QuantiFERON®-TB Gold In-tube Test for tuberculosis prevention in HIV-infected patients

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Keywords: QuantiFERON®-TB Gold In-tube Test; latent tuberculosis infection; human immunodeficiency virus; isoniazid preventive therapy; Thailand

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SUMMARY

Optimal testing strategy for diagnosing latent tuberculosis infection and guiding isoniazid preventive therapy (IPT) is uncertain among HIV-infected patients. A 4-year prospective study was conducted among Thai HIV-infected patients who underwent simultaneous tuberculin skin test (TST) and QuantiFERON®-TB Gold In-tube Test (QFT-IT) at care entry. Based on baseline test results, patients were categorized into 4 groups: 1) QFT-IT-positive, TST-reactive 2) QFT-IT-positive, TST-non-reactive 3) QFT-IT-negative, TST-reactive, or 4) QFT-IT-negative, TST-non-reactive. The QFT-IT-positive patients were offered 9-month IPT and underwent yearly QFT-IT. Among 150 enrolled patients, there were 8, 12, 16 and 114 patients in group 1, 2, 3 and 4, respectively. Sixteen of 19 QFT-IT-positive patients (84%) completed IPT. The incidence of tuberculosis was significantly higher in patients who declined IPT than those completing IPT (11.11 vs. 0 case/100 patient-year; \( P<0.001 \)). Among the 16 patients completing IPT, 11 (69%) and 2 (12%) had QFT-IT reversion at 1 year and 2 years after IPT, respectively. The remaining 3/16 (19%) had no reversion and their baseline interferon-\( \gamma \) levels were all above 1.2 IU/ml. Initial QFT-IT-guided IPT was effective in preventing tuberculosis. Serial QFT-IT for evaluating IPT effectiveness had limitations given delayed and no reversion, especially in those with high baseline interferon-\( \gamma \) levels.
INTRODUCTION

People living with human immunodeficiency virus (PLWHIV) who have latent tuberculosis infection (LTBI) are at increased risk for developing tuberculosis (TB) compared to those without HIV infection (1, 2). The World Health Organization (WHO) has recommended screening and isoniazid preventive therapy (IPT) for LTBI in PLWHIV given a 62% reported reduction in TB incidence (1, 3). There are currently two types of test used for diagnosing LTBI, tuberculin skin test (TST) and interferon-gamma release assay (IGRA). Either TST or IGRA is recommended for guiding IPT per the Centers for Disease Control and Prevention (CDC) recommendations (4). TST is the routinely available test in resource-limited settings where IGRA is not available (1).

Tuberculin skin test is less sensitive in immunocompromised persons than immunocompetent persons and false-reactivity has been associated with prior Bacillus Calmette–Guérin (BCG) vaccination and non-tuberculous mycobacterial (NTM) infection (5). Although IGRA are more sensitive and specific than TST among persons without HIV infection (6), reversion from positive to negative results within short and long-term periods were observed in PLWHIV who have no or low TB risk (7, 8). A meta-analysis of studies assessing TST and IGRA for LTBI screening among HIV-infected individuals demonstrated comparable performance between both tests (2). However, significant heterogeneity was noted among the studies included in this meta-analysis. In addition, the outcomes evaluated were the predictive value of IGRA for development of active TB and the sensitivity of IGRA in persons with culture-confirmed active TB in comparison with TST (2). Longitudinal studies that evaluate the efficacy of IPT based on positive TST, with or without IGRA results in PLWHIV from TB high-endemic countries, are needed for evidence-based treatment strategies.
There has been increasing interest in identifying a clinical biomarker of response to IPT. Previous studies reported positive correlation between effector T-cell responses assessed by IGRAs and antigenic and bacillary burden of *M. tuberculosis* (9, 10). Decreased T-cell responses after active TB and LTBI treatment were demonstrated in non-HIV-infected individuals (9, 11), yet the evidence for change in levels of interferon-gamma (IFN-γ) after LTBI treatment are limited and inconsistent to date (12-14). Additionally, data to inform on the long-term IFN-γ responses after IPT among HIV-infected patients from TB high-endemic settings are limited (15).

In Thailand, a TB prevalence of 171 cases per 100,000 population was estimated in 2014 (16). Guidelines for LTBI screening and treatment have not been established given the lack of data on long-term efficacy of such TB preventive strategies. The purpose of the study was to evaluate the efficacy of IGRA-guided IPT among PLWHIV and the IFN-γ responses after IPT in those with LTBI in this TB high-endemic setting.

**METHODS**

*Study design and setting*

A prospective cohort study was conducted from 1 March 2012 through 28 February 2016 among adult patients (aged ≥18 years) enrolled in HIV care at Thammasat University Hospital in central Thailand. The study was conducted in accordance with the amended Declaration of Helsinki and approved by Faculty of Medicine, Thammasat University Ethics Committee.

*Study protocol, definitions and outcome measurement*
All patients enrolled in care at the HIV clinic were screened for eligibility during year 1 of the four-year study period. Exclusion criteria were prior or currently active TB, history of LTBI treatment, or TST performed within the past year. Informed consent was obtained before study participation. Demographic data, BCG vaccination, history of TB contact, HIV clinical characteristics, and comorbidities were obtained by interview and medical record review. Long-term alcohol use and smoking were defined as everyday use of any amount of the substances for at least 1 year before enrollment. Active TB screening was performed based on symptoms and chest radiograph as recommended by WHO (1).

At enrollment, all participants received TST and IGRA testing. The TST was performed immediately after collection of the blood sample for the IGRA test which was the QuantiFERON®-TB Gold In-tube Test (QFT-IT) (Cellestis Limited, Carnegie, Victoria, Australia). The procedures and interpretation of the results of QFT-IT were according to the manufacturer’s standard guidelines (17). Level of IFN-γ was calculated by subtracting TB antigen response with nil response. Reversion of a QFT-IT test was defined as a positive test at baseline that became negative at one of the subsequent tests, while conversion of a QFT-IT test was defined as a change from negative at baseline to positive at one of the subsequent timepoints. For TST, 0.1 ml (5 tuberculin units) of purified protein derivative RT23 (Tubersol; Connaught Laboratories Limited, Toronto, Canada) was administered intradermally at the inner forearm and results were measured at 48–72 hours by the ballpoint pen method. An induration of at least 5 mm. was defined as TST reactivity. Participants were categorized into four groups based on the initial TST and QFT-IT results: QFT-IT-positive, TST-reactive (group 1), QFT-IT-positive, TST-non-reactive (group 2), QFT-IT-negative, TST-reactive (group 3), and QFT-IT-negative, TST-non-reactive (group 4). Patients who developed symptoms suggestive of active TB underwent further investigations.
according to suspected sites of infection, i.e., chest radiograph and sputum examination for acid-fast bacilli and culture for pulmonary TB (from expectorant, induced or bronchoalveolar lavage specimen). Treatment for LTBI was isoniazid 300 mg per day for 9 months. Combined antiretroviral therapy (ART) was initiated in patients with CD4 < 350 cells/µL according to the national guidelines. Adherence to IPT was monitored by standardized monthly pill counts (18). The primary study outcome was incidence of TB. Secondary outcomes were all-cause mortality, HIV clinical outcomes, including retention in care, change in CD4 counts, and HIV virological responses. Among QFT-IT-positive patients, change in IFN-γ level, reversion and conversion during the follow-up period were assessed.

Statistical analysis

Data analysis was performed using SPSS version 15 (Chicago, IL, USA). Pearson’s χ² or Fisher’s exact test was used to compare categorical data, as appropriate. Continuous variables were compared using the Mann-Whitney U-test or Kruskal-Wallis test based on the number of compared groups. Incidence of TB was calculated and compared using generalized linear models based on Poisson distribution. All P values were two-tailed; P < 0.05 was considered statistically significant.

RESULTS

Baseline characteristics of the study cohort

The cohort comprised 150 patients, of whom the median age was 40 years (range 17-65 years), 79 (53%) were male, 119 (79%) had baseline CD4 count ≥200 cells/µL, 109 (73%) had prior BCG vaccination, 21 (14%) reported history of TB exposure, and 113 (75%) were currently on ART, of whom 109 (96%) had HIV RNA suppression at study entry. All participants returned for TST reactivity measurement within 48-72 hours; there were no
indeterminate QFT-IT results. The four participant groups included 8 QFT-IT-positive, TST-reactive patients (group 1), 12 QFT-IT-positive, TST-non-reactive patients (group 2), 16 QFT-IT-negative, TST-reactive patients (group 3), and 114 QFT-IT-negative, TST-non-reactive patients (group 4). Most baseline characteristics were comparable between the groups except QFT-IT-positive, TST-non-reactive patients were more-likely to be female and QFT-IT-negative, TST-reactive patients were more-likely to report long-term tobacco use (Table 1).

**Tuberculosis and HIV outcomes**

The majority of participants (94.7%) completed the three-year follow-up period and none reported new exposure to an active TB case (Figure 1). The incidence of active TB was significantly higher in the QFT-IT-positive, TST-non-reactive group compared to other groups (2.78 vs. 0 cases/100 patient-years; Table 2). All-cause mortality, retention in care, median CD4 cell count, median change in CD4 cell count, and rates of HIV RNA suppression at each follow-up year were not significantly different between the 4 groups. Sixteen of the 20 QFT-IT-positive patients (80%) from group 1 and 2 accepted IPT, all of whom received at least 6 months of IPT (15 received isoniazid for 9 months and one received 6 months of the therapy due to 5-fold asymptomatic elevation of transaminases) with at least 95% adherence by pill count. There were no reports of other adverse reactions from IPT. After the 3-year period, 19 of 20 (95%) QFT-IT-positive patients had complete follow-up data. There was one QFT-IT-positive, TST-non-reactive patient (group 2), who had refused IPT, subsequently developed active pulmonary TB compared to no TB cases in the other groups. Incident TB was significantly higher in patients who refused IPT than those completing IPT (11.11 vs. 0 case/100 patient-years; P<0.001). Among patients with initial
Changes in IFN-γ levels and QFT-IT results overtime

Annual QFT-IT performed in 19 QFT-IT-positive patients at 1 and 2 years after the initial test are displayed as changes in IFN-γ level from the initial test to each follow-up year (Figure 2). The median baseline IFN-γ levels were not significantly different between IPT-treated patients and untreated patients (1.05 vs. 0.76 IU/mL; P=0.70). There was a trend in decreased median IFN-γ level more from the initial test to year 1 in IPT-treated patients compared to those without IPT (-0.65 vs. -0.13 IU/mL; P=0.08) while the decrease in the level from year 1 to year 2 was not significantly different between the two groups (-0.05 vs. -0.01 IU/mL; P=0.25). Among the 16 patients who received IPT, 11 (69%) had QFT-IT reversion at year 1 and an additional 2 patients (12%) had QFT-IT reversion at year 2; no conversion or significant increase in IFN-γ level from baseline were observed in these patients. The remaining 3 of the 16 patients (19%) had no reversion during the study period but significant decrease occurred in IFN-γ level (median change -0.74 IU/mL at year 1 and -1.50 IU/mL at year 2 from the initial level). These 3 patients had baseline interferon-γ levels of more than 1.2 IU/mL. The 3 QFT-IT-positive patients who declined IPT did not have QFT-IT reversion. In the QFT-IT-positive patient who declined IPT and subsequently developed active TB, the IFN-γ level decreased from 0.76 IU/mL to 0.63 IU/mL at year 1 (after completing active TB treatment) and to 0.28 IU/mL, which was deemed reversion, at year 2.

DISCUSSION

The major finding from this study was that QFT-IT-guided IPT was effective in preventing TB. None of the QFT-IT positive patients who completed at least 6 months of IPT developed
active TB during the 3-year follow-up period. The effectiveness of QFT-IT-guided LTBI treatment in this study was consistent with the results from a Norwegian study (15), yet our Thai cohort may have greater risk of TB exposure during the follow-up period given the higher prevalence of TB in the population. The use of both QFT-IT and TST at initial screening enabled us to categorize patient groups with concordant and discordant test results and allow comparative evaluation of the test performance. Among the 20 patients with LTBI defined by QFT-IT-positive results, 12 (60%) were TST non-reactive. The incidence of active TB in these 20 patients was significantly higher among those who refused IPT than those completing IPT. By using incident TB as the reference standard, these findings suggest better performance of QFT-IT than TST in identifying HIV-infected patients at-risk for developing active TB.

Subsequent LTBI testing is generally recommended in HIV-infected patients with initial negative LTBI screening, with the rationale that acquisition of TB may subsequently occur or low CD4 cell count at entry into care may confound initial screening (18). Given the unclear benefit of serial IGRA testing and associated costs (8, 15), we utilized TST as the subsequent test in patients with initial negative QFT-IT and non-reactive TST results (group 4). There was no TST conversion or active TB case detection in this patient group during the follow-up period. This finding suggests the potential use of serial TST in monitoring LTBI status after initial negative TST and IGRA tests among HIV-infected patients in resource-limited settings.

Additionally, this study demonstrated significant reduction of IFN-\(\gamma\) level after IPT in patients with LTBI at year 1 and subsequent non-significant reduction in IFN-\(\gamma\) between year 1 and year 2. Changes in IFN-\(\gamma\) level among patients who refused IPT were not significant. These findings suggest that frequent serial IGRA tests may be useful for monitoring IPT
response, especially in cases of whom the drug resistance of *M. tuberculosis* is unknown. Other studies reported similar responses of IFN-γ after LTBI treatment in both non-HIV-infected- (11, 13, 14, 19, 20) and HIV-infected individuals (15). However, studies in non-HIV-infected patients demonstrated the significant decrease in IFN-γ level regardless of compliance to LTBI treatment (14, 21). In a study from South Africa (14), QFT-IT was performed at the median of 9 days after TST. The TST may falsely elevate the baseline level of IFN-γ in the IPT untreated group (22), thus the decrease of the level back to normal was seen as significant decrease despite non-compliance to LTBI treatment. The observed significant decline in IFN-γ level among immunocompetent individuals, despite non-compliance to LTBI treatment, may be explained by biological variation and ability of self-immunity to eradicate *M. tuberculosis* in the latent form (21, 23). Nonetheless, this was not observed in our study and another study of HIV-infected patients (15). The reversion rate of QFT-IT was high (81%) in patients completing IPT and no reversion occurred in those without IPT in this study. This reversion rate was higher than those reported in HIV-infected persons in another study from Norway (23%) (15) and in non-HIV-infected persons (5-42%) (11, 13, 14, 19-21). The higher reversion rate in our study compared to the Norwegian study could be due to our higher rate of compliance to LTBI treatment, lower median baseline IFN-γ level (1.05 vs. 3.48 IU/mL) and the higher proportion of patients completing serial QFT-IT testing (95% vs. 52%) that can be accurately assessed for IFN-γ responses. Compared to the studies among non-HIV-infected individuals (11, 13, 14, 19-21), the higher reversion rate in this study could be explained by lower median baseline IFN-γ level and longer period between initial test and subsequent tests (24 months vs. 4-9 months after LTBI treatment) which allowed for detection of delayed reversion. In addition, most of the studies in non-HIV-infected persons did not assess adherence to LTBI treatment which may have impact on the IFN-γ response. Given the impact of the initial IFN-γ level on reversion, using magnitude
of decline in IFN-γ level instead of reversion at the time of retest to define IPT response may be more appropriate.

There are notable limitations to acknowledge associated with our study findings. First, the sample size was small and larger studies may be needed to inform evidence-based treatment guidance using IFN-γ response and reversion in QFT-IT positive patients who do and do not complete IPT. Second, we did not repeat QFT-IT in patients with initial QFT-IT negative result but used serial TST to monitor LTBI status per our protocol. Although the IFN-γ response could not be assessed among QFT-IT negative patients, this protocol was pragmatically-designed to be executed within our clinical care program and to assess TB prevention in a resource-limited setting.

In conclusion, QFT-IT was effective in diagnosing LTBI and guiding IPT among HIV-infected patients in this TB high-endemic setting. Patients with QFT-IT negative results at screening can be safely monitored using TST concurrently with the commencement of ART. Among patients with LTBI, significant decline in IFN-γ response was observed after IPT. However, reversion can be delayed or did not occur in those with high baseline IFN-γ levels. Further longitudinal studies with a larger sample size are needed to evaluate effectiveness of TST and IGRA-guided LTBI treatment and to determine appropriate magnitude of IFN-γ response and testing intervals to define reversion after IPT in HIV-infected patients from a TB endemic setting.

ACKNOWLEDGEMENT
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CONFLICT OF INTEREST

None to declare

REFERENCES


Study flow

All groups received TB symptom screening at each visit and chest radiograph yearly and when developing compatible symptoms including fever, productive cough more than 2 weeks, weight loss and night sweats.

Group 1 and 2 were offered IPT at baseline and received yearly QFT-IT.

Group 4 received yearly TST and IPT if subsequent TST was reactive.

f/u = follow-up; IPT = isoniazid preventive therapy; neg = negative; NR = non-reactive; pos = positive; QFT-IT = QuantiFERON®-TB Gold In-tube Test; R = reactive; TB = tuberculosis; TST = tuberculin skin test.

Changes in IFN-γ level (IU/mL) of the 19 QFT-IT-positive patients

Dash lines represent changes in IFN-γ level at specific time point of each individual patient. Solid line represents change in median IFN-γ level at specific time point of the 16 QFT-IT-positive patients who completed IPT.

IFN-γ level = interferon-gamma; IPT = isoniazid preventive therapy; QFT-IT = QuantiFERON®-TB Gold In-tube Test.
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year, median, range)</td>
<td>42 (25-49)</td>
<td>45 (29-64)</td>
<td>41 (26-53)</td>
<td>39 (17-65)</td>
<td>0.31</td>
</tr>
<tr>
<td>Male sex</td>
<td>7 (88)</td>
<td>3 (25)</td>
<td>10 (63)</td>
<td>59 (52)</td>
<td>0.04</td>
</tr>
<tr>
<td>Long-term tobacco smoking</td>
<td>1 (13)</td>
<td>0 (0)</td>
<td>7 (44)</td>
<td>15 (13)</td>
<td>0.04</td>
</tr>
<tr>
<td>Long-term alcohol drinking</td>
<td>2 (25)</td>
<td>2 (17)</td>
<td>5 (31)</td>
<td>19 (17)</td>
<td>0.50</td>
</tr>
<tr>
<td>Prior BCG vaccination</td>
<td>6 (75)</td>
<td>9 (75)</td>
<td>12 (75)</td>
<td>82 (72)</td>
<td>0.99</td>
</tr>
<tr>
<td>History of tuberculosis contact</td>
<td>1 (13)</td>
<td>2 (17)</td>
<td>2 (13)</td>
<td>16 (14)</td>
<td>0.99</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0 (0)</td>
<td>1 (8)</td>
<td>1 (6)</td>
<td>4 (4)</td>
<td>0.75</td>
</tr>
<tr>
<td>Duration of HIV infection (months, median, range)</td>
<td>30 (1-144)</td>
<td>45 (12-168)</td>
<td>54 (1-144)</td>
<td>56 (1-264)</td>
<td>0.85</td>
</tr>
<tr>
<td>CD4 count at enrollment (cells/µL, median, range)</td>
<td>461 (242-600)</td>
<td>405 (113-1148)</td>
<td>376 (9-914)</td>
<td>349 (8-1290)</td>
<td>0.38</td>
</tr>
<tr>
<td>CD4% at enrollment (median, range)</td>
<td>16 (7-27)</td>
<td>20 (11-35)</td>
<td>21 (1-30)</td>
<td>19 (1-40)</td>
<td>0.54</td>
</tr>
<tr>
<td>Receipt of antiretroviral therapy</td>
<td>4 (50)</td>
<td>11 (92)</td>
<td>14 (88)</td>
<td>84 (74)</td>
<td>0.12</td>
</tr>
<tr>
<td>HIV RNA suppression</td>
<td>4 (50)</td>
<td>11 (92)</td>
<td>13 (81)</td>
<td>81 (71)</td>
<td>0.17</td>
</tr>
<tr>
<td>Baseline TST reaction size (mm, median, range)</td>
<td>14 (10-30)</td>
<td>0 (0-2)</td>
<td>9 (5-13)</td>
<td>0 (0-4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Baseline IFN-γ level (IU/mL, median, range)</td>
<td>1.17 (0.36-9.88)</td>
<td>0.82 (0.38-4.31)</td>
<td>0.01 (-0.87-0.29)</td>
<td>0.01 (-0.31-0.32)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**NOTE:**
Data are in number (%) unless otherwise indicated.
BCG = Bacillus Calmette–Guérin; HIV = human immunodeficiency virus; IFN-γ = interferon-gamma; QFT-IT+ = positive QuantiFERON®-TB Gold In-tube Test; QFT-IT- = negative QuantiFERON®-TB Gold In-tube Test; RNA = ribonucleic acid; TST-NR = non-reactive tuberculin skin test; TST-R = reactive tuberculin skin test.
### Table 2 Tuberculosis and HIV outcomes during the 3-year study period

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Group 1 QFT-IT+ TST-R (N = 8)</th>
<th>Group 2 QFT-IT+ TST-NR (N = 12)</th>
<th>Group 3 QFT-IT‑ TST-R (N = 16)</th>
<th>Group 4 QFT-IT‑ TST-NR (N = 114)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tuberculosis outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3-year incidence of active tuberculosis (cases/100 patient-year)</td>
<td>0</td>
<td>2.78</td>
<td>0</td>
<td>0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Completed active tuberculosis treatment</td>
<td>NA</td>
<td>1/1 (100)</td>
<td>NA</td>
<td>NA</td>
<td>--</td>
</tr>
<tr>
<td>All-cause mortality (cases/100 patient-year)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>HIV outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retention in care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 year</td>
<td>7 (88)</td>
<td>12 (100)</td>
<td>15 (94)</td>
<td>108 (95)</td>
<td>0.21</td>
</tr>
<tr>
<td>At 2 years</td>
<td>7 (88)</td>
<td>12 (100)</td>
<td>15 (94)</td>
<td>108 (95)</td>
<td>0.21</td>
</tr>
<tr>
<td>At 3 years</td>
<td>7 (88)</td>
<td>12 (100)</td>
<td>15 (94)</td>
<td>108 (95)</td>
<td>0.21</td>
</tr>
<tr>
<td>CD4 count (cells/µL, median, range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 year</td>
<td>450 (250-666)</td>
<td>463 (162-1201)</td>
<td>556 (86-786)</td>
<td>397 (50-1326)</td>
<td>0.81</td>
</tr>
<tr>
<td>At 2 years</td>
<td>509 (225-750)</td>
<td>455 (150-1130)</td>
<td>639 (117-971)</td>
<td>471 (63-1353)</td>
<td>0.64</td>
</tr>
<tr>
<td>At 3 years</td>
<td>568 (288-775)</td>
<td>465 (199-1170)</td>
<td>660 (173-999)</td>
<td>481 (116-1668)</td>
<td>0.46</td>
</tr>
<tr>
<td>CD4 change (cells/µL, median, range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 year</td>
<td>+10 [-36-128]</td>
<td>+15 [-107-135]</td>
<td>+34 [-160-277]</td>
<td>+53 [-438-914]</td>
<td>0.59</td>
</tr>
<tr>
<td>At 2 years</td>
<td>+33 [-25-110]</td>
<td>+6 [-71-99]</td>
<td>+58 [-91-306]</td>
<td>+42 [-391-274]</td>
<td>0.30</td>
</tr>
<tr>
<td>At 3 years</td>
<td>+59 [-61-215]</td>
<td>+45 [-42-242]</td>
<td>+70 [-46-239]</td>
<td>+48 [-129-315]</td>
<td>0.61</td>
</tr>
<tr>
<td>HIV RNA suppression</td>
<td>7/7 (100)</td>
<td>12/12 (100)</td>
<td>14/15 (93)</td>
<td>105/108 (97)</td>
<td>0.68</td>
</tr>
<tr>
<td>At 2 years</td>
<td>7/7 (100)</td>
<td>12/12 (100)</td>
<td>15/15 (100)</td>
<td>108/108 (100)</td>
<td>1.00</td>
</tr>
<tr>
<td>At 3 years</td>
<td>7/7 (100)</td>
<td>12/12 (100)</td>
<td>15/15 (100)</td>
<td>108/108 (100)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**NOTE:**
Data are in number (%) unless otherwise indicated.
HIV = human immunodeficiency virus; QFT-IT+ = positive QuantiFERON®-TB Gold In-tube Test; QFT-IT‑ = negative QuantiFERON®-TB Gold In-tube Test; RNA = ribonucleic acid; TST-NR = non-reaction tuberculin skin test; TST-R = reactive tuberculin skin test.
Figure 1

All patients (N = 150)

Group 1
QFT-IT - pos
TST - R
(N = 8)

Group 2
QFT-IT - pos
TST - NR
(N = 12)

Group 3
QFT-IT - neg
TST - R
(N = 16)

Group 4
QFT-IT - neg
TST - NR
(N = 114)

IPT offering

Accepted IPT
(N = 6)

Refused IPT
(N = 2)

Completed IPT
(N = 6)

3-year f/u
TB (N = 0)
No TB (N = 6)

3-year f/u
TB (N = 0)
No TB (N = 1)
Lost to f/u (N = 1)

Refused IPT
(N = 2)

Completed IPT
(N = 10)

IPT not completed (N = 1)

3-year f/u
TB (N = 0)
No TB (N = 9)

3-year f/u
TB (N = 0)
No TB (N = 1)

3-year f/u
TB (N = 1)
No TB (N = 1)

3-year f/u
TB (N = 0)
No TB (N = 15)
Lost to f/u (N = 1)

3-year f/u
TB (N = 0)
No TB (N = 108)
Lost to f/u (N = 6)
Figure 2

IFN-γ level (IU/mL)