)
CHW costs	2.0 (3.1)	NA[d] –
Total costs	**64.2 (100.0)**	**96.0 (100.0)**

[a] See footnote a, Table 1.
[b] Patients who were cured and completed treatment.
[c] Figures in parentheses are percentages. Percentages are based on total costs for the respective programmes.
[d] NA = not applicable.

hospitals (*14–16*). Also, the number of hospital beds would be inadequate to admit all TB patients (*2, 17*).

There are also problems in promoting DOT for outpatient clinics, since health services may not be accessible, particularly in many rural areas in developing countries (*18*), as in Bangladesh, where patients collect drugs from government thana health complexes once a week instead of daily for observation. Moreover, TB cure rates in some south-east Asia countries were 76% in Bangladesh, 83% in India, 74% in Myanmar, 85% in Nepal, and 49% in Indonesia (*13*).

To ensure universal coverage by DOT, BRAC developed a model for providing care for TB patients at the community level that was based on community participation. Although the BRAC TB control initiative has consistently achieved the WHO target of an 85% cure rate (*2, 5, 19*), the treatment completion rate of sputum-negative and extrapulmonary patients in BRAC areas was lower than in thana health complexes. This may be because smear-negative and extrapulmonary patients are not a priority in the BRAC programme.

How cost-effective is the BRAC approach using CHWs, compared to government health services? Although there were

Table 5. **Characteristics and information for tuberculosis (TB) control programmes in BRAC[a] and government areas (July 1996–June 1997)**

Characteristics and information	BRAC programmes (with CHWs)[b]	Government programmes (without CHWs)
Characteristics		
Population (*n*)	336 707	320 530
Literacy rate (people aged 7 years and older and above) (%)	25.2	30.3
Works in agriculture (%)	73.9	73.2
Own agricultural land (%)	61.1	66.9
Information on tuberculosis control		
Total no. health staff involved in TB control	40	95
No. of field- level health workers	27	52
Total no. of CHWs	184	0
Loss of time per visit for DOT from CHWs	18.6 min	NA
Loss of time per visit for collecting drugs for SAT[c] from thana health complexes	NA[d]	2.69 h
Loss of time per visit for collecting drugs during continuation phase from CHWs/thana health complexes	9.4 min	2.87 h
Loss of time per visit to BRAC office/thana health complexes for diagnosis	1.85 h	2.9 h
Transportation cost per visit to BRAC office/thana health complexes for diagnosis and drug collection[e]	Taka 10.8 (US$ 0.26)[b]	Taka 24.2 (US$ 0.57)
Cost per smear test[e]	Taka 6.1 (US$ 0.14)	Taka 7.4 (US$ 0.17)

[a] See footnote a, Table 1.
[b] See footnote b, Table 1.
[c] SAT = self-administered treatment during intensive phase.
[d] NA = not applicable.
[e] For comparison, the average daily wage (8 h day) = Taka 50.0 (US$ 1.19). US$ 1= Taka 42.22 in 1996–97.

similar cure rates in both the BRAC and government areas, total health system costs in BRAC areas were substantially lower (48%) than in government facilities. Also, salary costs were much higher in the government areas, where more field staff were employed (Table 5), as were the costs incurred by patients.

In the BRAC area, the CHW lived in the same village as the patients and thus patient costs were much less, despite the fact that patients visited CHWs daily under the BRAC TB control strategy. In the government programme, by contrast, visits for drug collection were fewer, but patient costs were much higher due to the greater distances they had to travel. In addition, nearly one-half of government patients were advised to undergo further tests, including chest X-rays at private facilities. Under the BRAC programme, the additional tests were not required if the patients were sputum positive, in line with the national guidelines (*4*). Thus, local services in the community can reduce patient costs considerably (*16*). However, both the BRAC and government costs recorded in this study were lower than those in other, similar settings (*20, 21*). Population density, health services infrastructure, drug prices, and the general economic conditions of the country are important determinants of such costs.

Another important feature of the BRAC programme is that it identified more female patients, probably because women patients are more likely to approach a female CHW than a male CHW.

Our study showed that when CHWs are used, the DOT strategy was less expensive and more cost-effective than the government health services in a resource-poor country like Bangladesh. Data from a study in South Africa pointed to a similar conclusion (*20*). However, in the BRAC programme, the costs for diagnosis may be greater, due to the higher number of suspected patients referred by CHWs for sputum tests. This is partly due to the fact that patients in BRAC areas have easier access to CHWs and can be treated at their homes. Such patients can also continue their family and economic activities (*5, 20*).

In conclusion, the government programme appeared to be 50% more expensive than the equivalent government programme, for similar outcomes. For the same money, therefore, the BRAC programme could diagnose, treat, and cure three TB patients, while only two patients would be cured under the government programme. In Bangladesh, where most CHW programmes are run by NGOs, we recommend that the government health services collaborate with NGOs to mobilize CHWs for TB control. Such programmes could be more cost-effective and for the same funds could treat about 50% more TB patients than the regular national programme. ■

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Conflicts of interest: none declared.

Résumé

Rapport coût-efficacité du recours à des agents de santé communautaires dans la lutte contre la tuberculose au Bangladesh

Objectif Comparer le rapport coût-efficacité du programme de lutte antituberculeuse conduit par le Bangladesh Rural Advancement Committee (BRAC) – qui fait appel à des agents de santé communautaires – à celui du programme gouvernemental de lutte antituberculeuse – qui n'utilise pas ce type de personnel.

Méthodes Les statistiques de la lutte antituberculeuse et les données sur les coûts pour la période juillet 1996-juin 1997 ont été rassemblées pour les sous-districts desservis par le programme gouvernemental et le programme du BRAC dans des zones rurales du Bangladesh. Pour mesurer le coût par patient guéri, on a divisé le coût total par le nombre total de patients guéris.

Résultats Dans les zones desservies par le programme du BRAC et par le programme gouvernemental, on a identifié sur un an, respectivement, 186 et 185 patients atteints de tuberculose, avec des taux de guérison de 84 % et 82 % chez les sujets à frottis positif. Le coût par patient guéri était cependant de US$ 64 dans la zone desservie par le BRAC contre US$ 96 dans la zone du programme gouvernemental.

Conclusion Pour un résultat identique, le programme gouvernemental coûtait 50 % de plus. Bien que les deux programmes aient obtenu des taux de guérison satisfaisants en appliquant une stratégie en cinq points appelée DOTS, la participation d'agents de santé communautaires s'est avérée d'un meilleur rapport coût-efficacité dans les zones rurales du Bangladesh. A budget égal, le programme du BRAC pourrait guérir trois malades contre deux avec le programme gouvernemental.

Resumen

Costoeficacia de los agentes de salud comunitarios en la lucha contra la tuberculosis en Bangladesh

Objetivo Comparar la costoeficacia del programa contra la tuberculosis dirigido por el Comité para el Progreso Rural de Bangladesh (BRAC), en el que se recurre a agentes de salud comunitarios, con la del programa gubernamental contra la tuberculosis, que no hace uso de tales agentes.

Métodos A partir de material de la Administración y de las thanas (subdistritos) del BRAC en el Bangladesh rural, se recopilaron estadísticas sobre la lucha antituberculosa y datos sobre los costos correspondientes para el periodo de julio de 1996 a junio de 1997. El costo por paciente curado se determinó dividiendo los costos totales por el número de pacientes que sanaron.

Resultados En las zonas abarcadas por el BRAC y por el Gobierno se identificaron en total 186 y 185 enfermos de tuberculosis, respectivamente, a lo largo de un año, con tasas de curación del

84% y el 82% entre los pacientes con esputo positivo. Sin embargo, el costo por paciente curado fue de US$ 64 en las zonas del BRAC, y de US$ 96 en la zona de la Administración.

Conclusión El programa gubernamental era un 50% más costoso a igualdad de resultados. Aunque tanto dicho programa como el programa gubernamental lograron tasas de curación satisfactorias mediante la estrategia DOTS de 5 puntos, la participación de los agentes de salud comunitarios resultó ser una opción más costoeficaz en las zonas rurales de Bangladesh. Con el mismo presupuesto, el programa del BRAC podía curar a tres enfermos de tuberculosis por cada dos curados en el programa gubernamental.

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