

Costs of measures to control tuberculosis/HIV in public primary care facilities in Cape Town, South Africa

Harry Peter Hausler,^a Edina Sinanovic,^b Lilani Kumaranayake,^c Pren Naidoo,^d Hennie Schoeman,^e Barbara Karpakis,^d & Peter Godfrey-Faussett^c

Objective To measure the costs and estimate the cost-effectiveness of the ProTEST package of tuberculosis/human immunodeficiency virus (TB/HIV) interventions in primary health care facilities in Cape Town, South Africa.

Methods We collected annual cost data retrospectively using ingredients-based costing in three primary care facilities and estimated the cost per HIV infection averted and the cost per TB case prevented.

Findings The range of costs per person for the ProTEST interventions in the three facilities were: US\$ 7–11 for voluntary counselling and testing (VCT), US\$ 81–166 for detecting a TB case, US\$ 92–183 for completing isoniazid preventive therapy (IPT) and US\$ 20–44 for completing six months of cotrimoxazole preventive therapy. The estimated cost per HIV infection averted by VCT was US\$ 67–112. The cost per TB case prevented by VCT (through preventing HIV) was US\$ 129–215, by intensified case finding was US\$ 323–664 and by IPT was US\$ 486–962. Sensitivity analysis showed that the use of chest X-rays for IPT screening decreases the cost-effectiveness of IPT in preventing TB cases by 36%. IPT screening with or without tuberculin purified protein derivative screening was almost equally cost-effective.

Conclusion We conclude that the ProTEST package is cost saving. Despite moderate adherence, linking prevention and care interventions for TB and HIV resulted in the estimated costs of preventing TB being less than previous estimates of costs of treating it. VCT was less expensive than previously reported in Africa.

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Introduction

With an antenatal human immunodeficiency virus (HIV) prevalence of 29.5% and an estimated 6.29 million people infected,¹ South Africa has the largest number of people living with HIV/acquired immunodeficiency syndrome (AIDS) in the world.² HIV increases tuberculosis (TB) incidence by reactivation of latent infection³ and rapid progression of recent infection.⁴ With increasing HIV prevalence, TB incidence has risen throughout sub-Saharan Africa.^{5,6} In South Africa, the incidence of TB increased from 187/100 000 in 1989⁷ to 599/100 000 in 2004.⁸

Following the recommendations by national reviews for improved collaboration between the TB and HIV/AIDS programmes in South Africa,^{9,10} four TB/HIV Pilot Districts were initiated in 1999. These districts participated in ProTEST,¹¹ a WHO supported package

of TB/HIV interventions by providing voluntary counselling and testing (VCT) with rapid HIV testing, screening for TB through intensified case-finding (ICF), isoniazid preventive therapy (IPT), cotrimoxazole preventive therapy (CPT), and improved management of opportunistic infections. ProTEST aimed to decrease the transmission of HIV through VCT, decrease the transmission of TB through ICF and prevent the reactivation of TB through IPT.¹²

Cost and cost-effectiveness data for ProTEST interventions are important for programme managers to decide what is affordable for expanded implementation. The data are relevant in the era of antiretroviral treatment (ART) programmes because VCT is necessary to identify HIV-infected persons and ICF, IPT and CPT remain part of the comprehensive package of HIV care. There are few studies in developing countries

on the cost-effectiveness of VCT,¹³ rapid HIV testing,¹⁴ IPT^{15–19} and CPT.²⁰

We measured the costs and estimated the cost-effectiveness of the ProTEST package of TB/HIV interventions in Cape Town, South Africa.

Methods

Setting

The Central District of Cape Town, with a population of 296 000, consists of urban/peri-urban areas with vast socio-economic disparities. The antenatal HIV prevalence was 17% in 2001 and the TB incidence was 488/100 000 in 2002.²¹

Using purposive sampling, we chose three public primary health care facilities — a community health centre (CHC), a primary health care (PHC) clinic and a sexually transmitted infections (STI) clinic — from the 12 facilities that participated in ProTEST (Table 1, web version only, available from: [^a School of Public Health, University of the Western Cape, PO Box 51093, Cape Town 8002, South Africa. Correspondence to this author \(email: \[hhausler@uwc.ac.za\]\(mailto:hhausler@uwc.ac.za\)\).](http://www.</p></div><div data-bbox=)

^b Health Economics Unit, School of Public Health and Family Medicine, University of Cape Town, South Africa.

^c London School of Hygiene and Tropical Medicine, London, England.

^d Cape Town Administration, City of Cape Town, South Africa.

^e Independent consultant, Cape Town, South Africa.

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who.int/bulletin). All facilities promoted VCT to self-presenting and antenatal clients as well as TB and STI patients, and provided improved management of HIV-related infections. The CHC and PHC clinic also offered ICF (TB symptom screening for HIV-positive patients, and sputum smear investigations as well as chest X-ray for TB symptomatics), IPT (isoniazid 300 mg daily for six months for HIV-positive patients with no TB symptoms, a normal chest X-ray, and a positive tuberculin skin test) and CPT (life-long cotrimoxazole 480 mg daily for patients with HIV/AIDS, WHO clinical stage III or IV) (Fig. 1). We evaluated only VCT in the STI clinic and the complete ProTEST package in the CHC and PHC clinics.

Cost analysis

Following the *Costing guidelines for HIV/AIDS prevention strategies* developed by UNAIDS,²² we collected the costs incurred by public and nongovernmental organization (NGO) health-care providers retrospectively, using ingredients-based costing, i.e. costing each component of an activity, including capital and recurrent costs for one financial year. Financial costs represented actual expenditure, while economic costs were financial costs plus the estimated value of goods or services with no financial transactions and some adjusted financial costs when the price paid did not reflect the cost of using it elsewhere.

We did not include the costs of research. We could not measure the costs of drugs used in the treatment of opportunistic infections because they could not be separated from drugs that were dispensed for other infections. The costs of diagnostic tests for HIV and TB and the costs of prophylactic drugs were included. Start-up costs, including initial training costs, were regarded as capital costs because the effect of the activities lasted for more than a year. We annualized the capital costs using a discount rate of 8% (the discount rate most widely used in South Africa for that time),²³ assuming that the life-span of buildings is 30 years, furniture 10 years, equipment and vehicles five years and initial training five years. Life-spans were estimated based on consultations with district health officials.

Sources of recurrent cost data included financial records and interviews with project staff. Costs are presented in US\$ (US\$ 1 = R 9.28, exchange rate for

South African rand for the period April 2001 to March 2002).²⁴

Total costs were apportioned to the following project activities: health education, pre-test counselling, HIV testing, post-test counselling, screening for IPT/CPT, follow-up for IPT/CPT, management of opportunistic infections (OIs) and supervision/training/mentorship. All counsellor salary costs were allocated to VCT. We calculated the weighted average personnel cost per minute from estimates made by clinical staff of the proportion of time that they spent on ProTEST. We also interviewed clinical staff to estimate the average amount of time they spent on screening and follow-up of a client for prophylaxis. This time multiplied by the cost per minute multiplied by the number of clients gave the costs for screening and follow-up. Other costs (such as buildings, furniture, equipment, vehicles and maintenance) of the health services were multiplied by the proportion of all clinic visits that were for ProTEST to determine the amount that should be allocated to ProTEST. We divided these costs equally between project activities.

Estimating impact

Since we could not measure the efficacy of ProTEST interventions directly, results from recently published efficacy studies were used to estimate the impact of interventions, with special attention to studies done in African countries with a high burden of TB and HIV.

To estimate the cost per HIV infection averted, we used the results of a recent multicentre randomized controlled trial of VCT, which found that VCT decreased risk behaviours and estimated that for every 100 people accessing VCT, 10 HIV infections are averted (in sensitivity analyses, this ranged from 1 to 24 HIV infections averted).¹³

We developed a model that used the risk of primary TB disease after infection and risk of reactivation of latent TB infection in HIV-positive and HIV-negative adults,^{25–31} for estimating the number of TB cases averted each year (over a period of 10 years), by preventing HIV infection. We estimated that for every 100 people accessing VCT, 10 HIV cases and 5.2 TB cases would be prevented over 10 years.

For estimating the cost per TB case prevented through ICF it was assumed that every TB case infects 10–14 people per year and results in one more TB

case,³² that ICF might decrease the infectious period from 9.6 months in HIV-infected people³³ by 30%, and that 85% of detected cases will remain non-infectious (successfully treated or died).³⁴ For every 100 TB cases detected by ICF, 25 TB cases would be prevented.

For IPT using tuberculin purified protein derivative (PPD) tests for screening, the estimated cost per TB case averted was based on the following conservative assumptions: IPT decreases TB incidence by 60% (95% confidence interval (CI): 35–76%) for two years in PPD-positives (results from a meta-analysis of intention to treat clinical trials with 60–80% adherence),³⁵ annual incidence of TB in PPD-positive HIV-positive people is 8%; and each HIV-positive TB case causes one other case. Assuming similar efficacy to clinical trials, for every 100 people completing IPT using PPD screening, 19 (95% CI: 11–24) TB cases are averted.

Sensitivity analysis

We considered the cost-effectiveness of different screening protocols (including the WHO recommended protocol³⁶) in the sensitivity analysis and included discounting the cases of TB prevented in the future by VCT in the sensitivity analysis at a discount rate of 5% cumulatively over 1 to 10 years.^{37,38} We also conducted univariate sensitivity analyses with several variables for the PHC clinic.

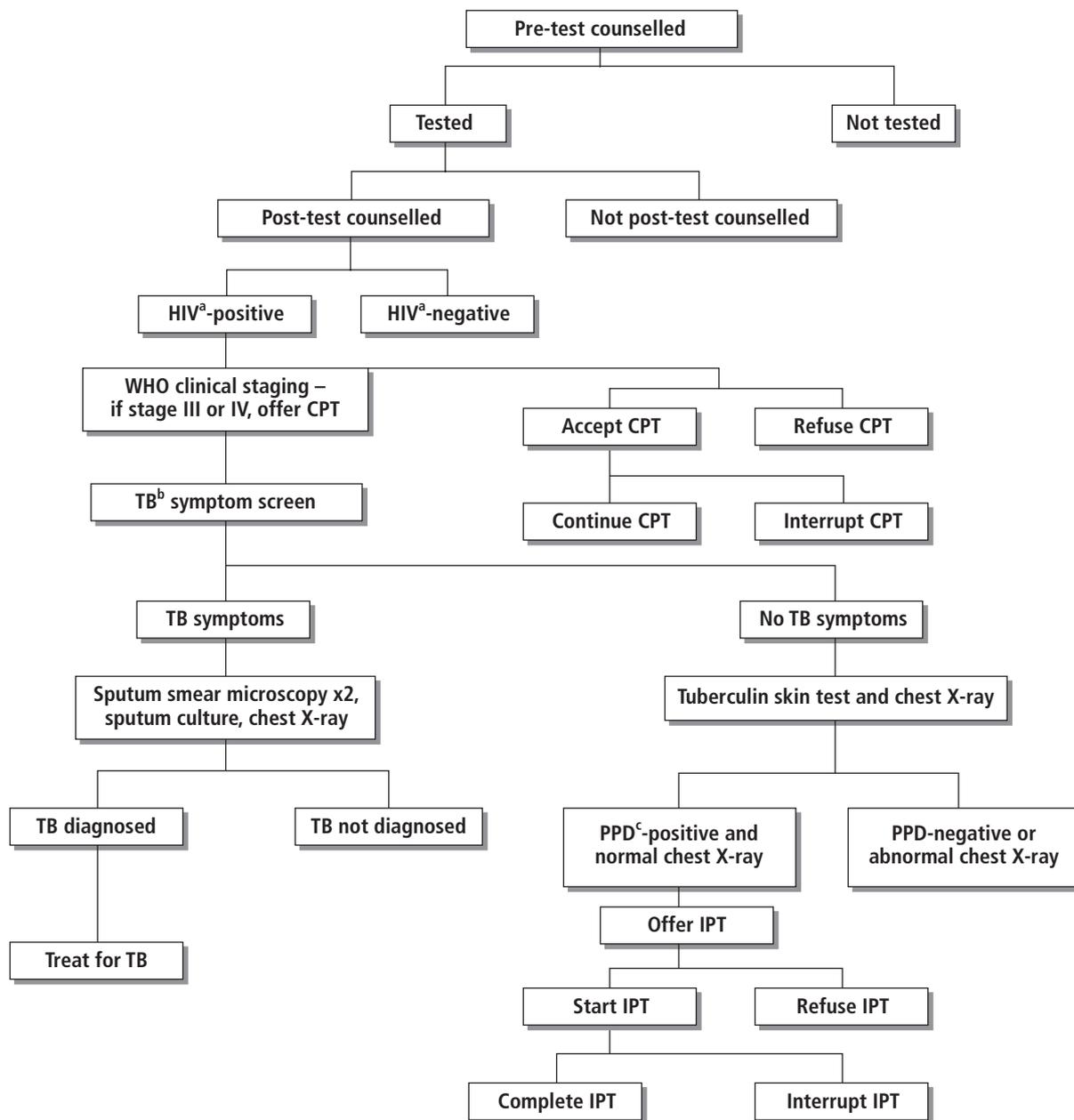
Findings

Cost analysis

All costs are given in US dollars (US\$). The unit costs were US\$ 1.07 for an HIV screening test, US\$ 2.01 for an HIV confirmatory test, US\$ 3.29 for an HIV enzyme-linked immunosorbent assay (ELISA), US\$ 2.20 for a sputum smear examination for TB, US\$ 5.12 for a sputum TB culture, US\$ 14.43 for a chest X-ray, US\$ 0.73 for a PPD test; US\$ 0.27/month for isoniazid; and US\$ 0.40/month for cotrimoxazole.

The summary of total costs is given in Table 2 (web version only, available from: <http://www.who.int/bulletin>). We found that the total economic cost for one year of ProTEST activities was US\$ 21 623 in the CHC, US\$ 47 280 in the PHC clinic and US\$ 36 575 in the STI clinic. The highest costs were associated with the management of OIs in facilities offering comprehensive clinical services followed by VCT services (the sum of

Fig. 1. Flow chart for voluntary counselling and testing (VCT), cotrimoxazole preventive therapy (CPT), intensified TB case-finding (ICF), isoniazid preventive therapy (IPT), Central District, Cape Town



^aHIV = human immunodeficiency virus.

^bTB = tuberculosis.

^cPPD = tuberculin purified protein derivative skin test.

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pre- and post-test counselling and testing). The combined cost of screening and follow-up for IPT and CPT was similar to the cost of TB/HIV/STI education. Start-up and coordination costs were low. Financial costs were slightly higher than economic costs in the PHC clinic and STI clinic because NGO counsellor salaries (actual costs, considered “financial”) were higher than the government coun-

sellor salaries (costs required for scaling up, considered “economic”).

Personnel costs accounted for a much higher proportion of the total costs than the cost of supplies: 82% versus 12% in the CHC, 85% versus 11% in the PHC clinic and 78% versus 17% in the STI clinic. Other capital costs (1% in all), and recurrent vehicle and building costs (1% in the CHC and

PHC clinic and 2% in the STI clinic) were small.

The STI clinic had the largest number of VCT clients (Table 3, web version only, available from: <http://www.who.int/bulletin>). At all sites, most people who received pre-test counselling were tested for HIV (97–99%). HIV prevalence was lower in the CHC (20%) and STI clinic (21%) than in the PHC clinic

Table 4. Economic unit costs for tuberculosis/human immunodeficiency virus (TB/HIV) interventions at each selected site, Central District, Cape Town, 2001–02 (in US\$)

Economic cost	Community health centre (CHC)	Primary health care (PHC) clinic	Sexually transmitted infections (STI) clinic
Voluntary counselling and testing (VCT)			
Cost per person pre-test counselled ^a	3	4	2
Cost per person tested for HIV ^b	3	4	3
Cost per person post-test counselled ^c	3	3	1
Isoniazid preventive therapy (IPT) and intensified case finding (ICF) for TB			
Cost of screening per person screened for IPT/TB ^d	12	7	Not available
Cost of screening per person started IPT (incremental to ICF) ^e	42	24	Not available
Cost of screening per person started IPT (including ICF) ^f	74	47	Not available
Cost of 6 person months of IPT ^g	9	6	Not available
Cotrimoxazole preventive therapy (CPT)			
Cost of screening per person screened for CPT ^h	2	1	Not available
Cost of screening per person started on CPT ⁱ	5	2	Not available
Cost of 6 person months of CPT ^j	8	6	Not available
ProTEST			
Cost per person accessing ProTEST ^k	24	31	9

^a Cost of pre-test counselling/number of people pre-test counselled.

^b Cost of testing/number of people tested.

^c Cost of post-test counselling/number of people post-test counselled.

^d Cost of screening asymptomatics for TB (chest X-ray, 2 smears, one culture) plus cost of screening asymptomatics for IPT (Mantoux, chest X-ray)/number of people screened for prophylaxis. Assume 4 minutes to screen symptomatic for TB and 8 minutes to screen asymptomatic for IPT.

^e Cost of screening asymptomatics for IPT/number of people who were given first month of IPT.

^f Cost of screening asymptomatics and symptomatics/number of people who received first month supply of IPT.

^g Cost of providing 6 months of IPT to those eligible (incremental to screening)/number of people completing 6 months of IPT if 100% adherence.

^h Cost of screening for CPT/number of people screened for CPT. Assume 8 minutes to screen for CPT (clinical staging).

ⁱ Cost of screening for CPT/number of people given first month supply of CPT.

^j Cost of providing 6 months of CPT to those eligible (incremental to screening)/number of people completing 6 months of CPT if 100% adherence.

^k Total costs of ProTEST/number of people pre-test counselled.

(27%). The 34 TB cases identified by ICF represented 4% of the 781 cases registered at the PHC clinic over the same period. All TB cases diagnosed at the CHC were referred to a TB clinic; the numbers referred were not recorded. The PHC clinic screened the highest numbers for prophylaxis and achieved better adherence rates than the CHC. The proportion of screened HIV-positive clients who started IPT was 15–16% and those who started CPT was 38–57%.

Our results showed that the unit costs were similar for VCT but lower for ICF, IPT and CPT in the PHC clinic compared to the CHC (Table 4). The cost per six person-months of providing prophylaxis after screening was US\$ 6–9 for IPT and US\$ 6–8 for CPT.

The cost per person completing VCT ranged from US\$ 7 to US\$ 11 (Table 5). The cost per TB case detected and cost per person completing six months of prophylaxis were about half as expensive at the PHC clinic than at the CHC.

Estimating impact

We found that the estimated cost per HIV infection averted through VCT ranged from US\$ 67 in the STI clinic to US\$ 112 in the CHC. The estimated cost per TB case prevented was US\$ 129–215 by VCT, US\$ 323–664 by ICF and US\$ 486–962 by IPT (Table 5).

Sensitivity analysis

The discounted health effect of VCT was 3.7 TB cases prevented for every 100 people completing VCT compared to 5.2 TB cases prevented with no discounting. This increased the cost per TB case prevented by VCT to US\$ 181–302.

Follow-up interviews with managers and staff showed that staff overestimated the time spent for each intervention when they used time sheets. The sensitivity analysis showed higher costs for all interventions when using time sheets (Table 6, web version only, available from: <http://www.who.int/bulletin>).

Lay counsellors and rapid HIV testing were more cost-effective as our results

showed that using nurse counsellors increased the cost per person post-test counselled by 182% and using ELISA increased the cost by 23%.

The cost per person completing IPT and the cost per TB case prevented were affected by changes in the screening protocol. Removing chest X-ray from the IPT screening protocol decreased the cost per TB case detected by 40% and decreased the cost per person completing IPT by 36% (Table 6).

Discussion

Cost analysis

Our findings show that total costs varied widely among the facilities and reflected the number and category of staff involved, the services offered, HIV prevalence and the number of clients. Personnel accounted for the highest proportion (78–85%) of total costs due to the labour-intensive nature of VCT and HIV clinical care. Cost of supplies was a much lower proportion of total costs (11–17%) reflecting the low cost of rapid

Table 5. Cost-effectiveness indicators for tuberculosis/human immunodeficiency virus (TB/HIV) interventions at each selected site, Central District, Cape Town, 2001–02 (in US\$)

	Community health centre (CHC)	Primary health care (PHC) clinic	Sexually transmitted infections (STI) clinic
Cost per person completing voluntary counselling and testing (VCT) ^a	9	11	7
Cost per TB case detected through intensified TB case-finding (ICF) ^b	166	81	Not available
Cost per person completed 6 months of isoniazid preventive therapy (IPT) in 8 months (incremental to ICF) ^c	110	51	Not available
Cost per person completed 6 months of IPT in 8 months (including ICF) ^d	183	92	Not available
Cost per person completing 6 months of cotrimoxazole preventive therapy (CPT) in 8 months ^e	44	20	Not available
Estimated cost per HIV infection averted			
Cost per HIV infection averted by VCT (range from sensitivity analysis ^f) ^g	93 (39–928)	112 (47–1118)	67 (28–668)
Estimated cost per TB case prevented			
Cost per TB case prevented by VCT ^h	178	215	129
Cost per TB case prevented by ICF ⁱ	664	323	N/A
Cost per TB case prevented by IPT ^j	962	486	N/A

^a Total cost of VCT = cost of pre-test counselling + cost of testing + cost of post-test counselling = Total cost of VCT/number of people post-test counselled.

^b Cost of investigating people with TB symptoms/number of people with TB symptoms.

^c Cost of screening and follow-up for IPT excluding ICF/number of people completing 6 months of IPT in 8 months.

^d Cost of screening and follow-up for IPT including cost of ICF/number of people completing 6 months of IPT in 8 months.

^e Cost of CPT/number of people completing 6 months of CPT in 8 months.

^f It is estimated that 0.1 (range 0.01–0.24) HIV infections are averted per person completing VCT. The range presented is based on the sensitivity analysis done by the VCT Efficacy Study Group to estimate the number of HIV infections averted by VCT.¹³

^g Total cost of VCT (see a above)/number of HIV infections estimated to be averted by VCT.

^h Total cost of VCT (see a above)/number of TB cases estimated to be prevented by VCT.

ⁱ Total cost of ICF/number of TB cases estimated to be prevented by ICF.

^j Total cost of IPT/number of TB cases estimated to be prevented by IPT.

HIV tests, isoniazid and cotrimoxazole. The high proportion of total costs attributable to personnel and the fact that salary costs are lower in many other African countries should be considered when assessing the affordability of these interventions in other settings.

The cost per person post-test counselled was lower in the STI clinic than in the other facilities because of the higher number of persons coming for testing and the exclusive use of lay counsellors. The cost per person post-test counselled in our study (US\$ 7–11) across all three sites was lower than that reported from Kenya (US\$ 30) and the United Republic of Tanzania (US\$ 32).¹³ This may be due to the use of lay counsellors instead of professional counsellors and rapid HIV tests instead of laboratory-based ELISAs. A study from South Africa showed that the cost per person post-test counselled almost halved from US\$ 20.95 to US\$ 11.30 by using rapid tests compared to ELISA.¹⁴ In our study using rapid HIV tests, almost every person tested received their HIV test results (99–100%) whereas with the use of ELISAs in the study in Kenya and the United Republic of

Tanzania a smaller proportion of people (70–95%) received their results.³⁹

The cost per clinical intervention (ICF, IPT, CPT) was lower at the PHC clinic than at the CHC. This was mostly due to the larger proportion of HIV-positive clients starting and completing prophylaxis as the weighted average personnel cost per minute was found to be similar for both facilities.

The cost per TB case detected at the PHC clinic was half that at the CHC (US\$ 81 versus US\$ 166). This is partially due to the higher TB incidence at the PHC clinic (1353/100 000) than in the whole population of the Central District (488/100 000) resulting in more cases being diagnosed (42% versus 24% of symptomatics diagnosed with TB). TB cases detected by ICF represented 4% of the PHC clinic's total TB case-load.

The cost per person completing six months of IPT incremental to ICF (US\$ 51–110) was considerably lower than the cost per person completing IPT including ICF (US\$ 92–183). Thus, once a programme decides to do ICF, the additional cost of providing IPT would be relatively small.

The cost per person completing six months of IPT (US\$ 92) with 57% adherence was higher than the cost reported in Uganda with 62% adherence (US\$ 24)¹⁹ and from a modelling study in Zambia with an assumed 63% adherence (US\$ 42),¹⁸ due to the higher cost of personnel and lower adherence to IPT in South Africa.

Estimating impact

Our estimates of cost per HIV infection averted by VCT (US\$ 67–112) compares favourably to the cost per HIV infection averted by other HIV prevention interventions, such as improved management of STIs (US\$ 280)⁴⁰ and nevirapine to prevent mother-to-child transmission of HIV (US\$ 318).⁴¹

Our results on cost per TB case prevented through VCT (US\$ 129–215), ICF (US\$ 323–664) and IPT (US\$ 486–962) were less than the cost of treating a new case of TB (US\$ 823–1362) reported in a previous study from Cape Town.⁴² The cost of providing IPT is also likely to be less than the cost of treating a TB case in other African countries where a smaller proportion of IPT costs would be for personnel and a higher

proportion of costs to treat TB would be for TB drugs.

Randomized clinical trials from Côte d'Ivoire reported that CPT decreases mortality in HIV-infected TB patients by 46% (95% CI: 23–62%)⁴³ and hospitalizations in symptomatic HIV-positive people by 43% (95% CI: 25–57%).⁴⁴ An observational cohort in Cape Town showed similar results with CPT decreasing mortality by 44% (95% CI: 15–67%) and the incidence of severe HIV-related illnesses by 48% (95% CI: 32–62%).⁴⁵ Another study from Cape Town has reported the number of hospitalization days for people not on ART as 1.84 per year at a cost of US\$ 206.⁴⁶ Therefore, if CPT decreased the cost of hospitalization by even 25% it would be cost-saving in this setting.

Sensitivity analysis

The sensitivity analysis showed higher costs for all interventions when using time sheets, highlighting the importance of methodologies for measuring personnel time and costs. Lower salaries for lay counsellors make their involvement more cost-effective than nurse counsellors. We assumed that the quality and effectiveness of their counselling is similar to nurse counsellors as has been found previously in South Africa.⁴⁷

Discounting TB cases prevented in the future by VCT increased the cost per TB case prevented by 140% from US\$ 129–215 to US\$ 181–302, which remained less than the cost of treating a TB case.

The adherence to IPT at the PHC clinic was 57%. Setting adherence at 62%, as for other studies, the cost per person completing IPT remained higher (US\$ 85) than in Uganda (US\$ 24)¹⁹ and Zambia (US\$ 42).¹⁸ High adherence levels (>95%) have been obtained with antiretroviral programmes in South Africa through adherence counselling, support groups, pill boxes, drug identification charts, daily schedules, diaries and treatment literacy educational materials.⁴⁸ We suggest that the cost-effectiveness of similar interventions to improve adherence to IPT be evaluated.

Limitations

One limitation of this study was that the three facilities were purposively sampled rather than randomly selected. While assessing the generalizability of the results, the following factors should be considered: urban/periurban/rural

setting, HIV prevalence, TB incidence, number of staff and salary levels. The following factors would decrease cost-effectiveness: settings with fewer patients per staff member, lower HIV prevalence, lower TB incidence and higher salaries.

Our estimates of the impact of VCT on HIV prevention were based on a study³⁹ that measured changes in risk behaviours and estimated changes in HIV incidence in Kenya, United Republic of Tanzania, and Trinidad and Tobago. We do not know if VCT in Cape Town was as effective as in that study, but a similar model of risk-reduction counselling was used and the communities had a similar HIV prevalence.

Another limitation of our study was that confidence intervals were not calculated for ascertaining the degree of certainty of cost-effectiveness estimates.

Policy implications

A study from Botswana showed that of the 560 clients screened only one case of TB was detected by chest X-ray and a large proportion of clients (18%) were lost to follow-up.⁴⁹ Our sensitivity analysis found that not using chest X-rays (with or without PPD) was the most cost-effective IPT screening protocol. It decreased the cost per TB case prevented by 36%. We recommend that the requirement for chest X-rays as part of the screening process for IPT in the WHO guidelines be removed.

Although excluding PPD decreases the cost per person completing IPT by 60%, the cost per TB case prevented decreases only by 4% because the efficacy of IPT is lower. PPD increases costs for screening (tuberculin, syringes, needles, personnel time) and for patients (time and transport to return for skin reactions to be read). There are also technical problems in administering and reading the test correctly. However, not doing PPD exposes many people to isoniazid (with its potential side effects) who might not benefit from it and increases the burden on health services (more people starting isoniazid and being followed up). Given that the cost-effectiveness of both approaches is similar, WHO's recommendations remain appropriate: PPD testing should be done, and where it is not feasible, it can be omitted when the prevalence of TB infection is greater than 30% or in high-risk groups.

To assess the affordability of interventions, we suggest that average cost data be combined with the number of

people eligible for each intervention and compared with the available resources. Interventions are likely to become more cost-effective as the number of people accessing services increases.

Assuming that 20% of adults test HIV positive and, among HIV-infected clients, 15% are eligible for IPT, 40% are eligible for CPT and 95% complete prophylaxis, the total package including VCT would cost US\$ 19 366 000–30 545 000. This includes testing 2 million people (about 10% of the adult population of South Africa at a cost of US\$ 14–22 million), screening for ICF/IPT (US\$ 2.8–4.8 million), screening for CPT (US\$ 400 000–800 000), providing IPT for six months (US\$ 342 000–513 000) and providing CPT for one year (US\$ 1 824 000–2 432 000). South Africa has allocated US\$ 400 million for a comprehensive plan to provide HIV care in 2005–06, with US\$ 120 million for antiretroviral drugs.⁵⁰ In this context, the ProTEST package is affordable in South Africa.

Conclusions

We conclude that VCT using lay counsellors and rapid HIV testing is a cost-effective intervention to prevent HIV and TB in South Africa. VCT services should be expanded for prevention and to link HIV-positive clients to care and support. Cost-saving interventions such as, ICF, IPT and CPT should be offered at all primary health care facilities in South Africa for HIV-positive clients. The use of chest X-rays for IPT screening decreases the cost-effectiveness of IPT. PPD screening does not influence the cost-effectiveness of IPT to prevent TB.

Our results prompted the South African Department of Health in December 2003 to include ProTEST interventions as part of the comprehensive package of care for people living with HIV linked to provision of antiretrovirals in South Africa. ■

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Competing interests: none declared.

Résumé

Coûts des mesures de lutte contre la tuberculose et le VIH dans les établissements de soins de santé primaires de la ville du Cap, en Afrique du Sud.

Objectif Mesurer les coûts et évaluer le rapport coût/efficacité de l'ensemble d'interventions ProTEST contre la tuberculose et le virus de l'immunodéficience humaine (VIH) dans des établissements de soins de santé primaires de la ville du Cap, en Afrique du Sud.

Méthodes Des données relatives aux coûts annuels ont été recueillies rétrospectivement par évaluation des coûts à partir des éléments de cette intervention. Le coût par contamination par le VIH prévenue et celui par cas de TB évité ont ensuite été estimés.

Résultats Dans les trois établissements étudiés, le coût par personne des interventions ProTEST se situait dans les plages suivantes : US \$ 7-11 pour la délivrance de conseils et le dépistage volontaire, US \$ 81-166 pour la détection d'un cas de tuberculose, US \$ 92-183 pour l'administration d'un traitement préventif par l'isoniazide et US \$ 20-44 pour l'administration d'un traitement préventif de six mois par le cotrimoxazole. Le coût par contamination par le VIH évitée grâce aux conseils et au dépistage volontaire a été estimé à US \$ 67-112. Le coût par cas de TB prévenu par ce même type d'intervention (prévention

du VIH) était de US \$ 129-215, par recherche intensive des cas de US \$ 323-664 et par traitement préventif par l'isoniazide de US \$ 486-962. Une analyse de sensibilité a mis en évidence que l'utilisation de la radiographie pulmonaire comme méthode de dépistage préliminaire à ce traitement permettait de prévenir les cas de TB dans une proportion de 36 %. Le dépistage préliminaire au traitement par l'isoniazide avec ou sans intradermoréaction par la fraction protéique purifiée de la tuberculine présentait une efficacité économique presque équivalente.

Conclusion L'article parvient à la conclusion que l'ensemble d'interventions ProTEST permet de réaliser des économies. En dépit d'une adhésion moyenne, le fait de lier les interventions à visées préventives à celles délivrant des soins contre la TB ou le VIH a entraîné une baisse du coût estimé de la prévention d'un cas de TB par rapport aux estimations antérieures du coût d'un traitement antituberculeux. L'étude indique un coût des interventions de conseil et de dépistage volontaire moins élevé que les chiffres rapportés antérieurement pour l'Afrique.

Resumen

Costo de las medidas de control de la tuberculosis/VIH en centros de atención primaria de Ciudad del Cabo, Sudáfrica

Objetivo Medir los costos y estimar la costoeficacia del paquete ProTEST de intervenciones contra la tuberculosis/virus de la inmunodeficiencia humana (tuberculosis/VIH) en establecimientos de atención primaria de Ciudad del Cabo, Sudáfrica.

Métodos Reunimos retrospectivamente datos anuales sobre costos utilizando sistemas de determinación de los costos basados en componentes en tres establecimientos de atención primaria, para poder así estimar el costo asociado a cada infección por VIH evitada y el costo por caso de tuberculosis prevenido.

Resultados Los intervalos de los costos por persona para las intervenciones de ProTEST en los tres centros fueron los siguientes: US\$ 7 - 11 para el asesoramiento y pruebas voluntarias (APV), US\$ 81 - 166 para la detección de un caso de tuberculosis, US\$ 92 - 183 para el régimen completo de terapia preventiva con isoniazida (TPI) y US\$ 20 - 44 para el tratamiento preventivo con cotrimoxazol durante seis meses. El costo estimado por infección por VIH evitada mediante APV fue de US\$ 67 - 112. El costo

por caso de tuberculosis prevenido mediante APV (gracias a la prevención de la infección por VIH) fue de US\$ 129 - 215, mediante la búsqueda intensificada de casos, de US\$ 323 - 664, y mediante TPI, de US\$ 486 - 962. El análisis de sensibilidad demostró que el uso de radiografías torácicas en el cribado para TPI reduce en un 36% la costoeficacia de ésta como medio de prevención de los casos de tuberculosis. El cribado para TPI tuvo casi la misma costoeficacia con o sin cribado mediante derivados proteínicos purificados de la tuberculina.

Conclusión Llegamos a la conclusión de que el paquete ProTEST permite ahorrar costos. Pese a la moderada observancia de los tratamientos, vinculando las intervenciones de prevención y atención para la tuberculosis y el VIH, los costos estimados para la prevención de la tuberculosis fueron inferiores a las estimaciones anteriores de los costos asociados al tratamiento de la misma. Las medidas de APV fueron menos costosas de lo que hasta ahora se había señalado en África.

ملخص

تكاليف إجراءات مكافحة السل المترافق بالإيدز في مرافق الرعاية الصحية الأولية في كيب تاون، جنوب أفريقيا

الهدف: قياس التكاليف وتقدير الفعالية لقاء التكاليف لمضمومة من التدخلات لمكافحة السل المترافق بالإيدز قبل الشروع بها في مرافق الرعاية الصحية الأولية في كيب تاون، جنوب أفريقيا.

الطريقة: جمعنا المعطيات الاستراتيجية حول التكاليف السنوية لما سبق إنجازه باستخدام تقدير التكاليف استناداً إلى المكونات في ثلاث من مرافق الرعاية الأولية، وتوصلنا لتقدير التكاليف لكل عدوى بالإيدز يمكن تفاديها وتكاليف كل عدوى بالسل يمكن اتقاؤها.

الموجودات: قُدِّرت التكاليف المصروفة على كل شخص قبل الشروع بالتدخلات في ثلاثة مرافق كما يلي: 7-11 دولاراً أمريكياً للتوعية والاختبار الطوعي، و81-166 دولاراً أمريكياً لكشف حالة سل، و92-183 دولاراً أمريكياً لاستكمال المعالجة الانتقائية بالإيزونيازيد و20-44 دولاراً أمريكياً لاستكمال ستة شهور من المعالجة الانتقائية بالكوتريمازول، فيما قُدِّرت التكاليف لعدوى الإيدز الذي يمكن اتقاؤها بالتوعية والاختبار الطوعي بـ 67-112 دولاراً أمريكياً، وتكاليف كل حالة سلية يمكن اتقاؤها بالتوعية والاختبار

الطوعي (من خلال اتقاء الإيدز) بـ 129-215 دولاراً أمريكياً، وتكاليف كل حالة سلية يمكن اتقاؤها بالكشف المكثف للحالات بـ 323-664 دولاراً أمريكياً، وتكاليف كل حالة سلية يمكن اتقاؤها باستكمال المعالجة الانتقائية بالإيزونيازيد بـ 486-962 دولاراً أمريكياً. وقد أظهرت تحاليل الحساسية أن استخدام الصور الشعاعية للتحري من أجل استكمال المعالجة الانتقائية بالإيزونيازيد قد أنقص من الفعالية لقاء تكاليف استكمال المعالجة الانتقائية بالإيزونيازيد لاتقاء حالات السل بمقدار 36%. إن التحري من أجل استكمال المعالجة الانتقائية بالإيزونيازيد مع التحري باستخدام المشتق البروتيني المتقى للتوبركلين أو بدون استخدامه كان له نفس الفعالية لقاء التكاليف.

الاستنتاج: استنتجنا أن مضمومة تقدير تكاليف التدخلات قبل الشروع بها توفر التكاليف، فبالرغم من الالتزام الضعيف، فقد أدى ربط تدخلات الوقاية والرعاية للسل والإيدز إلى أن تقدير التكاليف لاتقاء السل أقل من التقديرات السابقة لتكاليف معالجته. فالتوعية والاختبار الطوعي أقل تكلفة مما قد أشارت إليه التقارير سابقاً في أفريقيا.

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Table 1. Key characteristics of each selected facility, Central District, Cape Town

Characteristic	Community Health Centre (CHC)	Primary health care (PHC) clinic	Sexually transmitted infection (STI) clinic
Key features	Full- and part-time doctors, professional nurses and lay counsellors	Sessional doctors, professional nurses and lay counsellors	Sessional doctors, professional nurses and lay counsellors
Location	Urban	Periurban	Urban
Overall service range	Adult curative, chronic, STI, TB ^a , child health, family planning and antenatal services	Adult curative, chronic, STI, TB, child health, family planning and antenatal services	STI and family planning
ProTEST services available	VCT, ^b ICF, ^c IPT, ^d CPT ^e	VCT, ICF, IPT, CPT	VCT
Main VCT provider	Nurse	Lay counsellor	Lay counsellor
Type and number of staff employed	2 full-time and 1 sessional doctor 5 professional nurses 2 staff nurses 2 nursing assistants 1 pharmacist 1 pharmacy assistant 1 lay counsellor	4 sessional doctors 9 professional nurses 2 staff nurses 1 nursing assistant 1 social worker 4 lay counsellors	4 sessional doctors 4 professional nurses 7 lay counsellors
Provincial/local government	Provincial	Local	Local
Time period for which cost data collected	Financial year, April 2001–March 2002	Financial year, July 2000–June 2001 (costs were inflated to the April 2001–March 2002 financial year for comparative purposes)	Financial year, July 2000–June 2001 (costs were inflated to the April 2001–March 2002 financial year for comparative purposes)
Time period for which outcome data collected	April 2001–March 2002	April 2001–March 2002	April 2001–March 2002

^a TB = tuberculosis.

^b VCT = voluntary HIV counselling and testing.

^c ICF = intensified TB case-finding.

^d IPT = isoniazid preventive therapy.

^e CPT = cotrimoxazole preventive therapy.

Table 2. Summary of total costs per activity for tuberculosis/human immunodeficiency virus (TB/HIV) interventions for one year at each selected site, Central District, Cape Town, 2001–02 (in US\$)

ProTEST activity	Community health centre (CHC)		Primary health care (PHC) clinic		Sexually transmitted infections (STI) clinic	
	Financial	Economic	Financial	Economic	Financial	Economic
Start-up activities	703 (3%)	881 (4%)	826 (2%)	1034 (2%)	548 (1%)	687 (2%)
Coordination	119 (1%)	183 (1%)	238 (1%)	365 (1%)	119 (1%)	183 (1%)
TB/HIV/STI health education	2554 (12%)	2550 (12%)	4790 (10%)	4528 (10%)	6303 (16%)	6148 (17%)
HIV pre-test counselling ^a	2614 (12%)	2455 (11%)	5919 (12%)	4872 (10%)	8682 (23%)	7516 (20%)
Rapid HIV testing	2384 (11%)	2419 (11%)	6330 (13%)	6376 (13%)	12788 (33%)	12868 (35%)
HIV post-test counselling ^a	2262 (11%)	2446 (11%)	4436 (9%)	3696 (8%)	5639 (15%)	4967 (14%)
Screening for IPT ^b and CPT ^c (incremental cost) ^d	1423 (7%)	1458 (7%)	3153 (6%)	3199 (7%)	0	0
Follow up of people on IPT and CPT (incremental cost) ^d	297 (1%)	333 (1%)	1546 (3%)	1592 (3%)	0	0
Management of opportunistic infections	8482 (40%)	8518 (39%)	18483 (38%)	18398 (39%)	2275 (6%)	2355 (6%)
TB/HIV/STI training, mentorship and supervision	595 (3%)	563 (3%)	3710 (8%)	3494 (7%)	2191 (6%)	2036 (6%)
Total	21 285	21 623	49 192	47 280	38 427	36 575

^a The financial cost of lay counsellors was the sum of their salaries, whether they were employed by government or by nongovernmental organizations. The economic cost of lay counsellors was calculated as the cost of employing the same number of counsellors on government salaries because if the government wanted to replicate the service elsewhere it could not depend on the existence of nongovernmental organizations.

^b IPT = isoniazid preventive therapy.

^c CPT = cotrimoxazole preventive therapy.

^d The weighted average cost of clinical staff time was US\$ 0.12 per minute for PHC and US\$ 0.11 per minute for CHC. Interviews with health workers and managers resulted in the following time estimates: 8 minutes to screen for IPT if asymptomatic, 4 minutes to screen for TB if symptomatic, 8 minutes to do WHO clinical staging for CPT, 5 minutes to follow up for IPT or CPT.

Since screening includes screening of symptomatic clients for intensified TB case-finding (ICF), asymptomatic clients for IPT and clinical staging for CPT, costs that were not activity-specific (capital costs, vehicle and building recurrent costs) were allocated 20% for ICF, 40% for IPT and 40% for CPT based on the above time estimates. Similarly, for follow-up of IPT and CPT, costs were allocated 50% for IPT and 50% for CPT.

Table 3. Process and outcome indicators of tuberculosis/human immunodeficiency virus (TB/HIV) interventions available at each selected site, Central District, Cape Town

Indicator	Community health centre (CHC)	Primary health care (PHC) clinic	Sexually transmitted infections (STI) clinic
Voluntary counselling and testing (VCT)			
No. pre-test counselled	902	1509	4099
No. tested (% of counselled)	885 (98%)	1460 (97%)	4082 (99%)
No. HIV positive (% of tested)	181 (20%)	393 (27%)	861 (21%)
No. post-test counselled (% of tested)	882 (100%)	1460 (100%)	4031 (99%)
Isoniazid preventive therapy (IPT) and intensified TB case finding			
No. HIV positive screened for IPT/CPT	112	397	Not available
No. detected with TB ^a (% of screened)	8 (7%)	34 (9%)	Not available
No. started IPT (% of screened)	18 (16%)	58 (15%)	Not available
No. completed 6 months of IPT in 8 months (% of started)	8 (44%)	33 (57%)	Not available
Cotrimoxazole preventive therapy (CPT)			
No. started CPT (% of screened)	42 (38%)	228 (57%)	Not available
No. completing 6 months of CPT in 8 months (% of started)	11 (26%)	88 (39%)	Not available
ProTEST			
No. ProTEST-specific visits	989	3313	2062
Total number of clinic visits (ProTEST and non-ProTEST)	45098	103350	34112
Proportion of clinic visits for ProTEST	2%	3%	6%

^a The number of TB cases registered in the PHC clinic over the same period was 781. The total number of TB cases detected at the CHC was not available because TB cases were registered at a TB referral clinic and the number referred was not recorded.

Table 6. Sensitivity analysis for a selected primary health centre clinic in Central District, Cape Town, 2001–02

PHC	Scenario	Cost/ post-test counsel- led (US\$)	% differ- ence from baseline	Cost/ TB ^a case detected (US\$)	% differ- ence from baseline	Cost/ person complet- ing IPT ^b (US\$)	% differ- ence from baseline	Cost/ TB case prevented by IPT (US\$)	% differ- ence from baseline	Cost/ person complet- ing CPT ^c (US\$)	% differ- ence from baseline
Base case		11		81		92		486		20	
Discount rate for costs	3%	11	-0.4%	80	-0.4%	92	-0.6%	483	-0.6%	20	-0.8%
	13%	11	0.4%	81	0.4%	93	0.6%	489	0.6%	21	0.9%
Time allocation ^d	Time sheets	11	–	223	177%	231	150%	1216	150%	174	752%
Adherence	50%	11	–	81	–	104	13%	549	13%	20	–
	62%	11	–	81	–	85	-8%	447	-8%	13	-36%
	75%	11	–	81	–	71	-23%	378	-23%	11	-45%
	90%	11	–	81	–	60	-35%	314	-35%	10	-53%
Screening for IPT ^e	PPD ^f , no chest X-ray	11	–	49	-40%	59	-36%	312	-36%	20	–
	Chest X-ray, no PPD ^g	11	–	76	-6%	37	-60%	465	-4%	20	–
	No PPD ^g or chest X-ray	11	–	44	-46%	25	-73%	311	-36%	20	–
Annual counsellor salary and benefits	Community health worker (US\$ 1293)	9	-17%	81	–	92	–	486	–	20	–
	Admin (US\$ 3878)	14	23%	81	–	92	–	486	–	20	–
	Nurse (US\$ 12 925)	32	182%	81	–	92	–	486	–	20	–
Test kits	ELISA ^h	14	23%	81	–	92	–	486	–	20	–
TB cases detected	5% of screened	11	–	138	71%	92	–	486	–	20	–
	10% of screened	11	–	69	-14%	92	–	486	–	20	–
	20% of screened	11	–	35	-57%	92	–	486	–	20	–

^a TB = tuberculosis.

^b IPT = isoniazid preventive therapy.

^c CPT = cotrimoxazole preventive therapy.

^d All clinical staff in each of the facilities were asked to complete weekly time sheets twice daily for four weeks to specify the amount of time spent on each activity. The staff were then interviewed to check the validity of the time sheets.

^e In the base case costing, the actual costs were used rather than the costs that would have been incurred if all clients had received the screening tests according to the protocol. In the scenario with no chest X-rays, the cost of the X-rays was removed. If tuberculin purified protein derivative (tests) (PPDs) are not done then the client does not need to return to the clinic to have the skin reaction read. In the scenario with no PPD, the estimated time spent on screening an asymptomatic client decreased from 8 minutes to 4 minutes and the cost of the PPD was removed. It was assumed that all asymptomatic clients who were screened received prophylaxis and that their adherence was the same as if no PPD had been done.

^f With PPD screening: IPT decreases TB incidence by 60% for two years in PPD-positive clients³⁵, incidence of TB in tuberculin-positive people is 8%/year and each HIV-positive TB case causes one other case. For every 100 people accessing IPT using PPD screening, 19 TB cases are prevented.

^g With no PPD screening: IPT decreases TB incidence by 40% for two years in all HIV-positive clients³⁵ (PPD-positives and PPD-negatives combined), incidence of TB in HIV-positive people is 5%/year and each HIV-positive TB case causes one other case. For every 100 people accessing IPT with no PPD screening, 8 TB cases are prevented.

^h ELISA = enzyme-linked immunoabsorbent assay.