The Incremental Cost-Effectiveness of Engaging Private Practitioners to Refer Tuberculosis Suspects to DOTS Services in Jogjakarta, Indonesia

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Abstract. We aimed to evaluate the incremental cost-effectiveness of engaging private practitioners (PPs) to refer tuberculosis (TB) suspects to public health centers in Jogjakarta, Indonesia. Effectiveness was assessed for TB suspects notified between May 2004 and April 2005. Private practitioners referred 1,064 TB suspects, of which 57.5% failed to reach a health center. The smear-positive rate among patients reaching a health center was 61.8%. Two hundred eighty (280) out of a total of 1,306 (21.4%) new smear-positive cases were enrolled through the PPs strategy. The incremental cost-effectiveness ratio per smear-positive case successfully treated for the PPs strategy was US\$351.66 (95% CI 322.84–601.33). On the basis of an acceptability curve using the National TB control program's willingness-to-pay threshold (US\$448.61), we estimate the probability that the PPs strategy is cost-effective at 66.8%. The strategy of engaging PPs was incrementally cost-effective, although under specific conditions, most importantly a well-functioning public directly observed treatment, short-course (DOTS) program.

INTRODUCTION

In many high burden countries, patients with tuberculosis (TB) symptoms seek care from a wide array of care providers other than the National TB control program.¹ Treatment in the private-for-profit health sector (outside the National Tuberculosis control program) is often of poor quality and results in low cure rates. This raises concerns of missed opportunities for transmission prevention and increases the risk for drug-resistant TB.² Standardized treatment guidelines—such as the TB care guideline provided under the internationally recommended directly observed treatment, short-course (DOTS) treatment strategy—can significantly improve process and outcomes of care.³ Therefore, the World Health Organization (WHO) recommends in the new Stop TB Strategy to engage non-DOTS providers and scale up Public-Private Mix DOTS initiatives.⁴

However, the evidence on the effectiveness of the Public-Private Mix DOTS strategy remains controversial.^{4,5} A review of 14 projects in India, for instance, showed a wide variation of effects, with a median number of only 0.53 new cases notified per private provider per year.⁶ Furthermore, some assessments of the cost-effectiveness of Public-Private Mix DOTS initiatives suggest that they may be cost-effective mainly in comparison to non-DOTS diagnosis and treatment in the private sector.^{7–9} All studies point toward the importance of context-specific factors and it also remains unclear whether, and under what conditions, scaling up Public-Private Mix DOTS would be more cost-effective than strengthening public DOTS services. Further assessment of these initiatives, especially of the ones implemented on a large scale and in high burden settings, seems much needed.

Indonesia ranks third in the world for TB burden.¹⁰ The country has a large private health service sector where 60% of the population seeks medical care.¹¹ A population-based health seeking behavior study indicates that public health centers (HCs) are preferred for consulting with TB symptoms, but non-DOTS private doctor practices are a close second.¹²

Indonesia's National TB control program has achieved the international targets for case detection (> 70%) and treatment success rate (> 85%) in 2006.¹⁰ The National TB control program is heavily investing in implementing Public-Private Mix DOTS and allocated the second highest share of its 2008 budget to this end.¹⁰ A pilot Public-Private Mix DOTS project in Jogjakarta province showed that involving hospitals and chest clinics in diagnosis and treatment can contribute to increased case findings without affecting the treatment success rate.¹³ At the same time, an assessment of the current role of private practitioners (PPs) in TB control in this province suggested that their potential contribution to Public-Private Mix DOTS would possibly be small.¹⁴

To further inform decision making at the national level and to contribute to the international debate on Public-Private Mix DOTS, we set up an intervention in Jogjakarta province. It involved the PPs in the default strategy of TB diagnosis and treatment at HCs level and assessed the incremental cost-effectiveness of this involvement in terms of successful treatment of smear-positive case.

MATERIALS AND METHODS

Study setting. The province of Jogjakarta is located in the central Southern part of Java Island. The province contains five administrative districts, has 3.2 million inhabitants, and covers an area of 3,185 km². The primary care network consists of about 2,000 PPs (doctors, midwives, or nurses) and 117 government-run HCs. These first line services are backed up by 9 public and 24 private hospitals.

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The 117 public HCs are the backbone of the National Tuberculosis control program's DOTS services in Jogjakarta. They fall into three groups: 28 "microscopy health centers" that perform sputum smear microscopy for their own patients and for those of nearby "satellite health centers"; 82 "satellite health centers" that prepare sputum samples for examination in the microscopy health centers; 7 "independent health centers" that perform sputum smear diagnosis for their own patients only. Sputum smear microscopy in HCs in Jogjakarta municipality is not free of charge except for the poor. The TB treatment through the National TB control program is offered free of charge to all notified TB patients. District TB supervisors regularly visit the HCs to collect data, maintain communication between the facilities, and ensure drug supplies.¹⁵

The study intervention. As part of the Hospital-DOTS Linkage project referred above, which expanded DOTS coverage to hospitals and chest clinics, all HCs were trained in 2001–2002 to manage TB patients referred by hospitals.¹³ Using the increased capacity of HCs, we launched, in May 2004, an intervention to involve the PPs in Jogjakarta in TB control. This was preceded by preparatory work, which commenced in January 2004 with the development of a preliminary proposal and negotiations for funding from the Canadian International Development Agency (here forward indicated as the donor). Upon securing funding, we established a project team based in the Faculty of Medicine, Gadjah Mada University. Our team refined the preliminary proposal through a survey for updating the provincial PPs register, focus group discussions with PPs, and a survey of current TB practices among PPs.^{14,16} The revised proposal for the intervention, was discussed in a provincial level meeting with the key stakeholders (provincial DOTS committee, district health office, and professional associations) and their suggestions were incorporated. Subsequent commitment building workshops involved stakeholders at district level (including representatives from HCs and PPs) and discussed tentative roles of PPs and mechanisms for putting in place the information, drug distribution, and support systems for DOTS implementation in private practices. These consultations and workshops paved the way for reaching agreement on the final design and implementation plan of the intervention.

Private practitioners were encouraged to refer TB suspects to HCs for diagnosis and treatment, but could also opt for treating their TB patients themselves in accordance with national guidelines, using free drugs supplied by the National TB control program. This intervention was introduced through seminars, with lunch, of about 4-hour duration organized at the district level to which all PPs identified through a preliminary street survey were invited. Additional participants encompassed heads of HCs, TB focal staff at HCs, TB supervisors at district level, and staff of district health offices. Participants were seated according to health centers' catchment areas to facilitate communication between HCs and PPs in their areas. The seminar content included updates on TB and the DOTS strategy as well as discussing the role of PPs in TB control. We also informed PPs regarding our support to laboratory quality control at HCs level to assure them of diagnostic quality. Promotional and information materials for patients (pocket book and TB-card) were provided. The seminars ended with pledges of commitment from PPs to the engagement scheme.

The seminars were rolled out in one district per week, covering all five districts in the province within 5 weeks. The

engagement scheme became operational immediately after each seminar in the corresponding area. During implementation, PPs were expected to inform TB suspects regarding the disease and the importance of standard diagnosis and treatment. Referred suspects were given a referral slip completed by PPs and two copies were kept, one for the PPs records and another for project monitoring. In the HCs, health workers were expected to tag the referred patient with a special code in the register and to provide feedback to PPs on diagnosis and possibly on treatment result. We trained field assistants to visit participating PPs on a quarterly basis to collect the copies of referral slips; distribute bi-monthly newsletters covering progress and relevant technical topics; facilitate communication between PPs and the National TB control program, and document experiences or problems in the partnership. Monthly phone calls were used for communication between the quarterly visits.

Data collection. The measures of effectiveness used were the number of TB suspects tested, smear-positive cases detected, and cases successfully treated at HCs. Data were compiled from the National TB control program's reporting forms in the HCs during the study's patient intake period (May 2004–April 2005) with an additional 6 months taken to document treatment outcomes. The patients referred by PPs were ascertained through the special codes put by the health workers on the National TB control program registers in the HCs. These registers were cross-checked against copies of referral slips collected from PPs to identify any omitted coding. The compiled dataset was checked periodically by a field coordinator for completeness and cross-checked with the district and provincial TB supervisors to assure consistency with figures reported by the National TB control program.

Local costs were converted into U.S. dollars using the average official exchange rate in 2005 (IDR 9,705 = US\$1). Capital and start-up costs were annualized at a discount rate of 3%. Costs were calculated using Microsoft Office Excel 2003 (Microsoft Corp., Redmond, WA), except as noted below.

Patient costs were estimated using a structured questionnaire that was administered twice to a consecutive sample of 58 TB patients notified by HCs and 50 TB patients notified by PPs. Patients were interviewed retrospectively, a first time as close to diagnosis as possible, and for a second time just after treatment completion. Patient costs were classified as either out-of-pocket service payments or other costs. The former consist of laboratory, consultation, and drugs payment (non-TB drugs, e.g., cough medication, vitamins) before and during DOT. The latter costs encompass patients' transport costs and lost earnings as well as attendants' costs.

Because of the skewed nature of the data, bootstrapping in STATA 10 (Stata Corp., College Station, TX) with 1,000 iterations used to determine confidence intervals (CIs). The mean of the bootstrap results was taken as best estimate of the average patient costs.

We calculated the relative contribution of each cost category to the overall patient costs and the ratio of patient costs, comparing those who initially attended PPs before referral and those who went directly to HCs. We carried out a univariate sensitivity analysis by using the upper and lower bound of the 95% CI of cost categories and documenting the resulting change to the total patient's cost ratio.

Provider costs were categorized into service (consultation, drugs, smear microscopy) and program costs (start-up; TB

control program staff; training; supervision; treatment incentives; information, education, and communication; monitoring and evaluation; coordination and general management). For the service costs, we surveyed a total of 11 HCs from three districts (out of the five existing ones) purposively selected to represent the different types of HCs: three satellite health centers (one for each district), six microscopy health centers (two for each district), and two independent health centers (only existing in two districts—one for each). The districts were selected to represent settings of urban, semi-urban, and rural. Within each stratum, the health centers surveyed were selected at random. The cost of each service component (e.g., smear microscopy, DOTS drugs) was calculated separately, using an ingredient-based approach. Average cost and uncertainty ranges for the average costs at HCs were determined by bootstrapping, with weighing for each health center surveyed based on the proportion of all TB patients attended in all HCs from the same stratum.

Program costs at the donor level were calculated using the expenditure records of the project. We included the cost of training HCs to receive referrals in the base case analysis. Program costs for the government were derived from expenditure records of district health offices. Government start-up costs could not be assessed for the long established health center-based strategy, but data collection included expenditures for capital items and operational costs. In addition to expenditure records, cost data were validated using staff interviews and official reports.

Service and program costs, differentiated between those funded by the government and by the donor, were then attributed to activities before diagnosis, during diagnosis, and during treatment. The program cost at donor level was attributed to pre-diagnosis, because it concerned referral of suspects by PPs, with the exception of a monitoring and evaluation component, which was dedicated to cross-checking microscopy diagnosis at HCs. Approximately half (52.2%) of the program costs, which could not be clearly attributed to one of the three groups (e.g., supervision, coordination, and general management) were equally attributed to treatment, diagnosis, and pre-diagnosis. We attributed shared program costs between the two strategies (e.g., monitoring and evaluation) as a function of the number of suspects/patients involved in the various stages, i.e., number of suspects identified in the pre-diagnosis stage, number of suspects tested in the diagnosis stage, and number of patients treated in the treatment stage.

Cost-effectiveness analysis. The aim of our study was to set up an intervention that involved the PPs in Jogjakarta province in the default current strategy of TB diagnosis and treatment at health center level and to assess its incremental cost-effectiveness. This complementary strategy of involving PPs to refer TB suspects to HCs for diagnosis and possible treatment is thus incremental to the National TB control program's existing HCs-based DOTS strategy. Hence, from the provider perspective, we first estimated the average cost-effectiveness ratios—ACER (the average cost per effect, e.g., smear-positive case successfully treated, of a strategy)—for the HCs strategy and the respective incremental cost-effectiveness ratios—ICER (the additional cost of one unit of outcome gained, e.g., smear-positive case successfully treated, by an intervention)¹⁷—for the PPs strategy, using base-case effectiveness and cost figures.

Probabilistic uncertainty analysis based on confidence limits or uncertainty ranges of individual inputs, and using 10,000 draws, was done in @Risk (version 4.5, Palisade, Newfield, NY). We identified the probability that a strategy is cost-effective using the cost-effectiveness acceptability curve (CEAC).^{18,19} The CEAC was plotted as the proportion of the ICER estimates judged to be cost-effective (i.e., the probability of PPs being accepted) over the range of values of willingness-to-pay for an additional smear-positive case successfully treated.

We set a hypothetical willingness-to-pay threshold based on the National TB control program's estimated marginal cost. The source for the marginal cost estimation was official figures,^{11,15} although the National TB control program's budget reference did not include costs of consultation for diagnosis or for the DOT visit. We excluded costs at the national and provincial level to make a valid comparison with data in this study. The difference between the remaining 2005 and 2004 costs over the difference between the number of successfully treated patients in 2005 and 2004, US\$448.61, was then used as the National TB control program's marginal cost.

We further analyzed the sensitivity of total costs to input values that are likely to be under the control of program managers. To do this, we assessed possible scenarios to the CEACs: 1) HCs already trained to manage referred TB suspects, 2) lower smear-positive rate (20%) among suspects notified by PPs in combination with HCs already trained to manage referred TB suspects, 3) lower smear-positive rate (20%) among suspects notified by PPs in combination with higher proportion of suspects reaching HCs (62%), and 4) DOT consultation cost in HCs at the most efficient observed value (US\$1.04).

Ethical issues. Informed consent was obtained from interviewed respondents. Ethical approval was given by the ethical review committee of the Faculty of Medicine, Gadjah Mada University, Indonesia.

RESULTS

Effectiveness. Out of the estimated total of 2,000 PPs in Jogjakarta province, approximately 900 attended the introductory seminar. Eventually, only 410 PPs referred suspects during the study intake period. Only two TB patients were subsequently treated by the PPs that had notified them. Because the cost structure of these PPs treated patients were completely different, and there were only two of them, we limited the evaluation of the intervention to TB suspect referral and additional (incremental) gain in TB patients successfully treated. The number of suspects (1,064) notified by the 410 PPs was much lower than the number of suspects (10,878) notified through the HCs (Figure 1). Most of the suspects (57.5%) notified and referred by PPs never reached a health center. However, the smear-positive rate among those who reached the HCs was extremely high (61.8%). In contrast, the smear-positive rate among suspects identified in the HCs was rather low (3.8%).

The PPs strategy allowed registering an additional 280 new smear-positive cases over 12 months. Thus, PPs contributed 21.4% on a total of 1,306 new smear-positive cases detected in Jogjakarta province within the corresponding period. The remaining were detected by HCs (32.2%), hospitals (24.0%), and chest clinics (22.3%). Treatment success rates among smear-positive cases notified by PPs (90.7%) and those notified by HCs (88.4%) were similar ($P = 0.324$).

FIGURE 1. Flow of tuberculosis (TB) suspects notified by private practitioners (PPs) and health centers (HCs).

Patient costs. The total cost incurred by a successfully treated smear-positive patient was significantly higher ($P=0.01$) among those having been referred by PPs (US\$82.95) compared with those who presented immediately to HCs (US\$33.75) (Table 1). The main cost burden was out-of-pocket service payments for both patients notified by PPs (63.1%) and those notified by HCs (55.7%). Patients notified by PPs had to spend much more compared with patients notified by HCs on laboratory and consultation fees before DOT (3.89 times) and other drugs during DOT (2.54 times). Total of costs other than out-of-pocket service payments was higher as well among patients notified by PPs (US\$30.65) than HCs patients (US\$14.94).

Sensitivity analysis on the total patient cost ratio between the two strategies indicates that our estimate is robust to changes across a number of key variables (Figure 2). Only when the cost for laboratory and consultation before DOT in patients referred by PPs is at the lower bound of the 95% CI,

FIGURE 2. Sensitivity analysis for patient cost. This figure appears in color at www.ajtmh.org.

costs to patients notified by PPs are not substantially higher than to those notified by HCs.

Provider costs. The service unit costs incurred at HCs are provided in Table 2. Private practitioners notified patients had a lower frequency of DOT visits (12.1; 95% CI 11.0–13.3) compared with HCs patients (14.1; 95% CI 13.2–15.0).

Overall, before allocation to the two strategies, funding for program cost at the donor level was US\$51,446.35 compared with US\$30,129.19 for the Ministry of Health (Table 3). Most of the donor funding was for supervision (37.8%). In contrast, supervision received the least funding from the Ministry of Health (1.0%). The largest allocation from the Ministry of Health was given to incentives for patient treatment completion (30.1%).

The total 1 year cost was US\$119,658.68 for the HCs strategy, whereas the total 1 year incremental cost was US\$89,320.45 for the PPs strategy (Table 4). The largest share of total cost for the HCs strategy was diagnosis-related cost, 46.6%, in contrast to 0.4% for PPs strategy. The cost related to activities

TABLE 1
Patient costs per smear-positive tuberculosis (TB) patient in Jogjakarta, Indonesia*

Cost category	PP (N = 50)		HC (N = 58)		Ratio (PP: HC) [<i>P</i> value*]
	Absolute (US\$) (95% CI*)	Relative (%)	Absolute (US\$) (95% CI*)	Relative (%)	
Out-of-pocket service payments					
<i>Before DOT</i>					
Laboratory and consultation	36.57 (5.52–68.60)	44.1	9.41 (5.63–13.18)	27.9	3.89 [0.07]
Drugs	7.89 (3.95–11.77)	9.5	7.15 (1.84–12.47)	21.2	1.10 [0.84]
<i>During DOT</i>					
Follow-up sputum smear	3.27 (1.08–5.46)	6.3	0.45 (0.00–0.91)	2.4	7.27 [0.02]
Other drugs	4.57 (0.00–10.62)	5.5	1.80 (0.00–4.10)	5.3	2.54 [0.40]
<i>Sub-total</i>	52.30 (18.92–86.62)	63.1	18.81 (9.94–27.69)	55.7	2.56 [0.05]
Other costs					
Lost earnings	18.54 (5.77–34.27)	22.3	6.35 (1.08–11.62)	18.8	2.92 [0.09]
Transport	10.93 (6.82–16.66)	13.2	7.65 (4.83–10.48)	22.7	1.43 [0.17]
Attendants	1.18 (0.44–2.12)	1.4	0.93 (0.21–1.65)	2.8	1.27 [0.55]
<i>Sub-total</i>	30.65 (16.24–49.83)	36.9	14.94 (9.19–20.68)	44.3	2.05 [0.05]
Total	82.95 (49.01–122.60)	100.0	33.75 (21.93–45.58)	100.0	2.34 [0.01]

* PP = private practitioner; HC = health center.

TABLE 2

Average and incremental service unit cost (US\$) at health centers in Jogjakarta, Indonesia

Cost component		Unit cost	Standard deviation	95% confidence interval	
				Low	High
Consultation for diagnosis	Average	1.51	0.29	0.90	2.03
	Incremental	0.03	0.01	0.02	0.05
Consultation for DOT	Average	5.70	0.62	4.30	6.63
	Incremental	5.70	0.62	4.30	6.28
Smear microscopy (per slide)	Average	0.99	0.15	0.73	1.30
	Incremental	0.21	0.02	0.17	0.26

before diagnosis made up the largest share, 68.1%, of total cost for the PPs strategy, whereas for the HCs strategy it was 8.8%. For both strategies the second largest share of the total was related to patient treatment, which was 31.6% for PPs strategy and 45.0% for HCs strategy.

Cost-effectiveness. Average Cost-Effectiveness Ratio per smear-positive case successfully treated for the HCs strategy was US\$321.66 (95% CI 190.71–342.99), whereas Incremental Cost-Effectiveness Ratio per smear-positive case successfully treated for the PPs strategy was US\$351.66 (95% CI 322.84–601.33) (Table 5).

At a willingness-to-pay threshold for a smear-positive case successfully treated of US\$448.61 (the estimated National TB control program's marginal cost in 2004–2005), the PPs strategy was incrementally cost-effective in 66.8% of simulation iterations (Figure 3). Adjusting the DOT consultation cost in HCs to the most efficient observed value (US\$1.04) increased this percentage to 83.1%, whereas lowering the smear-positive rate to 20% and increasing the proportion of suspects who reached the HCs to 62% reduced the percentage to 63.1%. Lowering the willingness-to-pay threshold obviously reduces all the above percentages and at, for instance, US\$400 the PPs strategy is less than 50% likely to be cost-effective in most scenarios.

DISCUSSION

Our results suggest that involving PPs in a well-functioning public DOTS program (case detection rate > 70%; treatment

success rate > 85%) to have them refer TB suspects to HCs for diagnosis and eventual treatment can contribute to increasing case findings and effective TB treatment. Notwithstanding, the incremental cost-effectiveness of the PPs involvement strategy can be acceptable in particular settings and from a provider perspective when compared with the National TB control program's estimated marginal cost for successfully treating an extra patient or to a reasonable willingness-to-pay figure for such a result. This is quite likely to be the case in Jogjakarta, in a context where a low proportion of suspects referred by PPs actually reached HCs, an exceptionally high smear-positive rate among them and overcapacity in the National TB control program that permits to absorb the extra patient load.

Our analysis has some limitations. First, and most importantly, as in general the case in publications on the subject, our evaluation assessed the intervention after not more than 12 months of implementation. Repeating the assessment at a later time should provide information on both performance and sustainability under more routine conditions. Second, some variables were estimated imprecisely, which may have influenced the cost-effectiveness estimates. For instance, the cost for DOT consultation used relied on HCs staff reports on the percentage of time devoted to TB care, which yielded highly variable results. Because HCs staffs in Jogjakarta are, in general, underused, the overall personnel costs for TB diagnosis and treatment in HCs are over inflated and we may have captured costs that reflect, in fact, unused capacity. This, and other potential biases, cannot be fully addressed through sensitivity analysis. Third, a number of potential benefits, in particular new TB infections prevented, were not included because they were beyond the scope of the study. Finally, our findings may not be directly generalized to other settings because the epidemiology, health system characteristics, and socio-economic context may differ. Notwithstanding, generalization can at the least be considered to other high TB burden settings, particularly in Asia, with low-middle income economic, substantial presence of PPs, and a relatively well-functioning DOTS services in the public sector.

The PPs strategy in Jogjakarta contributed a considerable fraction (21%) of the new smear-positive TB cases detected in the province during the study period. Increases in TB case notification after involvement of private providers have also been reported by studies in Vietnam (18%),²⁰ Nepal (92%),²¹ India (11%),²² and Myanmar (21%).²³ The differences between these increases are likely caused by differences of context (e.g., TB incidence, baseline case notification, care seeking behavior), general intervention characteristics and task mix (e.g., suspect referral, treatment by PPs), and output (e.g., number, type and distribution of private providers effectively engaged). Furthermore, it is not appropriate to fully attribute the incremental effectiveness in all these studies to the PPs strategies. In Jogjakarta, earlier study indicates that PPs were already referring suspects to HCs before the implementation of PPs strategy.¹⁴ Additionally, we cannot infer from our study whether some of the TB suspects identified by PPs would have ended up in the HCs, or not, regardless of the intervention. Others have suggested that the potential benefit of involving private providers is mainly in terms of shortening diagnosis or treatment delay and not so much in increasing case detection.^{24,25} Whether the former effect applies in our case will need to be substantiated through further research. In any case, the additional yield we documented represents an

TABLE 3

Program cost (annual average) by source of funding before allocation to private practitioners (PPs) and health centers (HCs) strategy in Jogjakarta, Indonesia

Cost component	Ministry of Health		Donor	
	Absolute (US\$)	Relative (%)	Absolute (US\$)	Relative (%)
Start-up cost*	—	—	7,182.53	14.0
Staff	5,809.13	19.3	10,808.99	21.0
Routine training	6,712.10	22.3	—	—
Supervision	300.99	1.0	19,462.82	37.8
Information, education, communication	5,327.54	17.7	3,433.48	6.7
Monitoring & evaluation	2,287.53	7.6	1,194.53	2.3
Coordination & general management	632.08	2.1	9,364.00	18.2
Treatment incentive	9,059.83	30.1	—	—
Total	30,129.19	100.0	51,446.35	100.0

* Start-up cost was annualized and included start-up training (for private practitioner [PP] strategy).

TABLE 4

Incremental provider costs for the private practitioners (PPs) strategy and average provider costs for the health centers (HCs) strategy in Jogjakarta, Indonesia*

Cost component	Incremental PP costs		Average HC costs	
	Absolute (US\$)	Relative (%)	Absolute (US\$)	Relative (%)
Cost before diagnosis				
<i>Service costs</i>	–	–	–	–
<i>Program costs</i>				
IEC (MOH)	–	–	5,327.54	4.5
IEC (donor)	3,433.48	3.8	–	–
Staff (MOH)	–	–	1,936.38	1.6
Staff (donor)	10,808.99	12.1	–	–
Routine training (MOH)	–	–	2,237.37	1.9
Supervision (MOH)	–	–	100.33	0.1
Supervision (donor)	19,462.82	21.8	–	–
Monitoring & evaluation (MOH)	–	–	210.69	0.2
Coordination & general management (MOH)	–	–	210.69	0.2
Coordination & general management (donor)	9,364.00	10.5	–	–
Start-up (donor)	12,450.23	13.9	–	–
<i>Sub total before diagnosis</i>	60,787.21	68.1	10,574.82	8.8
Costs for diagnosis				
<i>Service costs</i>				
Consultation for diagnosis	13.00	0.0	16,398.49	13.7
Sputum smear	290.51	0.3	32,418.59	27.1
<i>Program costs</i>				
Staff (MOH)	–	–	1,936.38	1.6
Routine training (MOH)	–	–	2,237.37	1.9
Supervision (MOH)	–	–	100.33	0.1
Monitoring & evaluation (MOH)	–	–	762.51	0.6
Monitoring & evaluation (donor)	47.76	0.1	1,146.77	1.0
Coordination & general management (MOH)	–	–	210.69	0.2
<i>Sub-total diagnosis</i>	351.27	0.4	55,211.12	46.1
<i>Sub-total before treatment (before diagnosis + diagnosis)</i>	61,138.48	68.5	65,785.94	55.0
Cost for treatment				
<i>Service costs</i>				
Consultation for DOT	18,406.78	20.6	32,138.33	26.9
Follow-up sputum smear	341.17	0.4	2,383.86	2.0
DOT drug	7,345.82	8.2	11,044.97	9.2
<i>Program costs</i>				
Staff (MOH)	–	–	1,936.38	1.6
Routine training (MOH)	–	–	2,237.37	1.9
Supervision (MOH)	–	–	100.33	0.1
Monitoring & evaluation (MOH)	–	–	762.51	0.6
Coordination & general management (MOH)	–	–	210.69	0.2
Treatment incentive (MOH)	2,088.20	2.3	3,055.70	2.6
<i>Sub-total treatment</i>	28,181.97	31.6	53,872.74	45.0
Total cost	89,320.45	100.0	119,658.68	100.0

* MOH = Ministry of Health; DOT = Directly Observed Treatment; IEC = information, education and communication.

achievement under pilot conditions and one can expect some waning of effect after the intervention becomes institutionalized. Furthermore, the yield we observed is related to key intervention features: intensive dialogue with key stakeholders, generalized strong commitment to support and supervise implementation, a local intermediary (university) that facilitated the partnership between PPs and the National TB control program. Such enabling factors have also been identified as a key to success in other Public-Private Mix DOTS projects.^{26,27} Thus, a first consideration for those wishing to scale up

or replicate our intervention is to what extent these conditions can be ensured.

Notably, in our study most (67.5%) of the suspects referred by PPs did not reach the HCs and we do not know their fate. Loss during referral of suspects identified by PPs has previously been documented in Vietnam (30%)²⁰ and India (10%).²² The heavy loss in our study suggests that patients attending private practices may not like being referred to public HCs, which is possibly caused by a negative perception of their service quality. Alternatively, some of our patients may have not

TABLE 5

Incremental cost-effectiveness ratios (ICERs) for private practitioners (PPs) and average cost-effectiveness ratios (ACERs) for health centers (HCs) strategies in Jogjakarta, Indonesia

Indicator	PP		HC	
	ICER	95% CI	ACER	95% CI
Cost before diagnosis per suspect tested	134.19	49.78–242.30	0.97	0.73–7.26
Cost before treatment per smear-positive case detected	218.35	194.49–444.34	156.26	50.13–168.48
Total cost per smear-positive case successfully treated	351.66	322.84–601.33	321.66	190.71–342.99

FIGURE 3. Acceptability curve for cost-effectiveness per successfully treated smear-positive case. This figure appears in color at www.ajtmh.org.

perceived their symptoms as sufficiently severe to warrant the extra effort of attending a HC. In the Hospital DOTS Linkage project in Jogjakarta, loss of TB patients referred from hospitals to HCs for treatment was initially 24% (2002), but has been reduced to 11% by 2004.¹³ Hence, there may be a scope for increasing patient motivation to accept referral. Ensuring adequate patient counseling by PPs on the importance of proper diagnosis and treatment may achieve this. One may argue, however, that such an attempt would increase costs. In any case, there is certainly a need for operations research on strategies to minimize losses during referral to HCs.

The smear-positive rate we documented among suspects notified by PPs that reached the HCs was extremely high (61.8%) and are in sharp contrast with the rate in suspects notified by HCs (3.8%). A similar observation was made in a study in India.²² The authors suggest that their high smear-positive rate was a result of PPs being highly selective in making referrals. This is also a plausible explanation in Jogjakarta (besides the auto-selection of patients discussed previously); regretfully, we could not ascertain the proportion of PPs actually adhering to the National TB control program's criteria for TB suspect to substantiate this further. Nonetheless, the high smear-positive rate coupled with a high loss of patients during referrals suggests missed opportunities to detect a significant number of cases. The smear-positive rate among suspects identified in HCs on the other hand was far below the International Union against Tuberculosis and Lung Disease's recommended 10%.²⁸ This indicates that the HCs are not selective enough when screening, which might be a consequence of the National TB control program's pressure to boost the case detection rate toward the international target of 70%.

Our estimate of payments made by patients and their attendants show that the financial burden among those first attending PPs are substantially higher than among those directly consulting HCs. Sensitivity analysis corroborates these findings. They are in line with the findings from a comparable study in India⁷; however, the latter study reported that costs incurred during TB treatment comprised the majority of costs borne by the patients (67%). In contrast, in Jogjakarta most of the patient costs were out-of-pocket service payments before the start of DOT, in particular for suspects notified through

PPs (63.1%). The majority of the payments (53.6%) by these patients were for laboratory consultations and non-TB drugs. This suggests that they are initially managed for other diseases before eventually being referred to a health center with suspicion of TB. As mentioned, this could at the same time explain the extremely high smear-positive rate reported among those eventually tested.

When interpreting provider costs, it should be kept in mind that we estimated average costs for the HCs strategy but incremental costs for the PPs strategy. In addition to the cost for general supervision and project staff, the main driver of provider-side cost for involving PPs in Jogjakarta is regular supervision. The importance hereof and of follow-up with PPs to secure participation has also been noted in the Public-Private Mix projects in Nepal²¹ and India.²⁷ Replacing the specifically trained and dedicated personnel we hired for the study with HCs staff (given additional incentives) could, to some extent, reduce supervision costs. However, given the hierarchy between physician and non-physician health workers, such an approach could be less acceptable to PPs and less effective.

Furthermore, the start-up costs (although annualized), were much higher for the PPs strategy because it was a newly launched strategy (with high upfront investment costs), which involved donor-paid special staff. In contrast, the HCs strategy had been established over a decade ago and the HCs strategy relies on staff paid (low) government salaries. The cost for diagnosis in the PPs strategy, on the contrary, was low. This was a function of volume (number of suspects tested) and unit cost. The unit cost, notably, is an incremental cost and because the suspects were referred to HCs for technical and laboratory examinations, there were little incremental costs involved.

Our willingness-to-pay threshold was set as equivalent to the National TB control programs estimated 2004–2005 marginal costs, which did not include consultation costs. If these would be included, the marginal cost could shift upward, depending on the volume of unused capacity described previously, which could lead to a higher probability of the PPs strategy being “accepted.” On the other hand, the National TB control program's marginal cost encompasses activities in all provinces in Indonesia. This includes provinces with hard-to-reach areas, which drive national cost upward, but could be justified on equity grounds. It is further unlikely that there are sufficient private providers in remote areas to justify a Public-Private Mix strategy. Comparing incremental cost-effectiveness of Public-Private Mix in Jogjakarta to a national marginal cost figure increases the likelihood of a favorable finding: the marginal cost in provinces with better infrastructure is lower and would constitute the appropriate comparison. Notwithstanding, roughly 80% of the country's population in 2005 lived on Java and Sumatra islands where the infrastructure is generally more advanced.²⁹ Therefore, even if one could adjust the National TB control program's marginal cost for provincial infrastructure, the result might not substantially differ from the current estimate. At any rate, the installed public HCs capacity is a major determinant of the favorable Incremental Cost-Effectiveness Ratio in our PPs strategy.

The efficiency of this strategy also hinges on a very high smear-positive rate in patients referred to HCs. This figure raises concern over a substantial number of TB suspects not referred because PPs in the province do not treat in accordance to the national guideline.¹⁴ Furthermore, there is also concern over the large proportion of referred suspects who

never reached HCs, and in the end may not have received standard TB treatment. Ultimately, effectiveness of TB control concerns reduction of transmission,³⁰ which is influenced by the number of not treated or not adequately treated cases. If efficiency should not trump effectiveness, there is definitely much to be desired from the effectiveness of the PPs strategy in a broader sense.

Finally, our cost-effectiveness estimate for the PPs strategy is incremental to the cost-effectiveness of the HCs strategy, the backbone of the National TB control program. However, our analysis also suggests that the efficiency of the HCs strategy could be improved. Financial gaps in Indonesia's National TB control program until now have been met through support from the Global Fund to fight AIDS, TB, and Malaria. Concerns for efficiency in public health services, along with increased local political commitment for their financing, will assure the National TB control program sustainability.

In summary, we have shown that an intervention to engage PPs to refer TB suspects to DOTS services can be introduced relatively successfully, that this led to detecting or at least notifying many additional smear-positive cases, and that it formed a path for a significant number of such cases into the National TB control program, where they had excellent treatment outcomes. Most importantly, we have showed that our intervention was cost-effective, albeit under specific conditions and given high commitment for intensive dialogue and supervision. Before scaling up or replicating our intervention, one should consider these enabling factors, but also ways to ensure better screening by PPs and referral effectiveness, possible alternative strategies (e.g., community participation, involvement of hospitals), and the need for strengthening of the public sector. We recommend National TB control programs in resource-limited settings to first, and foremost, carry out a thorough appraisal of the DOTS services delivered through public health facilities. There is still considerable room for improvement. Priority for any substantial investments should be given to ensuring that services are delivered effectively and efficiently by the public sector. Cost-effectiveness of Public-Private Mix is incremental and the generic pre-condition remains a well-functioning public DOTS program.^{4,7,31}

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