IMPROVEMENTS IN PHYSICAL AND MENTAL HEALTH AMONG HIV-INFECTED PATIENTS TREATED FOR TB IN THAILAND

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Abstract. We conducted a prospective, observational study of human immunodeficiency virus (HIV) infected patients diagnosed with tuberculosis (TB) at public health facilities in Thailand to evaluate the impact of TB and HIV treatment on overall physical and mental health. Standardized data were collected from patients at the time of TB diagnosis, two months into TB treatment, and at completion of TB treatment. We calculated composite physical and mental health scores for patients that completed treatment, compared scores during treatment, and analyzed factors associated with improvements in these scores. Of 493 patients analyzed, 488 (99%) reported at least one physical health complaint and 210 (43%) had at least one mental health complaint at baseline. Improvement in physical health occurred in 377 (76%) and improvement in mental health occurred in 182 (37%). In a multivariable analysis, factors strongly associated with improvement in physical health were receiving TB treatment in Bangkok, age greater than 50 years, and improved mental health. Improvement in mental health was strongly associated with alleviation of physical symptoms, including bloody urine, foot pain, headache, muscle weakness, difficulty sleeping, chest pain, and dizziness.

INTRODUCTION

Tuberculosis (TB) is a major global public health problem, causing almost nine million illnesses and two million deaths each year (World Health Organization, 2007). The incidence of TB has risen in many parts of the world because of the human immunodeficiency virus (HIV) epidemic (Corbett *et al*, 2003). HIV-infected patients are uniquely susceptible to developing and dying from TB disease (Harries *et al*, 2004; Akksilp *et al*, 2007). HIV complicates both the diagnosis and management of TB disease. The traditional TB diagnostic test, the microscopic examination of expectorated sputum for acid-fast bacilli, has poor sensitivity in HIV-infected patients (Matee *et al,* 2008). HIV-infected TB patients are at high risk for death within six months of TB diagnosis (Nunn *et al,* 1992; Akksilp *et al,* 2007; Cain *et al,* 2007; Trinh *et al*, 2007). To reduce

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the risk of death, patients must take medications for TB, HIV, and HIV-related opportunistic infection prophylaxis for an extended period, during which drug-drug interactions, combined toxicity, and immune reconstitution inflammatory events can develop (Burman, 2005).

The TB/HIV syndemic has been particularly severe in Southeast Asia (Singer and Clair, 2003; Joint United Nations Program on HIV/AIDS, 2005; World Health Organization, 2005). In Thailand, an estimated 91,000 persons develop TB annually, a rate of disease that has changed little in recent years, despite national implementation of the World Health Organization (WHO)-recommended TB control strategies (World Health Organization, 2001). HIV-associated TB now accounts for an estimated 15-20% of all TB cases in Thailand, and the rate of death during TB treatment ranges from 15-40% (Yanai *et al,* 1996; Putong *et al*, 2002; Varma *et al,* 2007; Nateniyom *et al,* 2008). Although numerous studies have been published about the biomedical interventions required to reduce mortality in HIV-infected TB patients, no studies have previously evaluated other health-related endpoints in this population. In industrialized countries, policy makers have increasingly become concerned about the impact of health programs on the quality of life, not simply disease-specific mortality. Consistent with international guidelines, national TB programs (NTPs) measure bacteriologic cure and survival during TB treatment, yet do not measure the impact of these control programs on all-around physical and mental health. Only a small number of studies have evaluated health-related quality of life in TB patients, and none of these evaluated HIV-infected TB patients (Chamla, 2004; Dhingra and Rajpal, 2005; Muniyandi *et al,* 2007). Measuring health-related quality of life will become increasingly important, as mortality declines from expanded access to HIV treatment and reform of the health sector leads to greater integration of disease control programs into primary health care services (Kitahata *et al,* 2002).

In this study, we evaluated the impact of TB treatment on self-reported physical and mental health and factors predictive of improved health among a cohort of HIV-infected TB patients that completed TB treatment in Thailand.

MATERIALS AND METHODS

Study setting and population

We conducted a multi-center, observational, prospective cohort study of HIV-infected TB patients undergoing TB treatment at public healthcare facilities in Bangkok, Phuket, and Ubon Ratchathani and at the national infectious disease referral hospital (Bamrasnaradura Infectious Diseases Institute) in Nonthaburi Province, Thailand. The study population included adults age ≥18 years who were diagnosed with active TB disease according to NTP guidelines, had documented HIV infection, were registered for TB treatment at one of the participating facilities, and received TB treatment for <4 weeks before study enrollment. Prisoners and pregnant women. were excluded. After written informed consent, patients were interviewed and examined at the beginning of TB treatment, at the end of the intensive phase of TB treatment, and at completion of TB treatment. This study was approved by the ethical review committees of the Bangkok Metropolitan Administration, the Thailand Ministry of Public Health, and the US Centers for Disease Control and Prevention.

Data collection and laboratory studies

At enrollment, trained nurses administered a detailed questionnaire to collect data about demographics, medical history, social history, and symptoms, and physicians performed a standardized physical examination. During the following two study visits, nurses

asked about physical signs and symptoms experienced since the last study visit, and physicians performed another physical examination. Medical records for any health-related problem that patients encountered between the study visits were reviewed. At enrollment, patients provided blood samples for measurement of cell counts, serum chemistries, and CD4+ T-lymphocytes (CD4). Sputum and specimens from extra-pulmonary sites were collected for acid-fast bacilli (AFB) smear, mycobacterial culture, identification, and drug-susceptibility testing. All laboratory assays were conducted at local facilities. Patients were evaluated for TB treatment outcomes according to WHO and NTP guidelines.

Statistical analysis

We limited our analysis to patients that completed TB treatment. Although patients could initially be enrolled in the study based on a clinical diagnosis of TB, we excluded from the analysis patients who subsequently had their diagnosis changed (*eg*, nontuberculous mycobacterial infection).

Proportions were calculated for the description of demographic characteristics and clinical features of patients. We calculated summary physical and mental health scores. To derive the physical health score, we used variables from the questionnaire that asked about symptoms experienced in the four weeks before the study visit, including: coughing, coughing up blood, fever, diarrhea, loss of body weight, difficulty breathing, chest pain, mouth pain, odynophagia, nausea, abdominal pain, loss of appetite, burning with urination, bloody urine, genital sores, foot pain, pruritic rash, muscle pain, difficulty with vision, headache, muscle weakness, fatigue, difficulty sleeping, dizziness, decreased hearing, chills, severe night sweats, self-assessed symptom severity, and duration of symptoms. To derive the mental health score, we included questions that asked about self-reported depression and trouble thinking or concentrating in the four weeks before the most recent study visit. Each health problem was scored with one point; missing responses were scored with zero points. Physical health and mental health scores were created by summing the scores for all health problems related to each component. For physical health score, the self-assessed symptom severity (range 0-10), and duration of symptoms (range 0-infinity) were added to the sum of the total physical health score. A higher score indicated a more severe impairment of health, while a score of zero indicated no impairment of health.

Each patient was classified according to whether their physical or mental health improved, worsened, or remained stable during TB treatment. We defined improvements in physical or mental health as having a score at the end of TB treatment lower than the score on enrollment, worsening in health as having a score greater than on enrollment, and stable as having the same score at both visits.

We calculated the TB knowledge score as the sum of correct answers to seven questions about TB and TB treatment; these questions were derived from educational materials routinely provided to patients as part of the NTP. High TB knowledge was defined as having a TB knowledge score equal to or greater than the median score of the study population. We calculated a TB stigma score as the sum of four questions about TB stigma that a patient answered affirmatively (*eg*, "Would you share a meal with a family member with TB?"). Low TB stigma was defined as having a TB stigma score less than the median score of the study population.

We conducted a bivariable logistic regression to determine factors associated with improvements in physical or mental health at $p \leq 0.20$; these factors were then tested for co-linearity. We generated two-way interaction terms as products of covariates and con-

structed a multivariable logistic regression model by entering covariates and their interaction terms into the model. We fitted a parsimonious model using a backward, stepwise procedure and assessed model fitness using the Hosmer and Lemeshow goodness-of-fit test. A two-sided p-value of ≤0.05 was used to indicate statistical significance. No interaction terms were found significant in the final model. All analyses were performed using Stata software version 8.0 (StataCorp LP, College Station, TX, USA).

RESULTS

Characteristics and clinical features

From May 2005 to September 2006, 849 HIV-infected TB patients were enrolled in the study; 493 (58%) patients were eligible for this analysis (Fig 1). Of the 493 patients, 343 (70%) were male (Table 1). The median age was 35 years [interquartile range (IQR), 30-41]. Twenty-five patients (5%) were >50 years old. Pulmonary TB was diagnosed in 301 patients (61%). Of these, 272 had AFB smear or culture results available, and 222 (82%) either had at least one specimen positive for AFB or were culture-positive for *Mycobacterium tuberculosis*. The median CD4 count at enrollment was 72 cells/μl (IQR, 28-87). Of the 488 patients with available CD4 counts, 289 (59%) had a CD4 level <100 cells/μl.

The median baseline physical and mental health scores were 31 (range, 0-379) and 0

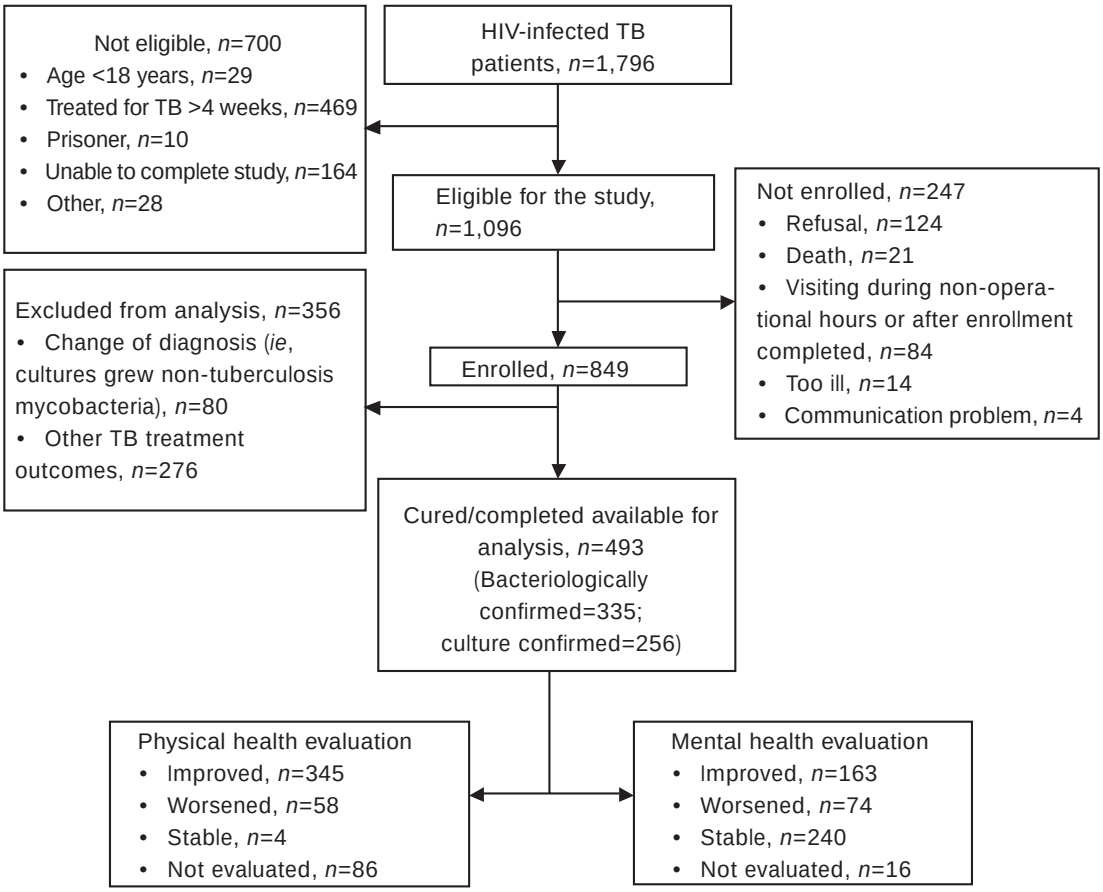

Fig 1–Flow of patients.

Table 1
Characteristics and clinical features of HIV-infected TB patients stratified by whether physical or mental health improved or did not improve after completing TB treatment.

Characteristics and clinical features	Grand total[a] (total *n*=493)	Physical health		Mental health	
		Stable or worsened (total *n*=62)	Improved (total *n*=345)	Stable or worsened (total *n*=314)	Improved (total *n*=163)
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Age >50 years old	27 (5)	8 (13)	14 (4)	17 (5)	10 (6)
Male	343 (70)	44 (71)	243 (70)	224 (71)	108 (66)
Finished >6th grade education	196 (40)	29 (47)	130 (38)	130 (41)	61 (37)
TB classification					
Pulmonary TB	301 (61)	32 (52)	214 (62)	196 (62)	97 (60)
Smear positive[b]	183 (64)	25 (81)	124 (61)	118 (77)	58 (63)
Bacteriologic confirmation[b]	222 (82)	25 (90)	158 (81)	140 (80)	76 (86)
Culture confirmation[b]	183 (67)	19 (73)	129 (61)	119 (73)	59 (61)
Extra-pulmonary TB	151 (31)	23 (37)	105 (30)	99 (32)	46 (28)
Pulmonary TB and extra-pulmonary TB	41 (8)	7 (11)	26 (8)	19 (6)	20 (12)
DOT by healthcare worker/village health volunteer	161 (33)	16 (26)	111 (32)	103 (33)	51 (31)
Hospitalized on enrollment	102 (21)	14 (23)	63 (18)	52 (17)	41 (25)
Site registered for TB treatment					
Bangkok	130 (28)	8 (13)	102 (30)	93 (30)	36 (22)
National infectious diseases hospital	122 (25)	22 (35)	79 (23)	68 (22)	48 (29)
Ubon Ratchathani	179 (36)	20 (32)	129 (37)	114 (36)	61 (37)
Phuket	62 (13)	12 (19)	35 (10)	39 (12)	18 (11)
Low TB stigma[c]	179 (36)	14 (23)	132 (38)	123 (39)	49 (30)
High TB knowledge[d]	396 (80)	47 (76)	283 (82)	264 (84)	122 (75)
Ever used sleeping pills	84 (17)	6 (10)	60 (17)	48 (15)	33 (20)
Ever used inhalant	89 (18)	6 (10)	72 (21)	53 (17)	33 (20)
Body mass index <18.5 at enrollment	273 (55)	29 (47)	199 (58)	173 (55)	90 (55)
Took Co-trimoxazole during TB treatment	422 (86)	48 (77)	295 (86)	269 (86)	138 (85)
Took fluconazole during TB treatment	304 (62)	35 (56)	215 (62)	194 (62)	99 (61)
Took ART during TB treatment	248 (50)	28 (45)	175 (51)	148 (47)	92 (56)
HIV risk group					
Heterosexual	293 (63)	37 (60)	210 (61)	187 (60)	94 (58)
Men who have sex with men	29 (6)	3 (5)	23 (7)	20 (6)	9 (6)
Injecting drug users	122 (26)	14 (23)	85 (25)	77 (25)	41 (25)
Blood procedure	122 (26)	4 (6)	12 (3)	14 (4)	9 (6)
Hemoglobin <10 g/dl	23 (5)	28 (45)	138 (40)	125 (40)	77 (47)
Total bilirubin >2 mg/dl	36 (7)	2 (3)	25 (7)	27 (9)	6 (4)
CD4+ T-lymphocyte <100 cells/μl[b]	289 (59)	36 (60)	196 (57)	98 (61)	183 (77)
Had sexual intercourse in the past 6 months	235 (48)	34 (55)	164 (48)	137 (44)	90 (55)

TB=tuberculosis; HIV=human immunodeficiency virus; DOT=directly observed therapy; ART=anti-retroviral therapy.

[a]Those not evaluated were included.

[b]Only those with available results.

[c]TB stigma score was calculated as the sum of four questions about TB stigma that a patient answered affirmatively (*eg*, "Would you share a meal with a family member with TB?"); low TB stigma was defined as having a TB stigma score less than the median score of the study population.

[d]TB knowledge score was calculated as the sum of correct answers to seven questions about TB and TB treatment; high TB knowledge was defined as having a TB knowledge score equal to or greater than the median score of the study population.

(range, 0-2), respectively. Four hundred eighty-eight patients (99%) reported at least one physical health complaint at baseline, and 210 (43%) reported at least one mental health complaint. The most frequent physical health complaint was fever, reported by 80% of patients, followed by fatigue (73%), coughing (71%), loss of appetite (64%), severe night sweats (51%), chills (50%), muscle pain (49%), difficulty sleeping (49%), chest pain (47%), muscle weakness (42%), foot pain (42%), and difficulty breathing (41%). Of 493 patients, 173 (35%) reported feeling sad or depressed in the four weeks before TB treatment, and 149 (30%) reported having trouble thinking or concentrating in the past four weeks. Of the 493 patients, physical health improvement occurred in 377 (76%), worsening occurred in 107 (22%), and no change in 9 (2%). Mental improvement occurred in 182 patients (37%), worsening occurred in 41 patients (8%), and no change occurred in 270 patients (55%).

Nearly 70% of patients who had fever at baseline reported no fever at the end of TB treatment, making fever the symptom most frequently alleviated (Table 2). More than half of patients reported improvement in the following symptoms compared to baseline: cough (54% improved), loss of appetite (53%), weight loss (53%), and fatigue (51%). The proportion of patients reporting improvement ranged from 30-50% for a range of other symptoms, including chills, severe night sweats, chest pain, difficulty breathing and sleeping, muscle pain and weakness, and headache. Generally, the proportion of patients reporting improvement was inversely related to the proportion of patients reporting stable health; when the proportion of patients reporting improvement decreased, the proportion of patients with stable physical health increased (Table 2). Few patients reported worsening of symptoms at the end of TB treatment, although the proportion of patients reporting worsening of their skin problem (*eg*, rash) at the end of TB treatment was relatively high (22%) compared with the proportion of patients reporting improvement (16%).

Factors associated with improvement in physical health

In a multivariable analysis, the factors most strongly associated with improvements in physical health were: receiving TB treatment at a facility in Bangkok compared with other provinces [adjusted odds ratio (AOR), 2.2; 95% confidence interval (CI), 1.2-4.0]; age <50 years (AOR, 3.1; CI, 1.3-7.2); and improvement in mental health (AOR, 2.2; CI, 1.3-3.6) (Table 3). Among the 277 patients that received anti-retroviral therapy (ART) before or during TB treatment, 205 (74%) reported an improvement in physical health; among the 216 patients that did not receive ART, 172 (80%) reported an improvement in physical health. ART was not associated with improvement in physical health in bivariable and multivariable analyses. Among patients receiving ART, the proportion reporting improvement in physical health was also not significantly different for the 64 patients that initiated ART before TB treatment (77% improved) compared with the 213 that initiated ART during TB treatment (73% improved).

Factors associated with improvements in mental health

In multivariable analysis, improvement in mental health was strongly associated with relief in an array of physical symptoms, including: bloody urine (AOR, 2.4; CI, 1.0-5.6), foot pain (AOR, 2.0; CI, 1.2-3.2), headache (AOR, 2.1; CI, 1.3-3.4), muscle weakness (AOR, 2.2; CI, 1.4-3.6), difficulty sleeping (AOR, 2.0; CI, 1.2-3.1), chest pain (AOR, 1.7; CI, 1.1-2.7), and dizziness (AOR, 2.4; CI, 1.3-4.2) (Table 4). Other factors independently associated with improved mental health were having sexual activity in the past six months compared to not having such activity in the past

Table 2
Physical and mental symptoms among HIV-infected TB patients at the end of TB treatment compared with the beginning of TB treatment.

Symptoms	Improved *n* (%)	Worsened *n* (%)	Stable *n* (%)	Not evaluated[a] *n* (%)
Physical health				
Fever	342 (69)	7 (1)	129 (26)	15 (3)
Cough	264 (54)	21 (4)	192 (39)	16 (3)
Loss of appetite	261 (53)	15 (3)	205 (42)	12 (2)
Weight loss[b]	258 (53)	11 (2)	213 (43)	11 (2)
Fatigue	252 (51)	24 (5)	205 (42)	12 (2)
Chills	222 (45)	11 (2)	245 (50)	15 (3)
Severe night sweats	213 (43)	8 (2)	248 (50)	24 (5)
Chest pain	197 (40)	16 (3)	268 (55)	12 (2)
Difficulty breathing	178 (36)	21 (4)	282 (57)	12 (2)
Difficulty sleeping	173 (35)	29 (6)	279 (57)	12 (2)
Muscle pain	162 (33)	42 (9)	276 (56)	13 (3)
Muscle weakness	161 (33)	17 (3)	302 (61)	13 (3)
Headache	148 (30)	42 (9)	289 (59)	14 (3)
Nausea	134 (27)	17 (3)	329 (67)	13 (3)
Foot pain	129 (26)	45 (9)	306 (62)	13 (3)
Mouth pain	115 (23)	32 (6)	334 (68)	12 (2)
Difficulty thinking	115 (23)	27 (5)	337 (68)	14 (3)
Diarrhea	98 (20)	20 (4)	357 (72)	18 (4)
Odynophagia	94 (19)	14 (3)	372 (75)	13 (3)
Decreased hearing	90 (18)	23 (5)	366 (74)	14 (3)
Dizzy	88 (18)	22 (4)	370 (75)	13 (3)
Pruritic rash	81 (16)	109 (22)	290 (59)	13 (3)
Difficulty with vision	63 (13)	43 (9)	374 (76)	13 (3)
Cough up blood	44 (9)	5 (1)	432 (88)	12 (2)
Burn with urination	34 (7)	13 (3)	434 (88)	12 (2)
Genital sores	33 (7)	10 (2)	435 (88)	15 (3)
Bloody urine	7 (1)	1 (0)	470 (95)	15 (3)
Mental health				
Abdominal pain	138 (28)	10 (2)	331 (67)	14 (3)
Depressed	143 (29)	26 (5)	309 (63)	15 (3)

[a]Data not available.
[b]Improvement was determined by having a gain of more than 10% of body weight at the end of treatment compared with the beginning of TB treatment.

six months (AOR, 1.8; CI, 1.1-2.8). Improved mental health was less likely to occur in patients who reported taking antibiotics in the four weeks before TB treatment (AOR, 0.5; CI, 0.3-0.8).

DISCUSSION

HIV-infected TB patients living in Thailand had substantial impairment of their physical and mental health when first diagnosed with

Table 3

Bivariable and multivariable logistic regression analyses of factors predictive of improvements in physical health[a] among HIV-infected TB patients that completed TB treatment (*n*=447).

Factors	OR	95% CI		p-value	AOR	95% CI		p-value
		Lower	Upper			Lower	Upper	
Treated at facility in Bangkok	2.0	1.2	3.4	0.01	2.2	1.2	4.0	<0.01
Age <50 years old	2.4	1.1	5.3	0.02	3.1	1.3	7.2	0.01
Improvement in mental health	1.7	1.1	2.7	0.02	2.2	1.3	3.6	<0.01

TB=tuberculosis; HIV=human imuunodeficiency syndrome; OR=odds ratio; AOR=adjusted odds ratio; CI= confidence interval.

[a]Physical health score at end of TB treatment less than that of baseline; one point was assigned to each of the 27 symptoms listed in Table 2 (excluding difficulty thinking and feeling depressed), physical health score was the sum of points each patient had plus self-assessed symptom severity and days of duration of symptoms; improvement was defined as having a score at the end of TB treatment less than the score at enrollment.

Table 4

Bivariable and multivariable logistic regression analyses of factors predictive of improvement in mental health[a] among HIV-infected TB patients that completed TB treatment (*n*=441).

Factors	OR	95% CI		p-value	AOR	95% CI		p-value
		Lower	Upper			Lower	Upper	
Took antibiotics in 4 weeks before TB diagnosis	0.8	0.5	1.0	0.05	0.5	0.3	0.8	<0.01
Had sex in past 6 months	1.7	1.2	2.5	<0.01	1.8	1.1	2.8	0.01
Bloody urine improved	2.7	1.3	5.4	<0.01	2.4	1.0	5.6	0.04
Foot pain improved	2.7	1.8	4.2	<0.01	2.0	1.2	3.2	<0.01
Headache improved	2.6	1.8	4.0	<0.01	2.1	1.3	3.4	<0.01
Muscle weakness improved	3.7	2.5	5.6	<0.01	2.2	1.4	3.6	<0.01
Difficulty sleeping improved	3.2	2.1	4.7	<0.01	2.0	1.2	3.1	<0.01
Chest pain improved	2.5	1.7	3.7	<0.01	1.7	1.1	2.7	0.02
Dizziness improved	4.0	2.4	6.4	<0.01	2.4	1.3	4.2	<0.01

TB=tuberculosis; HIV=human imuunodeficiency syndrome; OR=odds ratio; AOR=adjusted odds ratio; CI= confidence interval.

[a]Mental index score at end of TB treatment less than that of baseline; one point was assigned to a given patient if he/she had any difficulty in thinking or feeling depressed; mental score was the sum of points each patient had; improvement was defined as having a score at the end of TB treatment less than the score at enrollment.

TB. Completing TB treatment, as expected, relieved some physical symptoms but had little impact on mental health, and the persistence of physical symptoms was highly correlated to impaired mental health.

Although physical symptoms of TB were largely relieved during treatment, some new symptoms emerged, such as rash, likely related to progression of AIDS or adverse drug effects (Tappero *et al*, 1995). Factors strongly

associated with improved physical symptoms included being less than 50 years old and being treated in Bangkok. Advanced age has been associated with impaired physical health in studies from the US and at least one study from Thailand (WHOQOL HIV Group, 2004; Liu *et al*, 2006, Kauf *et al,* 2008). Now 20 years into the epidemic of HIV in Thailand and with more widespread access to ART, it is anticipated that older persons will also be receiving HIV care and treatment. Our study suggests that HIV and TB clinics should consider ways to address the unique physical health needs of this population. We also found that treatment in Bangkok was strongly associated with improved physical health. In Bangkok, patients from this study were treated for TB in urban health centers, most of which have small TB clinics with high rates of directly observed therapy. Qualitative studies may help elucidate whether the findings from our study are related to specific features or clinical services of these facilities or to unique characteristics of HIV-infected TB patients from Bangkok that were not measured by our questionnaire.

We found that two thirds of patients had either no change or worsening in mental health after completing TB treatment, and that improved mental health was closely correlated to relief of many non-TB physical health symptoms. Our findings suggest that HIV-infected TB patients may benefit from a more holistic approach to medical care that includes addressing all medical problems, not simply HIV and TB treatment, and provision of mental health services. In resource-limited settings, access to essential TB and HIV services has improved rapidly in recent years, and international agencies are considering strategies to integrate these services into existing health systems that are more responsive to patient needs (Kitahata *et al,* 2002). Our findings highlight the importance of this movement and the particular need for mental health services.

We did not find that ART was associated with substantial relief of physical symptoms, even though ART results in rapid restoration of the immune system and has been associated with improved quality of life in the US (Hammer *et al,* 2006). We think that the absence of a statistical association is attributable to our study design. ART is the single strongest predictor of survival in HIV-infected patients (Dheda *et al,* 2004; Manosuthi *et al,* 2006; Akksilp *et al,* 2007) and, in our study, was also associated with a reduction in defaulting on treatment (data not shown). By excluding patients that died or defaulted from our analysis, we removed an important comparison group. We excluded these patients, because they did not have follow-up data for the end of treatment, but, had we included such patients and counted them as having the worst possible physical health score, we would likely have shown a marked benefit from ART.

A major limitation of our study was that we evaluated the patient's physical and mental health using a detailed questionnaire, but the questionnaire has not been formally validated for assessing health-related quality of life in Thailand. Although widely used in North America, standardized tools for measuring quality of life (*eg*, SF-36) have not been widely studied in settings with different resources, health systems, and cultures and have not yet been validated in TB patients (Dion *et al,* 2004). We limited our analysis to changes in physical and mental health, but did not measure changes in other domains, such as social or economic well-being, which are often assessed in quality of life studies. Further research is needed throughout the world to refine measurement of health-related quality of life and to evaluate the impact of disease-specific public health programs, such as TB and HIV, on overall physical and mental health.

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