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Nationwide Cohort Study of Antiretroviral Therapy Timing: Treatment Dropout and Virological Failure in China, 2011–2015

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Background. People living with human immunodeficiency virus (PLWH) are still being diagnosed late, rendering the benefits of "early" antiretroviral therapy (ART) unattainable. Therefore, we aimed to evaluate the benefits of "immediate" ART.

Methods. A nationwide cohort of PLWH in China who initiated ART January 1, 2011, to December 31, 2014 and had baseline CD4 results >200 cells/μL were censored at 12 months, dropout, or death, whichever came first. Treatment dropout and virological failure (viral load ≥400 copies/mL) were measured. Determinants were assessed by Cox and log-binomial regression.

Results. The cohort included 123 605 PLWH. The ≤30 days group had a significantly lower treatment dropout rate of 6.72%, compared to 8.91% for the 91–365 days group and to 12.64% for the >365 days group. The ≤30 days group also had a significantly lower virological failure rate of 5.45% (31–90 days: 7.39%; 91–365 days: 9.64%; >365 days: 12.67%). Greater risk of dropout (91–365 days: adjusted hazard ratio [aHR] = 1.33, 95% confidence interval [CI] = 1.25–1.42; >365 days: aHR = 1.55, CI = 1.47–1.54), and virological failure (31–90 days: adjusted risk ratio [aRR] = 1.35, CI = 1.26–1.45; 91–365 days: aRR = 1.66, CI = 1.55–1.78; >365 days: aRR = 1.85, CI = 1.74–1.97) were observed for those who delayed treatment.

Conclusions. ART within 30 days of HIV diagnosis was associated with significantly reduced risk of treatment failure, highlighting the need to implement test-and-immediately-treat policies.

Keywords. HIV/AIDS; antiretroviral therapy; treatment dropout; virological failure; China.

The benefits of "early" antiretroviral therapy (ART) initiation when CD4 counts are still high are well accepted. Studies have shown reduced risk of clinical events, increased odds of virological suppression, and prolonged survival [1, 2], as well as reduced risk of tuberculosis and some cancers [3, 4], and decreased sexual and mother-to-child transmission [5–7]. Thus, early ART is now recommended for all people living with human immunodeficiency virus (PLWH) [8, 9]. However, in real-world settings, many PLWH continue to be diagnosed late. These "late presenters" already have low CD4 counts and thereby have missed the opportunity to receive "early" ART. Therefore, in many settings, the focus has turned from "early" to "immediate" ART [2, 10–12], or ART initiation quickly after diagnosis, regardless of CD4 count.

Several projects in China have strived for earlier human immunodeficiency virus (HIV) diagnosis, faster ART initiation, and better retention in care, by expanding testing and treatment and streamlining the care cascade. Newly diagnosed PLWH were encouraged to promptly initiate ART regardless of CD4 count despite national guidelines restricting ART eligibility by CD4 level until early 2016. One study since found that time from diagnosis to ART initiation was reduced to a median of 5 days, ART initiation rose to 91% within 1 year, and mortality fell by 62% [13]. In another study, odds of achieving testing completeness (HIV, CD4, and viral load [VL] testing) within 30 days increased 20-fold, odds of initiating ART within 90 days increased 3.5-fold, and mortality declined by nearly 60% [14].

We hypothesized that immediate ART would reduce treatment dropout and virological failure, and we conducted a nationwide cohort study of patients in China's National Free ART Program (NFATP) to evaluate these outcomes and their determinants.

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METHODS

Design

A nationwide observational cohort study was conducted among NFATP patients who initiated ART between January 1, 2011, and December 31, 2014. Figure 1 describes the study design. For each participant, the beginning of follow-up was the date of first ART initiation. All were followed until the date of dropout, death, or 12-month follow-up, whichever came first. The study ended December 31, 2015.

Enrolment

All individuals who had records of first ART initiation between January 1, 2011, and December 31, 2014 were screened for eligibility. Criteria were (*a*) age ≥18 years on date of first ART initiation, (*b*) HIV infection route self-reported as sexual contact or injecting drug use, and (*c*) baseline CD4 count ≥200 cells/μL. PLWH with CD4 <200 cells/μL were not eligible because of their increased odds of rapid ART uptake due to severe symptoms. Participants were excluded for inability to link their records between the 2 databases or for having no follow-up records.

Data

Data were extracted from China's HIV/AIDS Comprehensive Response Information Management System (CRIMS) [15], a nationwide, real-time, reporting system that is controlled and maintained by the National Center for AIDS/STD Control and Prevention (NCAIDS) of the Chinese Center for Disease Control and Prevention (China CDC). In China, all new cases of confirmed HIV infection require CRIMS reporting. CRIMS has been described elsewhere [15], but in brief, records include demographics, HIV test dates, transmission routes, and CD4 test dates and results.

Upon initiation of ART, information must be reported into the NFATP Data System, a subsystem of CRIMS also controlled and maintained by NCAIDS, China CDC. Although the NFATP and its data system have been described previously [16–18], 2 important programmatic changes occurred during the study period in 2012. First, tenofovir disoproxil fumarate (TDF) was recommended for first-line ART regimens. Second, although the CD4 count-based ART eligibility criterion was ≤350 cells/μL over the entire study period, an exception for pregnant women, serodiscordant couples, and individuals with tuberculosis or hepatitis B coinfection was made, and these individuals were encouraged to begin ART regardless of CD4 level. NFATP Data System records include ART initiation dates, details of ART regimens, CD4 test dates and results, and VL test dates and results.

According to standard practice in China during our study, free CD4 testing was performed at treatment baseline and then repeated every 6–12 months after ART initiation. After

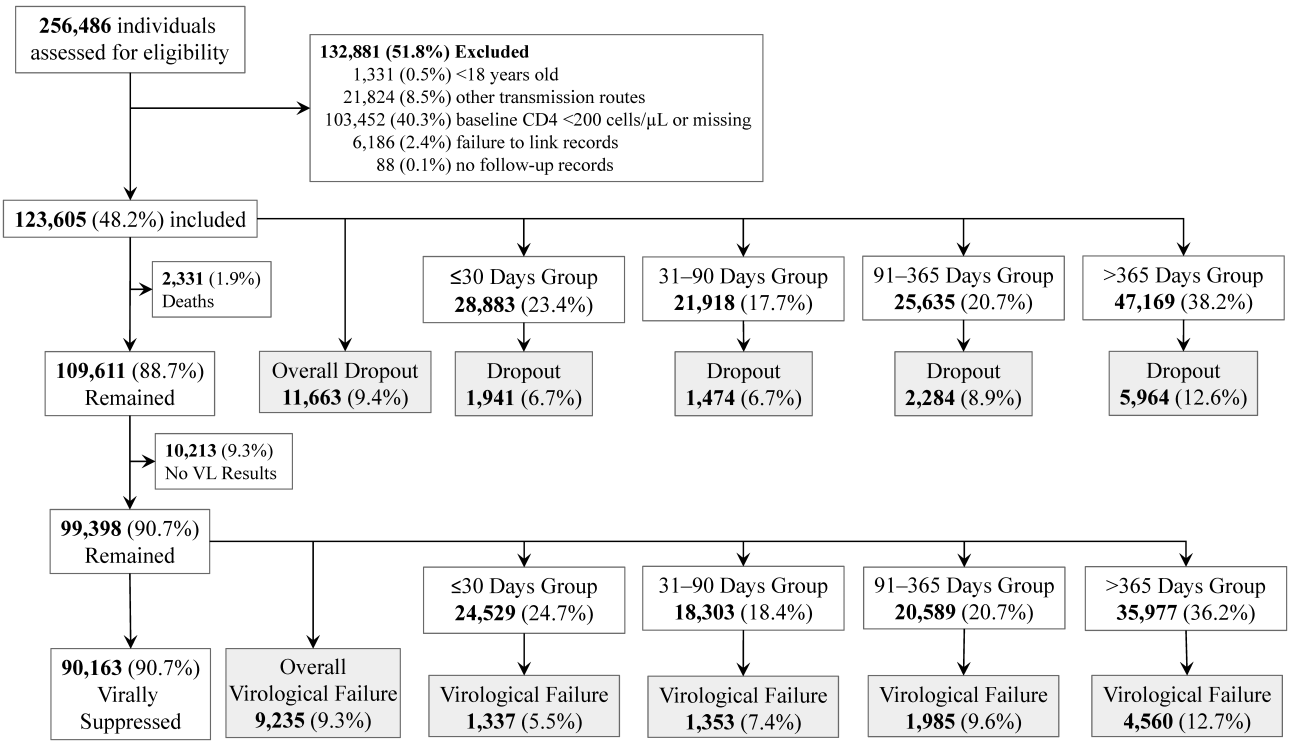

Figure 1. Study design and cohort development. All individuals newly enrolled in ART between January 1, 2011 and December 31, 2014 were screened. Participants were categorized into 4 subgroups: the ≤ 30 days group (ART initiation ≤ 30 days after HIV diagnosis), the 31–90 days group (ART initiation 31–90 days after HIV diagnosis), the 91–365 days group (ART initiation 91–365 days after HIV diagnosis), and the >365 days group (ART initiation >365 days after HIV diagnosis). Outcomes were treatment dropout and virological failure (VL ≥400 copies/mL) at 12-months follow-up. Abbreviations: ART, antiretroviral therapy; HIV, human immunodeficiency virus; VL, viral load.

ART initiation, clinical follow-ups were performed at 2 weeks, 1 month, 2 months, 3 months, and every 3 months thereafter. Free VL testing was performed once every 12 months after ART initiation. Study data were extracted on June 30, 2016.

Subgroups

All participants were categorized into 4 groups based on their time interval from the date of HIV diagnosis and the date of first ART initiation. Patients who initiated ART within 30 days of HIV diagnosis were categorized as the "≤30 days group." Patients who initiated ART after 30 days but within 90 days were categorized as the "31–90 days group." Patients who initiated ART after 90 days but within 1 year were categorized as the "91–365 days group." Finally, patients who initiated ART after 1 year were categorized as the ">365 days group." The first outcome, treatment dropout, was assessed after this initial categorization. Subsequently, only those remaining in the cohort at the end of the 12-month follow-up period (i.e., those who did not dropout or die), and had VL test results, were again categorized into the "≤30 days group," the "31–90 days group," the "91–365 days group," and the ">365 days group" for assessment of the second outcome, virological failure (Figure 1).

Outcomes

Treatment dropout events were defined as loss to follow-up or discontinuation of ART within 12 months after first ART initiation. Patients were censored at death or at last follow-up or at the end of the 12-month follow-up period. Virological failure was defined as VL ≥400 copies/mL at between 6 and 18 months after ART initiation. Because ART patients in China were provided free VL testing only once each year after ART initiation, we expanded the observational window for the virological failure outcome to ensure that we captured at least one VL test result for each participant. For those who had more than one VL test result during this window, the result nearest the 12-month follow-up date was selected. Determinants of treatment dropout and virological failure were also assessed.

Analysis

Main Analyses

Continuous variables were summarized using median and interquartile range (IQR) and categorical variables using number and percent. Characteristics of participants were compared using rank-sum test for continuous variables and χ^2 test for categorical variables. First ART initiation date was subtracted from latest censored date to calculate observed time, which was expressed in person-years (PY). Cox proportional hazards regression was used to assess determinants of treatment dropout, generating hazard ratios (HRs) and 95% confidence intervals (CIs). Univariate and multivariate log-binomial regression models were used to assess determinants of virological failure, producing risk ratios (RRs) and CIs. All *P*-values were 2-sided, and $P < .05$ was considered statistically significant.

Post hoc Analyses

We performed 3 additional analyses. First, to evaluate whether there was any additional benefit to ART initiation in intervals less than 30 days, we divided the ≤30 days group into 3 smaller groups: ≤1 day, 2–7 days, and 8–30 days, and present treatment dropout and virological failure rates. Second, to evaluate whether outcomes were different for those who initiated ART at higher CD4 counts, we created a subgroup with baseline CD4 count results >350 cells/μL and present treatment dropout and virological failure rates stratified by time interval from diagnosis to treatment. Finally, to evaluate virological failure using an "intent-to-treat" (ITT) approach, all individuals who either died or dropped out of treatment were included as failures, and ITT virological failure rates are presented stratified by baseline CD4 count and time interval from diagnosis to treatment.

All statistical analyses were performed using SAS software (version 9.1.3, SAS Institute Inc., USA).

Ethics

This study was approved by the Institutional Review Board of NCAIDS, China CDC. All NFATP patients signed an informed consent upon entry. No additional informed consent was sought. All records were de-identified prior to analysis.

RESULTS

A total of 256 486 individuals were screened for study eligibility, and a total of 123 605 (48.2%) were included in the study cohort (Figure 1). Characteristics of participants are shown in Table 1. Median age was 36 years (IQR: 28–46). A majority was male (70.5%) and reported that their HIV infection route was heterosexual contact (63.5%). Median baseline CD4 count was 308 cells/μL (IQR: 257–379).

Among the 123 605 participants in our cohort, 28 883 (23.4%) initiated ART within 30 days of HIV diagnosis (≤30 days group), whereas 21 918 (17.7%) initiated ART between 31 and 90 days after HIV diagnosis (31–90 days group), 25 635 (20.7%) initiated ART between 91 and 365 days after HIV diagnosis (91–365 days group), and 47 169 (38.2%) initiated ART more than 365 days after HIV diagnosis (>365 days group; Figure 1, Table 1). Median time between HIV diagnosis and ART initiation for the ≤30 days group was 14 days (IQR: 7–21), for the 31–90 days group was 51 days (IQR: 40–67), for the 91–365 days group was 190 days (IQR: 132–264), and for the >365 days group was 998 days (IQR: 622–1649; data not shown).

Those in the ≤30 days group tended to be older (age >50: 26.4% vs 21.8% in the 31–90 days group, 19.0% in the 91–365 days group, and 10.6% in the >365 days group). A greater proportion of those in the ≤30 days group reported their HIV infection route as heterosexual contact (73.0% vs 64.5%, 64.5%, and

Table 1. Characteristics of Participants

Characteristics	Entire Study Cohort, N (%)	≤30 Days Group, N (%)	31–90 Days Group, N (%)	91–365 Days Group, N (%)	>365 Days Group, N (%)	*P* Value
Overall	123 605 (100)	28 883 (100)	21 918 (100)	25 635 (100)	47 169 (100)	
Age, years						
Median (IQR)	36 (28–46)	39 (29–51)	37 (28–48)	36 (27–47)	35 (29–42)	<.001
18–30	39 887 (32.3)	8442 (29.9)	7301 (33.3)	9037 (35.3)	15 107 (32.0)	<.001
31–50	61 451 (49.7)	12 824 (44.4)	9847 (44.9)	11 723 (45.7)	27 057 (57.4)	
>50	22 267 (18.0)	7617 (26.4)	4770 (21.8)	4875 (19.0)	5005 (10.6)	
Sex						
Male	87 161 (70.5)	20 133 (69.7)	16 278 (74.3)	18 592 (72.5)	32 158 (68.2)	<.001
Female	36 444 (29.5)	8750 (30.3)	5640 (25.7)	7043 (27.5)	15 011 (31.8)	
HIV infection route						
Injecting drug use	15 405 (12.5)	700 (2.4)	735 (3.4)	1792 (7.0)	12 178 (25.8)	<.001
Homosexual contact	29 735 (24.1)	7103 (24.6)	7038 (32.1)	7312 (28.5)	8282 (17.6)	
Heterosexual contact	78 465 (63.5)	21 080 (73.0)	14 145 (64.5)	16 531 (64.5)	26 709 (56.6)	
TB coinfection						
Yes	3105 (2.5)	507 (1.8)	614 (2.8)	761 (3.0)	1223 (2.6)	<.001
No	120 500 (97.5)	28 376 (98.2)	21 304 (97.2)	24 874 (97.0)	45 946 (97.4)	
Hepatitis B coinfection						
Yes	8220 (6.7)	1851 (6.4)	1386 (6.3)	1549 (6.0)	3434 (7.3)	<.001
Yes	74 169 (60.0)	18 183 (63.0)	12 420 (56.7)	14 376 (56.1)	29 190 (61.9)	
Not tested	41 216 (33.3)	8849 (30.6)	8112 (37.0)	9710 (37.9)	14 545 (30.8)	
Serodiscordant couple						
Yes	28 175 (22.8)	6495 (22.5)	4995 (22.8)	6146 (24.0)	10 539 (22.3)	<.001
No	95 430 (77.2)	22 388 (77.5)	16 923 (77.2)	19 489 (76.0)	36 630 (77.7)	
Baseline CD4 count (cells/μL)						
Median (IQR)	308 (257–379)	298 (248–364)	297 (250–354)	309 (259–376)	319 (265–402)	<.001
200–350	85 220 (69.0)	20 784 (72.0)	16 264 (74.2)	17 844 (69.6)	30 328 (64.3)	<.001
>350	38 385 (31.0)	8099 (28.0)	5654 (25.8)	7791 (30.4)	16 841 (35.9)	
Initial ART regimen						
TDF not included	75 827 (61.4)	16 650 (57.7)	13 869 (63.3)	16 888 (65.9)	28 420 (61.4)	<.001
TDF included	47 778 (38.6)	12 233 (42.3)	8049 (36.7)	8747 (34.1)	18 749 (38.6)	
Year ART initiated						
2011	18 772 (15.2)	2840 (9.8)	2692 (12.3)	4346 (16.9)	8894 (18.9)	<.001
2012	25 454 (20.6)	5170 (17.9)	4510 (20.6)	5639 (22.0)	10 135 (21.5)	
2013	34 411 (27.8)	8118 (28.1)	6272 (28.6)	7099 (27.7)	12 922 (27.4)	
2014	44 968 (36.4)	12 755 (44.2)	8444 (38.5)	8551 (33.4)	15 218 (32.3)	

Characteristics of the entire study cohort, and subgroups based on duration from diagnosis to ART initiation—the ≤30 days group, the 31–90 days group, the 91–365 days group, and the >365 days group—in China, 2011–2015.

Abbreviations: ART, antiretroviral therapy; HIV, human immunodeficiency virus; IQR, interquartile range, TB, tuberculosis; TDF, tenofovir disoproxil fumarate.

56.6%), whereas a larger proportion of those in the >365 days group reported injecting drug use as their route of HIV infection (25.8% vs and 7.0% in the 91–365 days group, 3.4% in the 31–90 days group, and 2.4% in the ≤30 days group). A greater proportion of those in the >365 days group had higher baseline CD4 counts (>350 cells/μL: 35.9% vs 30.4%, 25.8%, and 28.0%).

Treatment Dropout and Determinants

A total of 11 663 participants dropped out of treatment within the 12-month follow-up period (Figure 1). As shown in Table 2, the overall dropout rate for the entire study cohort was 9.44% (CI = 9.27–9.60). Treatment dropout rate was lowest for the ≤30 days group at 6.72% (CI = 6.43–7.01) and the 31–90 days group at 6.73% (CI = 6.39–7.06), followed by the 91–365 days group at 8.91% (CI = 8.56–9.26) and the >365 days group at 12.64% (CI = 12.34–12.94). Details of treatment dropout rate overall and by time from diagnosis to treatment group stratified by participant characteristics can be found in Supplementary Table S1.

As shown in Table 3, 123 605 participants contributed 114 475 PY of observed time, during which a total of 11 663 participants dropped out of treatment, for an overall dropout rate of 10.19 per 100 PY. Significantly greater risk of dropout was found among those who were aged >50 years (adjusted HR [aHR] = 1.30, CI = 1.23–1.38), reported their route of HIV infection as heterosexual contact (aHR = 2.44, CI = 2.28–2.62) or injecting drug use (aHR = 5.31, CI = 4.94–5.71), had a baseline CD4 count >350 cells/μL (aHR = 1.19, CI = 1.14–1.24), and were in the 91–365 days group (aHR = 1.33, CI = 1.25–1.42) or the >365 days group (aHR = 1.55, CI = 1.47–1.54).

Table 2. Main Outcome Measures and Results of Post hoc Analyses

Time From Diagnosis to Treatment	Entire Cohort (Baseline CD4 >200 Cells/μL)			Subgroup Including Only Those With Baseline CD4 >350 Cells/μL		
	Treatment Dropout Rate, % (CI)	Virological Failure Rate, % (CI)	Intent-to-Treat Virological Failure Rate, % (CI)	Treatment Dropout Rate, % (CI)	Virological Failure Rate, % (CI)	Intent-to-Treat Virological Failure Rate, % (CI)
1 day group	7.86 (6.50–9.22)	4.58 (3.43–5.73)	19.45 (17.45–21.46)	8.56 (6.14–10.98)	5.07 (3.01–7.13)	19.84 (16.40–23.29)
2–7 days group	7.45 (6.79–8.11)	5.56 (4.94–6.19)	20.61 (19.59–21.63)	8.72 (7.47–9.96)	5.40 (4.31–6.50)	20.59 (18.80–22.38)
8–30 days group	6.43 (6.10–6.76)	5.48 (5.15–5.81)	19.46 (18.93–19.99)	7.90 (7.19–8.60)	5.18 (4.55–5.81)	19.31 (18.28–20.35)
≤30 days group	6.72 (6.43–7.01)	5.45 (5.17–5.73)	19.70 (19.24–20.16)	8.14 (7.54–8.73)	5.23 (4.70–5.76)	19.66 (18.79–20.52)
31–90 days group	6.73 (6.39–7.06)	7.39 (7.01–7.77)	22.67 (22.11–23.22)	7.53 (6.85–8.22)	6.70 (5.99–7.41)	21.65 (20.57–22.72)
91–365 days group	8.91 (8.56–9.26)	9.64 (9.24–10.04)	27.43 (26.88–27.97)	9.49 (8.83–10.14)	9.11 (8.40–9.83)	26.79 (25.80–27.77)
>365 days group	12.64 (12.34–12.94)	12.67 (12.33–13.02)	33.39 (32.97–33.82)	14.04 (13.51–14.56)	13.69 (13.10–14.29)	34.74 (34.02–35.46)
Overall	9.44 (9.27–9.60)	9.29 (9.11–9.47)	27.06 (26.81–27.30)	10.91 (10.60–11.22)	9.77 (9.44–10.11)	28.01 (27.56–28.46)

Main outcome measures of treatment dropout and virological failure overall and for the ≤30 days group, the 31–90 days group, the 91–365 days group, and the >365 days group is presented inside the red box. Post hoc analyses for the entire cohort as well as only those participants with baseline CD4 count results >350 cells/mm^3, and assessed at a range of earlier time points are also presented.

Abbreviation: CI, confidence interval.

Virological Failure and Determinants

Among the 99 398 participants remaining in the cohort (i.e., excluding those who had not dropped out or died) who had VL test results, a total of 9235 had VL ≥400 copies/mL (Figure 1). As shown in Table 2, the overall virological failure rate was 9.29% (CI = 9.11–9.47). Virological failure rate was lowest for the ≤30 days group at 5.45% (CI = 5.17–5.73), followed by the 31–90 days group at 7.39% (CI = 7.01–7.77) and the 91–365 days group at 9.64% (CI = 9.24–10.04), with the highest rate among the >365 days group at 12.67% (CI = 12.33–13.02). Details of virological failure rate overall and by time from diagnosis to treatment group stratified by participant characteristics can be found in Supplementary Table S2.

As shown in Table 4, greater risk of virological failure was found among those who reported their route of HIV infection as heterosexual contact (adjusted RR [aRR] = 1.78, CI = 1.67–1.90) or injecting drug use (aRR = 4.08, CI = 3.81–4.73) and were in the 31–90 days group (aRR = 1.35, CI = 1.26–1.45), the 91–365 days group (aRR = 1.66, CI = 1.55–1.78), or the >365 days group (aRR = 1.85, CI = 1.74–1.97).

Results of post hoc analyses are also presented in Table 2. After further dividing the ≤30 days group into smaller time intervals, we found very little difference in treatment dropout rates and virological failure rates between the shorter time interval groups. Similarly, we found that compared to the entire study cohort, only small differences were observed in treatment dropout and virological failure rates for those with baseline CD4 results of >350 cells/μL. By contrast, when we reanalyzed the virological failure outcome using the ITT approach, we observed much higher virological failure rates—19.70% for the ≤30 days group, 22.67% for the 31–90 days group, 27.43% for the 91–365 days group, and 33.39% for the >365 days group.

DISCUSSION

Our study revealed that those who initiated ART within 30 days after diagnosis had significantly reduced rates of treatment dropout and virological failure. Furthermore, those who initiated ART in 31–90 days had a 35% greater risk of virological failure, those who initiated in 91–365 days had a 33% greater risk of treatment dropout and 66% greater risk of virological failure, and finally, those who initiated ART in >365 days had a 55% greater risk of dropout and an 85% greater risk of virological failure. Notably, individuals in our delayed ART groups tended to be middle-aged, injecting drug users, and/or have higher CD4 counts, factors that may have influenced their ability to access care. Nevertheless, this reflects real-world conditions in China. We also noticed that individuals infected via heterosexual contact had 2.44 times greater risk of dropout and 1.78 times greater risk of virological failure, compared to those infected via homosexual contact. It is possible that homosexuals in urban areas, have better access to care, and have a better compliance.

Our findings add important additional dimensions to two recent studies of interventions meant to accelerate time from testing to treatment in China. The results of those studies were dramatically increased rates of timely diagnosis and thorough clinical assessment, substantially reduced time from diagnosis to ART initiation, significantly greater rates of ART initiation, and meaningfully improved survival [13, 14]. Furthermore, an even more recent nationwide cohort study of PLWH who had baseline CD4 counts >500 cells/μL found that those who entered China's NFATP and immediately initiated ART (≤30 days after diagnosis, compared to >30 days) experienced 63% lower mortality [19]. Thus, the benefit of immediate ART is meaningful, even for those who are not diagnosed late. Of note, another recent study in China found that those with CD4 counts >500 cells/μL at baseline had greater probability of attrition (i.e., loss to follow-up or ART cessation), suggesting that these patients may require additional support to promote retention in care over time [20].

Consistent with our study, a clinical trial of a new rapid ART initiation algorithm (ART in a single clinic visit) in South Africa

Table 3. Determinants of Treatment Dropout

Characteristics	Entire Cohort, N	Observed Time, PY	Dropped Out, N	Dropout Rate, per 100 PY	Unadjusted HR (CI)	*P* Value	Adjusted HR (CI)	*P* Value
Overall	123 605	114 475	11 663	10.19				
Age, years								
18–30	39 887	37 545	3386	9.02	1.00		1.00	
31–50	61 451	56 911	5883	10.34	1.14 (1.09–1.19)	<.001	0.90 (0.86–0.94)	<.001
>50	22 267	20 019	2394	11.96	1.31 (1.25–1.38)	<.001	1.30 (1.23–1.38)	<.001
Sex								
Male	87 161	80 716	8056	9.98	0.93 (0.90–0.97)	<.001	1.05 (1.01–1.10)	.061
Female	36 444	33 759	3607	10.68	1.00		1.00	
HIV infection route								
Homosexual contact	29 735	28 887	1142	3.95	1.00		1.00	
Heterosexual contact	78 465	72 460	7402	10.22	2.55 (2.40–2.72)	<.001	2.44 (2.28–2.62)	<.001
Injecting drug use	15 405	13 128	3119	23.76	5.79 (5.41–6.19)	<.001	5.31 (4.94–5.71)	<.001
TB coinfection								
Yes	3105	2780	355	12.77	1.25 (1.12–1.39)	<.001	1.06 (0.95–1.17)	.32
No	120 500	111 695	11 308	10.12	1.00		1.00	
Hepatitis B coinfection								
Yes	41 216	38 158	3683	9.65	1.00		1.00	
No	8220	7660	739	9.65	1.09 (1.01–1.18)	.022	1.15 (1.06–1.24)	.001
Not tested	74 169	68 656	7241	10.55	1.00 (0.92–1.08)	.998	1.10 (1.01–1.19)	.022
Serodiscordant couple								
Yes	28 175	26 113	2630	10.07	1.00		1.00	
No	95 430	88 362	9033	10.22	1.01 (0.97–1.06)	.522	1.10 (1.06–1.15)	<.001
Baseline CD4 count (cells/μL)								
200–350	85 220	79 217	7475	9.44	1.00		1.00	
>350	38 385	35 258	4188	11.88	1.26 (1.21–1.30)	<.001	1.19 (1.14–1.24)	<.001
Initial ART regimen								
TDF not included	75 827	70 074	7346	10.48	1.08 (1.04–1.12)	<.001	1.21 (1.16–1.26)	<.001
TDF included	47 778	44 401	4317	9.72	1.00		1.00	
Year ART initiated								
2011	18 772	17 466	1764	10.10	1.00		1.00	
2012	25 454	23 515	2513	10.69	1.06 (1.00–1.13)	.082	1.18 (1.11–1.25)	<.001
2013	34 411	31 439	3805	12.10	1.20 (1.13–1.27)	<.001	1.43 (1.35–1.52)	<.001
2014	44 968	42 055	3581	8.52	0.85 (0.80–0.90)	<.001	1.13 (1.06–1.20)	<.001
Time of ART initiation								
≤30 days group	28 883	27 285	1941	7.11	1.00		1.00	
31–90 days group	21 918	20 699	1474	7.12	1.00 (0.94–1.07)	.983	1.05 (0.99–1.13)	.13
91–365 days group	25 635	23 819	2284	9.58	1.34(1.26–1.43)	<.001	1.33 (1.25–1.42)	<.001
>365 days group	47 169	42 672	5964	13.98	1.94 (1.84–2.04)	<.001	1.55 (1.47–1.54)	<.001

Treatment dropout, observed time, dropout rate, and determinants of treatment dropout as assessed by Cox regression modeling in China, 2011–2015.

Abbreviations: ART, antiretroviral therapy; CI, 95 % confidence interval; HIV, human immunodeficiency virus; HR, hazard ratio; PY, person-years; TB, tuberculosis; TDF, tenofovir disoproxil fumarate.

observed both an increase in retention and in viral suppression at 10 months follow-up [21]. A study in rural Uganda and Kenya found that delay in ART initiation of more than 30 days after HIV diagnosis was associated with elevated rates of treatment dropout at 12 months [22]. In Myanmar, 94% of ART-eligible study participants were on ART by 90 days, and only 3% had dropped out of treatment in a median of 13 months of follow-up [23]. A very large, retrospective analysis of newly diagnosed PLWH in high-income countries has found that immediate initiation of ART increases viral suppression earlier in follow-up [24]. Finally, a smaller study of a same-day ART intervention in the United States found reduced time to virological suppression [25]. We believe that in the China context, immediate ART eliminates the chance that newly diagnosed PLWH receive confusing or incorrect messages about HIV/AIDS treatment and care, a problem known to contribute to losses to follow-up in the pre-ART period.

These results from around the globe make a good case for movement to test-and-immediately-treat policies. However, implementation will be challenging. For China, this means that some 200 000 diagnosed but untreated PLWH should be started on ART as quickly as possible. Streamlining of the HIV care cascade will be required. To cope with increased demand for HIV services, China's NFATP will again need to be rapidly scaled up. Moreover, close surveillance of HIV VL in ART patients via regular testing will be important for early detection

Table 4. Determinants of Virological Failure

Characteristics	Virological Failure, N (%)	Unadjusted RR (CI)	*P* Value	Adjusted RR (CI)	*P* Value
Overall	9235 (100)				
Age, years					
18–30	2764 (29.9)	1.00		1.00	
31–50	4767 (51.6)	1.15 (1.10–1.20)	.002	0.91 (0.87–0.95)	<.001
>50	1704 (18.5)	1.18 (1.11–1.25)	<.001	1.17 (1.10–1.24)	<.001
Sex					
Male	6574 (71.2)	1.05 (1.00–1.09)	.030	1.14 (1.09–1.19)	<.001
Female	2661 (28.8)	1.00		1.00	
HIV infection route					
Homosexual contact	1344 (14.6)	1.00		1.00	
Heterosexual contact	5713 (61.9)	1.78 (1.68–1.88)	<.001	1.78 (1.67–1.90)	<.001
Injecting drug use	2178 (23.6)	4.47 (4.19–4.76)	<.001	4.08 (3.81–4.73)	<.001
TB coinfection					
Yes	268 (2.9)	1.26 (1.12–1.41)	<.001	1.05 (0.94–1.18)	.38
No	8967 (97.1)	1.00		1.00	
Hepatitis B coinfection					
Yes	656 (7.1)	1.00		1.00	
No	4873 (52.8)	0.81 (0.75–0.88)	<.001	0.83 (0.77–0.89)	<.001
Not tested	3706 (40.1)	1.15 (1.06–1.24)	<.001	1.18 (1.09–1.28)	<.001
Serodiscordant couple					
Yes	2307 (25.0)	1.00		1.00	
No	6928 (75.0)	0.89 (0.85–0.93)	<.001	0.95 (0.91–1.00)	.038
Baseline CD4 count (cells/μL)					
200–350	6204 (67.2)	1.00		1.00	
>350	3031 (32.8)	1.08 (1.03–1.12)	<.001	1.07 (1.03–1.12)	.002
Initial ART regimen					
TDF not included	6201 (67.1)	1.30 (1.25–1.36)	<.001	1.34 (1.28–1.40)	<.001
TDF included	3034 (32.9)	1.00		1.00	
Year ART initiated					
2011	1771 (19.2)	1.00		1.00	
2012	1964 (21.3)	0.81 (0.76–0.86)	<.001	0.92 (0.87–0.98)	.009
2013	2499 (27.1)	0.78 (0.74–0.83)	<.001	1.00 (0.94–1.06)	.90
2014	3001 (32.5)	0.69 (0.65–0.73)	<.001	0.99 (0.93–1.05)	.74
Time of ART initiation					
≤30 days	1337 (14.5)	1.00		1.00	
31–90 days	1353 (14.7)	1.36 (1.26–1.46)	<.001	1.35 (1.26–1.45)	<.001
91–365 days	1985 (21.5)	1.77 (1.65–1.89)	<.001	1.66 (1.55–1.78)	<.001
>365 days	4560 (49.4)	2.33 (2.19–2.47)	<.001	1.85 (1.74–1.97)	<.001

Virological failure and determinants of virological failure as assessed by univariate and multivariate log binomial regression modeling in China, 2011–2015.

Abbreviations: ART, antiretroviral therapy; CI, 95% confidence interval; HIV, human immunodeficiency virus; RR, risk ratio; TB, tuberculosis; TDF, tenofovir disoproxil fumarate.

of virological failure and prompt switching to second-line therapy. Dramatic scale up of VL testing capacity and aggressive pursuit of new point-of-care technologies allowing decentralization and increased coverage will be needed. Finally, an estimated 300 000 PLWH in China still do not know their status [26]. China must redouble its case-finding efforts to help these people get the care they need.

Our study had some limitations. First, our study was conducted among subjects in routine HIV care. Thus, participants were not randomly assigned to groups, creating potential for bias. Second, missing values for some variables in our data set could have resulted in under- or overestimation of the outcomes of interest. Third, although unlikely, it is possible that some misclassification bias occurred, due to treatment interruptions or unascertained deaths being counted as dropouts. If an individual stopped and restarted ART during our 12-month follow-up period, they were still counted as on ART at 12 months. Moreover, all deaths among PLWH in China are recorded in CRIMS, causing them to be classified as died, not dropped out.

Our results demonstrate that immediate ART is associated with reduced treatment dropout and virological failure. Taken together with the results of other recent studies in China [13, 14, 19], and other settings [21–25, 27], it is clear that shortening the time from diagnosis to treatment maximizes health and survival and should be an urgent priority. Moreover, movement toward a test-and-immediately-treat policy could help China

meet the UNAIDS 90-90-90 targets, if it can overcome the many implementation challenges.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Author Contributions. Y. Z. and Z. W. designed the study. Y. Z. and S. Y. performed the statistical analysis. Y. Z., Z. W., and J. M. M. interpreted the results and developed the initial manuscript draft. All authors contributed to manuscript revisions and approved the final version for publication. Z. W. had full access to all the data and had final responsibility for the decision to submit for publication.

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