

Advance Publication by J-STAGE

Japanese Journal of Infectious Diseases

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Received: March 9, 2018. Accepted: January 4, 2019

Published online: January 31, 2019

DOI:10.7883/yoken.JJID.2018.105

Advance Publication articles have been accepted by JJID but have not been copyedited or formatted for publication.

Assessment of the 24th week success of anti-retroviral therapy in ACTHIV-IST Database: Results from a region with increasing incidence

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Running title: Results from a region with increasing incidence

Keywords: virological failure, antiretroviral therapy, immunological failure, HIV viral load, 24th week treatment success, Turkey

Summary: We aimed to assess 24-week virological and immunological success of treatment naive and experienced patients included in ACTHIV-IST database. ACTHIV-IST database were screened retrospectively from January 2012 to January 2014. Data of these patients such as age, sex, being treatment naive or experienced, date of diagnosis, date of commencing antiretroviral therapy, antiretroviral therapy regimen, CD4⁺ cell count and viral load before and after therapy were analyzed. In the 24th week of antiretroviral therapy, virological and immunological failures were 40 (17.9%) and 29 (14.1%), respectively. Virological failure was associated with a baseline viral load > 100,000 copies ($p=0.004$). CD4⁺ cell count lower than 200 cells/ μ l was not found to be associated with virological failure ($p=0.843$). Immunological failure was substantially rare in patients with a baseline CD4⁺ cell count >200 cells/ μ l ($p=0.005$). While an HIV-RNA $\leq 100,000$ copies/ml was protective against virological failure in the 24th week, in individuals having an HIV-RNA >100,000 copies/ml virological failure was 3.2 times more likely to occur. Baseline virological failure was the most predictive parameter to estimate 24th week virological success and virological failure. Virological failure is an important prognostic parameter resulting in CD4⁺ cell depletion, AIDS-related events and increase in mortality.

INTRODUCTION

Potent antiretroviral therapy (ART) has resulted in substantial reductions in mortality, progression to AIDS, opportunistic infections and hospitalizations, particularly among those who achieve viral suppression (1, 2). Viral suppression is also associated with decreased morbidity and mortality related to other comorbidities (eg, cardiovascular disease, liver disease, and nephropathy) and decreased HIV transmission to un-infected persons. Although incidence of HIV infection is low in Turkey, reported new cases are increasing. Viral load (VL) is an important and early parameter in assessment of the treatment success. CD4⁺ cell depletion and subsequent progression to AIDS is reported to be a consequence of VL in some studies (3). Causes of virological failure (VF) include high VL or depleted baseline CD4⁺ cells, comorbidities affecting adherence to treatment, baseline drug resistance or occurring during the treatment, failure of previous treatments, adverse effects of the drugs, suboptimal pharmacokinetic states, and suboptimal virology patency (4). In the contemporary era, success of the treatment may be summarized as suppression of the VL and achieving undetectable levels along with immunological success as well as preventing of HIV related events. (3). We aimed to assess 24-week virological and immunological success of treatment naive and experienced patients included in ACTHIV-IST (Action against HIV in Istanbul) database.

MATERIALS AND METHODS

Data collection

ACTHIV-IST database was used in our study. ACTHIV-IST consists of 5 centres following up treatment naive and experienced patients in Istanbul, which is the most populated city of Turkey. ACTHIV-IST was established in 2012 and new cases are being enrolled in the database retrospectively

Study Design and study participants

ACTHIV-IST database were screened retrospectively from January 2012 to January 2014. One thousand two hundred eighty nine patients older than 18 year old were included in this study. ART initiation decision depended on the up to date international guidelines at the time of the study. Three hundred thirty nine treatment naive and experienced patients were recorded in the database during the time span of the study. Of those, 256 patients were initiated ART and 32 were excluded due to absence of CD4+ cell count and VL follow up results in 24th week. Two hundred twenty four patients were enrolled in the study and data such as age, sex, being treatment naive or experienced, date of diagnosis, date of commencing ART, ART regimen, major ART mutation genes, adherence to treatment, CDC stage, presence of opportunistic and coexisting infections, CD4+ cell count and VL before and after therapy were analysed. Adherence to treatment was based on self-reports.

Definitions

Virological failure: VF is defined as a VL >1000 copies/ml in WHO guideline updated in 2015 (5-7). Whereas Department of Health and Human Services (DHHS) guide updated in April 2015 (4, 8) and British AIDS Association (BHIVA) guideline updated in January 2016 accepted a VL >200 copies/ml as VF, European AIDS Clinical Society (EASC) 2015 guideline accepted a VL >50 copies/ml (9). Taking into consideration laboratory errors, high sensitivity of the novel techniques and temporary increases (4, 10-12) when VL is 50-200 copies/ml; we accepted a VL >200 copies/ml as VF.

Immunological failure: According to 2010 criteria of WHO: Definitions of immunological failure (13) include (13) (1) a CD4 cell count of <100 cells/ μ L after 24 weeks of therapy, (2) a return to, or a decrease below, the baseline CD4 cell count after 24th week of therapy, or (3) a >50% decrease from the on-treatment peak CD4 cell count (5).

Complete Responder Patients: Both virological and immunological responders in 24th week of ART.

Non-responder Patients: Both virological and immunological non-responders in 24th week of ART.

Immunological Only Responders: Patients in whom viral replication is persisting despite immunological response.

Virological Only Responders: Patients who exhibit virological response in the absence of immunological response.

Microbiological analyses

Plasma HIV-1 RNA was measured using quantitative real time reverse transcriptase polymerase chain reaction (RT-PCR; COBAS Taq-Man HIV-1 test Roche Molecular Systems, Pleasanton, CA) with a lower limit of detection as 47 HIV-1 RNA copies/ml. For CD4 cell count, the samples were prepared and run on a Flow cytometer (FACS Calibur, Beckton Dickinson Biosciences, Franklin Lakes, NJ) according to the manufacturer's instructions.

Statistical analyses

Descriptive statistics of continuous quantitative data (age, CD4⁺ cell count before the treatment and in the 24th week, HIV-RNA VL were expressed as ratio and interval, whereas count and percentage were used to express frequency distribution of categorical data (sex, being treatment naive or experienced, ART regimen, treatment success). Normal distribution of continuous quantitative data was checked by sample Kolmogorov-Smirnov test. Normally distributed data were expressed as mean $\pm$ standard deviation and non-normally distributed data were expressed as median (interquartile range (IQR)). Independent-Samples Mann-Whitney U test and Independent Samples t-test were used to compare means of continuous variables. Relationship between categorical variables was tested by Pearson Chi-Square test

(of Fisher's exact test as applicable). Comparison of median baseline CD4⁺ cell count and 24th week median CD4⁺ count of treatment naive and experienced patients was made by using Friedman test. Association of increase in 24th week median CD4⁺ cell count with ART regimen was assessed by Independent-Samples Kruskal-Wallis test. Correlation of VL before ART with CD4⁺ cell count in 24th week and correlation of viral failure with variables were investigated by Pearson and Spearman's correlation test. Binary logistic regression ("backwards: LR" method) model was developed to predict 24th week viral failure of treatment naive and experienced patients. Data were analysed using Statistical Package for Social Sciences version 17 (SPSS Inc., Chicago, IL, USA). A statistical test was considered significant at $p \leq 0.05$ and 95% confidence interval.

RESULTS

Two hundred twenty-four patients were enrolled in the study. Mean age was 39.08 ± 11.51 . Of those, 184 (82.1%) were male, 209 (93.3%) were treatment naive. Median baseline CD4⁺ cell was 241 cells/mm³ (IQR, 93.75-324) and median baseline HIV-RNA VL was 177.05 copies/ml (IQR, 55.35-680.150) (Table 1). ART dose skipping ratio was 4.5% (n=10). Of those, 9 (4%) had HIV-related malignancies, 40 (17.9%) had concurrent opportunistic infections, 19 (8.5%) had co-infections. In the treatment naive patients group, major ART mutation gene was detected in 12 (5.7%) individuals. In a treatment experienced patient, who had both VF and IF, M184V nucleoside reverse transcriptase inhibitor (NRTI) mutation gene was detected as well as V90I major ART mutation gene for NNRTI. Four patients died during follow up.

Patients were grouped according to their response to treatment as complete responders, virologic only-responders, immunological only-responders, and non-responders. Considering the virological and immunological responses in all patients, 148 (66.1%) were complete

responders, 12 (5.4%) were non-responders, 36 (16.1%) were virological only responders and 28 (12.5%) were immunological only responders in our patient group. Being treatment naive was found to be a significant factor affecting complete response ($p=0.0001$). Taking into account only treatment experienced 15 patients, 9 (60%) exhibited discordant response ($n=8$ virological only responders, $n=1$ immunological only responder). Baseline CD4⁺ cell count was not different among groups ($p=0.154$) except that a baseline VL $\leq$ 100,000 copies/ml was associated with complete response significantly ($p=0.05$).

In the 24th week of ART in treatment naive and experienced patients, VF and IF were detected in 40 (17.9%) and 29 (14.1%) patients, respectively. Sex, adherence to treatment, and existence of major ART mutation genes were not associated with VF ($p=0.398$, $p=0.29$, $p=0.39$, respectively) and IF ($p=0.119$, $p=1$, $p=1$, respectively). VF ratio was not associated with HIV stage at admission ($p=0.7$), whereas immunological success ratio was higher significantly in patients in whom HIV stage at admission was 1-2 ($p=0.008$). Initial and 24th week levels of CD4⁺ cell were not different among age groups ($p=0.284$). VF was associated with IF (OR, 2.4; 95% CI, 0.98-5.7; $p=0.05$). A baseline virological load $\leq$ 100,000 copies/ml was protective against VF (OR, 0.3; 95% CI, 0.13-0.7; $p=0.004$). However, a baseline CD4⁺ cell count of 200 cells/ μ l or less was not found to be related with VF (OR, 1.07; 95% CI 0.51-2.2; $p=0.843$). On the other hand, a baseline CD4⁺ cell count >200 cells/ μ l was protective against IF (OR, 0.22; 95% CI, 0.07-0.66; $p=0.004$) (Table 2). Median time spans between diagnosis and initiation of treatment in VF and IF groups were 2.13 (IQR, 1.24-8.44) and 2.33 (IQR, 1.1-23.9) months, respectively. The difference was not statistically significant ($p=0.96$). This time span did not differ also in virological and immunological success groups ($p=0.57$).

24th week VL in ART naive and experienced patients was <50 copies/ml in 142 (63.4%), 50-200 copies/ml in 42 (18.8%) and >200 copies/ml in 40 (17.8%) patients. One hundred thirty

two (58.9%) of treatment naive patients had a VL <50 copies/ml. An HIV-RNA $\leq 100,000$ copies/ml was associated with a VL <50 copies/ml in 24th week ($p=0.001$).

The most common ART regimen was tenofovir disoproxil fumarate/emtricitabine-efavirenz (TDF/FTC+EFV) ($n=133$, 59.4%) followed by tenofovir disoproxil fumarate/emtricitabine-lopinavir/ritonavir (TDF/FTC+LPV/r) ($n=77$, 34.4%) (Figure 1). TDF/FTC+LPV/r regimen were preferred to TDF/FTC+EFV in individuals who were CDC stage 1-2 on admission ($p=0.006$) and had a baseline CD4⁺ cell count >200 cells/ μ l ($p=0.006$). On the other hand, use of these regimens were similar in terms of VF, IF, adherence to treatment, and a baseline virological load >100,000 copies/ml ($p=0.14$, $p=0.09$, $p=0.5$, $p=0.87$, respectively) (Table 3). Logistic regression analysis revealed that baseline HIV-RNA >100,000 copies/ml was the independent risk factor for 24th week VF in treatment naive and experienced patients (OR, 3.2; 95%CI, 1.33-7.71; $p=0.009$).

DISCUSSION

In HIV-infected individuals on antiretroviral therapy (ART), the decision on when to switch from first-line to second-line therapy is dictated by treatment failure, and this can be measured in three ways: clinically, immunologically, and virologically (14). Biologically, VF occurs earlier, followed by IF and clinical failure. Although immunological monitoring may result in premature switch, it is a more accurate parameter than clinical monitoring for assessing treatment success.

We assessed the treatment success with regard to both immunological and virological parameters in our study. VF was 17.9% and IF was 14.1%. VF was independent from age, sex, ART regimen, time elapsed from diagnosis to treatment, baseline CD4⁺ cell count, baseline VL, adherence to treatment, major ART mutation genes, and CDC stage in univariate and multivariate analyses (4, 15-17). However, baseline VL was an important

determining factor of treatment success also in complete responders group. A baseline CD4+ cell count < 200 cells/ μ l was associated with IF. Searching the literature with both English and Turkish keywords for studies from Turkey revealed a conference paper from Glasgow Congress 2014. In this paper, 693 HIV infected patients, diagnosed in 2011-2012 in 24 centres (HIV-TR cohort) from Turkey, were included. 24th week HIV-RNA was detected below 50 copies/ml in 385 patients (63.4%) in this cohort (18). Authors did not mention about risk factors in patients with an HIV-RNA>50 copies/ml.

In another study comparing treatment regimens regarding VF and IF, in which TDF/FTC was back-bone and LPV/r or EFV was the third agent, the authors concluded that the LPV/r including regimen was more successful immunologically. In this study, success of certain treatment regimens, adherence to treatment and adverse effects were assessed rather than factors influencing treatment success. (19). Therefore, to the best of our knowledge, in Turkey, our paper is the first study assessing treatment success with regard to probable risk factors.

Non-adherence to treatment, drug resistance and subtherapeutic drug level are shown to be causes of VF in the literature. However, VL monitoring was shown to be one of the best predictor of clinical progression and a major parameter of response to treatment in a study of 3675 patients from Johannesburg (20). Ingole et al demonstrated that baseline VL was an important risk factor for 24th week VF, and criteria of IF had very low sensitivity and PPV for predicting VF (14). Baseline VL was found to be the most important factor associated with the treatment success in our study. Rate of IF was lower than that of VF consistent with the literature suggesting that virological criteria were more predictive for assessment of treatment success and treatment may be switched in the early period by virological monitoring. Thus, treatment switching may be delayed if treatment success was assessed according to only immunological criteria. In a study advocating this by Rawizza et al., median VF and median

IF were 10.4 and 15.6 months, respectively and VL monitoring was found to be gold standard for assessing the treatment success in high-income countries (21). However, Philips et al reported that a baseline high VL was not associated with VF but viral suppression was slower in patients with a baseline VL>100.000 copies/ml (22). In our study, a baseline VL>100.000 copies/ml was associated with VF in univariate and multivariate analyses. We think VL monitoring as well as immunological criteria for assessing treatment success may help treatment switch be in the appropriate time in high-income countries.

Several studies demonstrated that immune reconstitution of individuals diagnosed and treated in older ages was poor compared with that of diagnosed and treated in younger ages despite successful ART and viral suppression (15). However Patterson et al. advocated that immune reconstitution and viral suppression did not differ among treatment regimens classified according to age (23). We grouped patients according as whether they were <50 or not and found no difference between VF and IF. In addition, CD4+ cell count in 24th week and mean change of CD4+ cell count from baseline were similar in two groups contrary to most studies. Likewise, virological success did not differ between two groups in Althoff et al's study (16). Better virological success in other studies is attributed to better adherence to treatment in older patients in their study. Furthermore, they showed that virological success was higher in NNRTI-based regimens compared with PI-based regimens in all groups (16). This might be explained by reduction in pill count with NNRTI-based regimens and higher adherence to the treatment. In a study from Turkey, the authors explained well adherence to PI-based regimens with advanced stage of the disease and lower adverse effects of PI-based regimens compared with NRTI-based regimens even with less pill counts (19). In subgroup analyses of NRTI-based regimen group, it is notable that patients were not in advanced CDC stages of the disease and had a higher baseline CD4+ cell count, in our study. However, treatment regimens were not associated with adherence to treatment. Prospective studies are needed to

assess the association of adherence to different treatment regimens with the stage of the disease, age, educational status, and marital status in Turkey.

Presence of major ART mutation genes was not associated with VF or IF in our study. Incidence of mutation genes were lower than that of other studies from our country (24). We think VF and IF should be assessed in cohorts having high incidence of ART mutation genes. Suppression of the VL and increase in CD4⁺ count is often anticipated with commencing of the ART, but this may not happen in every case. Of patients in our study, 66.1% were complete responders, 5.4% were non-responders, 16.1% were virological only-responders, and 12.5% were immunological only-responders. Ratio of complete responders was significantly higher in treatment naive group consistent with the literature. (14, 25). In industrialized countries, discordant responses have been reported to occur in 20–30% of patients 6 months to 2 years after starting therapy (26). There are limited data on discordant responses in patients being treated in developing countries. Risk factors for immunological-only response include younger age, a lower baseline CD4 count, higher baseline VL, poor adherence to therapy, and antiretroviral drug resistance. A virological-only response is associated with increasing age, low baseline CD4 count, and low VL (26–28). Nicastri et al reported that median baseline CD4⁺ cell count was higher and VL was lower in virological only responders whereas median baseline CD4⁺ cell count was lower and VL was higher in immunological only responders in their multicentre study (29). VL of virological only responders was lower in our study. As opposed to expectations probability of detectable viremia was found to be higher with PI/r-based ART regimens compared with NNRTI-based regimens in cohort studies and clinical trials (30, 31). There are contrary studies. Treatment success with PI-based regimens was reported to be higher than that with NNRTI-based regimens. Because HIV replicative capacity is higher in patients on NNRTI-based regimens than in patients receiving PI-based regimens, perhaps reflecting different barriers to selection

of resistant virus (14). In our study, ART regimen was not found to be associated with 24th week virological success in treatment naive and experienced patients, but immunological success was higher with NNRTI-based regimens. There are some limitations of this study. Small size of patient group especially small proportion of treatment-experienced patients was the major limitation. We did not assess the factors non-adherence to treatment. Adherence to treatment was based on self-reports rather than objective criteria. Furthermore, other factors which might influence VF and IF could not be investigated due to lack of short term follow up data.

CONCLUSION

Baseline VL was found to be the most predictive parameter to estimate 24th week virological success and 24th week VF was 3.2 times more likely to occur in individuals with a VL>100,000 copies/ml. VF is an important prognostic parameter resulting in CD4⁺ cell depletion, AIDS-related events and increase in mortality. To the best of our knowledge, we think our study is worthwhile in terms of being the first study assessing treatment success by virological and immunological criteria in treatment naive and experienced patients from Turkey.

Conflicts of Interest: None to declare.

Authors' contributions

S.B. and B.M. were responsible for concept and design of the study. S.B. undertook acquisition and interpretation of data and drafting of the manuscript. All authors contributed to data collection. B.M. undertook critical review of the manuscript. S.B. undertook statistical analysis and review of the manuscript.

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Figure 1: Distribution of ART regimens

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Table 1. Demographical data, HIV RNA level and CD4 cell count before initiation of ART.

Variable	
Sex no. (%)	
Female	40 (17.9)
Male	184 (82.1)
Age (mean±SD)	39.08±11.51
Female	38.35±11.85
Male	39.23±11.46
Treatment Status (n,%)	
Naive	209 (93.3)
Experienced	15, 6.7%
HIV RNA copies/mL	177,05 (IQR, 55,35-680,150)
CD4 cells/μL	241.5 (IQR, 93.75-324)

SD: standard deviation, IQR: interquartile range

Table 2. Univariate analysis of virological failure and immunological failure groups.

Characteristic	VF	VS	p-Value	OR	95% CI	IF	IS	p-Value	OR	95% CI
Sex: Male (n, %)	31, 16.8	153, 83.2	0.398	1.43	0.62-3.3	22, 75.9	148, 84.1	0.29	1.68	0.65-4.31
Age (median, IQR)	35, 28-47.5	39.5, 30.2-48	0.17			39, 30.5-50.5	38, 30-47	0.49		
Age <50 years (n, %)	35, 18.7	152, 81.3	0.45	1.47	0.53-4.05	22, 75.9	151, 85.8	0.17	0.52	0.2-1.34
HIV related malignancies: (n,%)	No data	9, 4.9	0.36			2, 6.9	4, 2.3	0.2	0.31	0.05-1.79
Coinfection:(n, %)	1, 2.5	18, 9.8	0.2	4.2	0.54-32.6	No data	19, 10.8	0.08		
Opportunistic infection:(n,%)	7, 17.5	33, 17.9	0.94	1.03	0.42-2.53	4, 13.8	34, 19.3	0.47	1.49	0.48-4.58
CDC stage:1 and 2 (n,%)	25, 62.5	109, 59.2	0.7	1.1	0.56-2.32	24, 82.8	100, 56.8	0.008*	3.64	1.33-10
Time on ART (months) (median, IQR)	2.13, 1.24-8.44	2.23, 1.1-9.26	0.96			2.33, 1.1-23.96	2.23, 1.2-9.1	0.57		
Treatment:Naive (n, %)	37, 17.7	172, 82.3	0.735	0.86	0.23-3.2	19, 65.5	171, 97.2	0.0001*	0.05	0.01-0.18
Major ART mutation gene: (treatment naïve and experienced) (n,%)	2, 5	11, 6	1	1.2	0.25-5.67	1, 3.4	9, 5.1	1	1.5	0.18-12.3
ARTnonadherence: (n, %)	3, 7.5	7, 3.8	0.39	2.05	0.5-8.2	3, 10.3	6, 3.4	0.11	3.2	0.7-13.8
InitialVL≤100,000 copy/mL (n,%)	29, 14.9	165, 85.1	0.004*	0.3	0.13-0.7	26, 89.7	154, 87.5	1	1.23	0.34-4.43
InitialCD4+>200 cell/μL (n, %)	21, 17.2	101, 82.8	0.843	1.07	0.51-2.2	23, 85.2	90, 55.9	0.004*	0.22	0.07-0.6

VL: viral load, IQR: interquartile range

VF: Virological Failure

VS: Virological Succeeding

IF: Immunological Failure

IS: Immunological Succeeding

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Table 3. Univariate analyses of FTC/TDF-EFV and FTC/TDF-LPV/r regimens

	FTC/TDF-EFV no. (%)	FTC/TDF-LPV/r no. (%)	p-value	OR	CI %95
CDC: stage 1-2 (n, %)	88, 66.2	36, 46.8	0.006*	2.2	1.25-3.95
Initial CD4+>200 cell/μL(n, %)	82, 66.7	32, 46.4	0.006*	0.4	0.23-0.79
Initial VL>100,000 copy/mL(n,%)	18, 13.5	10, (14.3)	0.87	1	0.47-2.39
VF	19, 14.3	17, 22.1	0.14	0.5	0.28-1.21
IF	11, 9.1	12, 17.1	0.09	0.4	0.2-1.16
ART nonadherence:(n, %)	128, 96.2	72, 93.5	0.5	0.5	0.47- 2.39

FTC/TDF-LPV/r: tenofovir disoproxil fumarate/emtricitabine-lopinavir/ritonavir,

FTC/TDF-EFV: tenofovir disoproxil fumarate/emtricitabine-efavirenz

Figure 1. Distribution of ART regimens

