



Public-sector ART in the Free State Province, South Africa: Community support as an important determinant of outcome

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ABSTRACT

The treatment outcomes for large-scale public antiretroviral therapy (ART) programs in developing countries, although promising, are still preliminary. The scaling-up of ART in resource-limited settings is inevitably hampered by human resource shortages. Therefore, community support for ART patients may play an important role in achieving favorable treatment outcomes. This study aimed to extend the current literature by investigating how immunological and virological responses to ART, measured at three points in time (after six, 12, and 24 months of ART), are influenced by patient characteristics (age, sex), health literacy (educational level and knowledge about HIV/AIDS), baseline CD4 cell count, baseline viral load, and three forms of community support (treatment buddy, community health worker [CHW], and HIV/AIDS support group). Cross-lagged regression analysis was used to test these relationships in a sample of 268 patients enrolled in the public-sector ART program of the Free State Province of South Africa (2004–2007). After 24 months of ART, 76.4% of patients were classified as treatment successes (viral load < 400 copies/mL, CD4 \geq 200 cells/ μ L), compared with 64.1% at 12 months and 46.1% at six months. When we examined the predictors of ART success, baseline health and all three community support initiatives had a positive effect on ART outcomes after six months, whereas patient characteristics had little effect. Six months later, patients with the support of a treatment buddy, CHW, or support group had better ART outcomes, whereas the impact of baseline health had diminished. After two years of treatment, community support again emerged as the most important predictor of treatment success. This study confirms that the ART provided by South African public-sector health services is effective. These results provide evidence from the field that communities can be mobilized to sustain these favorable outcomes under conditions of limited human resources for healthcare.

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Introduction

As has been observed in many industrialized countries, the provision of antiretroviral (ARV) treatment (ART) can transform AIDS from a deadly disease into a more manageable, albeit still incurable, chronic illness (Bucciardini et al., 2006; Gifford & Groessl, 2002; Mocroft et al., 1998; Wouters, Meulemans, Van Rensburg, Mortelmans, & Heunis, 2007). The treatment outcomes for large-scale public ART programs in developing countries, although promising, are still preliminary (Baggaley, 2006; Fairall et al., 2008; Larson et al., 2008). As Ferradini et al. (2007) stated, medium- to long-term studies of patient cohorts are still scarce and have

usually involved very limited numbers of patients (DART Virology Group and Trial Team, 2006; Diabaté, Alary, & Koffi, 2007; Ferradini et al., 2007; Wouters, Heunis, van Rensburg, & Meulemans, 2009).

There are many challenges in successfully scaling-up ART in resource-limited settings. Although we acknowledge the still significant gaps in financing, shortages of human resources for healthcare are often cited as the most important obstacle to successful treatment scale-up (El-Sadr & Abrams, 2007; Schneider, Blaauw, Gilson, Chabikuli, & Goudge, 2006; Van Damme, Kober, & Kegels, 2008). Ample pilot studies have demonstrated good performances in terms of adherence, treatment success, and survival (Coetzee, Boule, et al., 2004; DART Virology Group and Trial Team, 2006; Diabaté et al., 2007; Orrell, Bangsberg, Badri, & Wood, 2003). However, this success rests on a significant human resource base because, although ART is highly effective, its management is complex. The large numbers of patients eligible for

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treatment, combined with the labor-intensive nature of public-sector ART programs, overstretch the public-health system and overburden healthcare staff. This is the case in South Africa (Gilbert, 2006; Van Damme, Kober, & Laga, 2006) and specifically in the Free State Province (Schneider, Hlophle, & Van Rensburg, 2008).

Where health systems require strengthening, the mobilization of the full human resource is necessary to ensure a successful comprehensive AIDS strategy (Pronyk, Harpham, Busza, et al., 2008; Schneider et al., 2006; Van Damme et al., 2008). In a recent Special Issue of *Social Science & Medicine* on Future Health Systems, Standing et al. (2008) and Van Damme et al. (2008) proposed that community mobilization is a possible strategy with which to meet treatment needs in the countries of southern Africa (Standing, Mushtaque, & Chowdhury, 2008; Van Damme et al., 2008). In practice, the *Médecins Sans Frontières* program in Lusikisiki, Eastern Cape Province, South Africa, has shown that engaging the community in HIV/AIDS care can improve the quality of care (MSF (Médecins Sans Frontières), 2006), providing social support and counseling when health professional roles must be limited to technical medical tasks because of human resource shortages (Standing et al., 2008). South Africa's *Operational Plan for Comprehensive HIV and AIDS Care, Management and Treatment* values these community support initiatives 'as an indispensable extension of the reach and strength of professional involvement in ART services' (Department of Health, 2003). However, their potential capacity to address the overwhelming human resource challenges in HIV care is inadequately understood (Pronyk et al., 2008; Schneider et al., 2008), making a systematic assessment of these programs and activities an urgently required research topic (Lehmann & Sanders, 2007).

Community support for ART patients in the public sector represents a continuum that stretches from more formalized (even paid) community health workers (CHWs) to informal activities, including voluntary support groups for people living with HIV/AIDS (PLWHA) or members of their social networks who volunteer to act as ARV treatment buddies. The roles of these initiatives have broadened with time, but are generally oriented towards the care and support of PLWHA, rather than AIDS prevention or the promotion of health (Schneider et al., 2008). CHWs are multiskilled and multipurpose HIV/tuberculosis workers, involved in counseling, adherence support, and home-based care. Since their emergence, various tasks have shifted from health professionals to CHWs, including tracking drop-outs and supplying drug-readiness training (Schneider et al., 2008). Given the nature and magnitude of the HIV epidemic, it is increasingly important to empower ART patients to take responsibility for their own treatment, rather than relying on CHWs to enforce ART adherence. Consequently, patients are requested to identify a 'treatment buddy', usually someone living in their household, who is aware of the patient's status and who is willing to assist him/her with adherence issues. The treatment buddy attends education sessions, signs the consent to begin ART together with the patient, and reminds and supports the patient once ART has commenced (Coetzee, Hildebrand et al., 2004). Patient mobilization and empowerment also include the support of an AIDS patient by fellow PLWHA. Peer-support groups, which are generally not exclusively for patients on ART, facilitate the discussion of factors that may enhance or impede adherence, such as adverse events, disclosure, and other psychosocial issues, and also act as forums for health promotion and education.

Previous studies have identified the patient's characteristics, pre-ART health, and health literacy (educational level and knowledge about HIV/AIDS and ART) as predictors of ART outcomes (DART Virology Group and Trial Team, 2006; Hinkin et al., 2004; Kalichman et al., 2008; van Leth et al., 2005; Murphy, Marelich, Hoffman, & Steers, 2004; Nicastrri et al., 2005; Wood et al., 2006). However, the published longitudinal research into the relationship

between community support for ART patients and treatment outcomes is limited, especially in resource-limited settings (Burgoyne, 2005; MSF (Médecins Sans Frontières), 2006). This study aimed to extend the current literature by investigating how immunological and virological responses to ART, measured at three points in time (after six, 12, and 24 months of ART), are influenced by patient characteristics (age, sex), health literacy (educational level and knowledge about HIV/AIDS), baseline CD4 cell count, baseline viral load, and three forms of community support (treatment buddy, CHW, and HIV/AIDS support group) in a sample of 268 patients enrolled in the public-sector ART program of the Free State Province of South Africa (2004–2007). In addition, a series of open-ended questions was used to assess the contributory role of these community support initiatives in achieving durable ART success.

Methods

Setting

This study is part of an ongoing cohort study of patients enrolled in the public-sector ART program in the Free State Province of South Africa. This research was approved by the Ethics Committee of the Faculty of Humanities, University of the Free State, and authorized by the Provincial Department of Health.

Study population

The sampling frame consisted of a list of names, obtained from the Provincial Department of Health, of adult patients certified as medically ready to commence ART (CD4 < 200 cells/ μ L and/or WHO stage IV) within two months of the first patient having received his/her treatment. To detect a 5% difference in this population at the 95% confidence level, 268 patients were selected randomly, in proportion to the number of patients per clinic.

Data collection and study variables

'Baseline' was defined as the date of ART initiation (time 0 or after 0 days of ART). We gathered three waves of panel data to examine the impact of community support on treatment outcomes. At time 1 (median treatment duration = 171 days [IQR: 151–189 days] or approximately six months), trained enumerators conducted face-to-face interviews with 268 study participants using a standard questionnaire, after the written consent of all the patients had been obtained, first by the clinic nurse and later again by the enumerator. Approximately six months later (time 2, median treatment duration = 363 days [IQR: 321–391 days]), 232 patients of the original cohort of patients were interviewed again using an updated version of the questionnaire. One year later, 203 of the original study participants were interviewed yet again (time 3, 749 days [IQR: 726–775 days]).

Because patient characteristics may influence ART success, data on age and sex were collected. In a recent article, Nutbeam (2008) stated that health literacy reflects two distinctive concepts (Nutbeam, 2008). First, health literacy can be defined as a risk factor. According to this definition, low literacy and numeracy skills limit a patient's ability to comprehend health information and follow written medical instructions (Lee, Arozullah, & Cho, 2004). Consequently, health literacy can be developed through education. In the absence of a specific health literacy scale, we used the patient's educational level as an indicator of this concept of health literacy. In measuring educational level, five educational categories were established based on the patient responses: no education, primary school, some secondary education, grade 12, and tertiary education. Second, a different conceptual approach defines health literacy as an

asset or a means to enabling individuals to exert greater control over their health and treatment. In this study, the patient's knowledge of HIV/AIDS and ART was measured as reflecting the patient's understanding of the disease and treatment and his/her skills and capacities to support his/her empowerment in health-related decision making and management (Nutbeam, 2008). Knowledge about HIV/AIDS and ART was measured using nine five-point Likert-scale items¹ (Balfour et al., 2007). An exploratory factor analysis was performed to examine the factor structure of the knowledge scale (1 factor). The variance extracted test and Cronbach's α for the scale used to measure the patient's knowledge about HIV/AIDS and ART indicated good validity and reliability. Raw item scores were summed and divided by the number of items on the scale to produce a factor score measuring knowledge about HIV/AIDS and ART.

CD4 cell counts and plasma HIV viral RNA levels, measured immediately before the commencement of ART (time 0), were used as the baseline measures of CD4 cells and viral load, respectively. Information on community support was collected at times 1, 2, and 3. Because the patient groups were not mutually exclusive, the three forms of community support were treated separately in all analyses: having a treatment buddy, having a CHW, and participating in an HIV/AIDS support group. Finally, and in accordance with previous studies, we measured the treatment outcomes as a combination of the virological and immunological measures (Brigido et al., 2004; Ferradini et al., 2007; Wood et al., 2006). Virological status was measured as the level of plasma HIV viral RNA (viral load) at times 1, 2, and 3, and was categorized dichotomously as undetectable (< 400 copies/mL) or detectable (≥ 400 copies/mL) (Monforte et al., 1998). Immunological outcomes were assessed at times 1, 2, and 3, with a distinction made between patients who had not responded ($CD4 < 200$ cells/ μ L) and patients who had partially or fully responded ($CD4 \geq 200$ cells/ μ L). We calculated a summation score that categorized patients as treatment successes (patients with undetectable viral load and $CD4 \geq 200$ cells/ μ L), partial treatment successes (patients with undetectable viral load or $CD4 \geq 200$ cells/ μ L), and treatment failures (patients with detectable viral load and $CD4 < 200$ cells/ μ L) (Brigido et al., 2004; Ferradini et al., 2007; Monforte et al., 1998; Wood et al., 2006). All clinical data were collected directly from the patient files only after the written consent of all the patients had been obtained and with the authorization of the Provincial Department of Health.

Finally, the instrument also included both closed and open-ended questions focusing on the characteristics of the community support providers (sex, age, relationship to the patient), the types of support provided by these community support initiatives, and the patient satisfaction levels with this support (Wouters, Heunis et al., 2008). The closed questions allowed us to investigate the nature of the community support providers (sex, age) and how the providers were related to the patients. The open-ended questions yielded rich qualitative descriptions, which were most useful in understanding the complex issues and processes encouraging or hampering durable ART success—that is, the types of support provided by the community support initiatives.

¹ The patients were asked to indicate on a five-point scale the extent to which they agreed or disagreed with each of the following statements: (i) Unprotected sex is safe because of ART; (ii) People on ART can still transit HIV through unprotected sex; (iii) Unprotected sex with withdrawal before ejaculation protects against HIV; (iv) It is unacceptable to stop ART after gaining weight; (v) It is acceptable to stop ART when one no longer suffers from opportunistic infections; (vi) One can protect other people from HIV by sharing one's ART; (vii) ART cures HIV; (viii) After a couple of years, one can stop ART; (ix) Missing a few doses of ART is acceptable. These items are the outcome of a literature review and the researchers' visits to the primary healthcare facilities assessed in the study.

Statistical analyses

We used a fully cross-lagged regression analysis² to study the impact of baseline health, patient characteristics, health literacy, and community support on ART outcomes over time (Hays, Marshall, Wang, & Sherbourne, 1994). Fig. 1 presents the regression model to be tested. Dashed arrows connecting like variables over time represent within-variable regression paths. By including the regression paths between the same variable measured in different survey waves, we estimated the relative stability of the variable over time. Solid lines show the regression paths from all three community support initiatives (treatment buddy, CHW, and support group) to the ART outcomes at the three time points. The model also separately analyzes the effects of patient characteristics (age and sex) and baseline health (baseline CD4 and viral load [time 0]) on ART outcomes for each wave. Finally, we added the cross-lagged effects (e.g. between times 1 and 2) of all three community support measures on the ART outcomes to test the impact of community support on health over time. The analysis was performed with the statistical software package LISREL version 8.72.

The data from the open-ended questions were transcribed thematically and the content was analyzed by two investigators. Common ideas were categorized into key themes grounded in the respondents' accounts, and were semiquantified to allow the identification of dominant themes.

Results

Sample description

Table 1 shows the demographic characteristics and baseline health of our sample of 268 ART patients. It also describes the health literacy measures and the use of social capital initiatives over time. The patients' virological and immunological measures are also shown across time.

Overall, none of the 268 patients had both a CD4 cell count above 200 cells/ μ L and an undetectable viral load at the start of treatment. A descriptive analysis showed that after six months of ART, 46.1% of respondents could be classified as treatment successes (CD4 cell count ≥ 200 cells/ μ L and undetectable viral load), 44.3% as partial treatment successes, and only 9.6% had not yet responded to treatment. Approximately 12 months after the commencement of ART, the proportion of treatment successes had increased to 64.1%, depleting the number of partial treatment successes (27.4%), whereas the number of treatment failures remained stable (8.5%). Two years after the initiation of ART, 76.4% of respondents were classified as treatment successes, further depleting the proportion of partial treatment successes (16.1%). Again, the proportion of patients not responding to treatment had decreased only slightly to 7.5%.

² Cross-lagged regression analysis is a statistical method that allows the examination of the interrelationships between multiple variables over time. This method requires, at minimum, two variables measured synchronously at two points in time. Cross-lagged regression analysis is particularly well suited to addressing longitudinal analytical problems. Unlike standard multiple regression models, cross-lagged regression analysis using LISREL (structural equation modeling) permits the simultaneous assessment of multiple dependent variables in a single model. LISREL also allows the examination of both the direct and indirect effects of one variable on another. Using LISREL, it is possible to estimate, for example, whether the temporal changes in the support mechanisms are related to ART efficacy. Moreover, within the context of LISREL, a given variable (e.g., ART success at T1) can be treated as both independent (predicting ART success at T2) and dependent (predicted by community support), providing a model that more closely parallels the complex nature of most clinical phenomena.

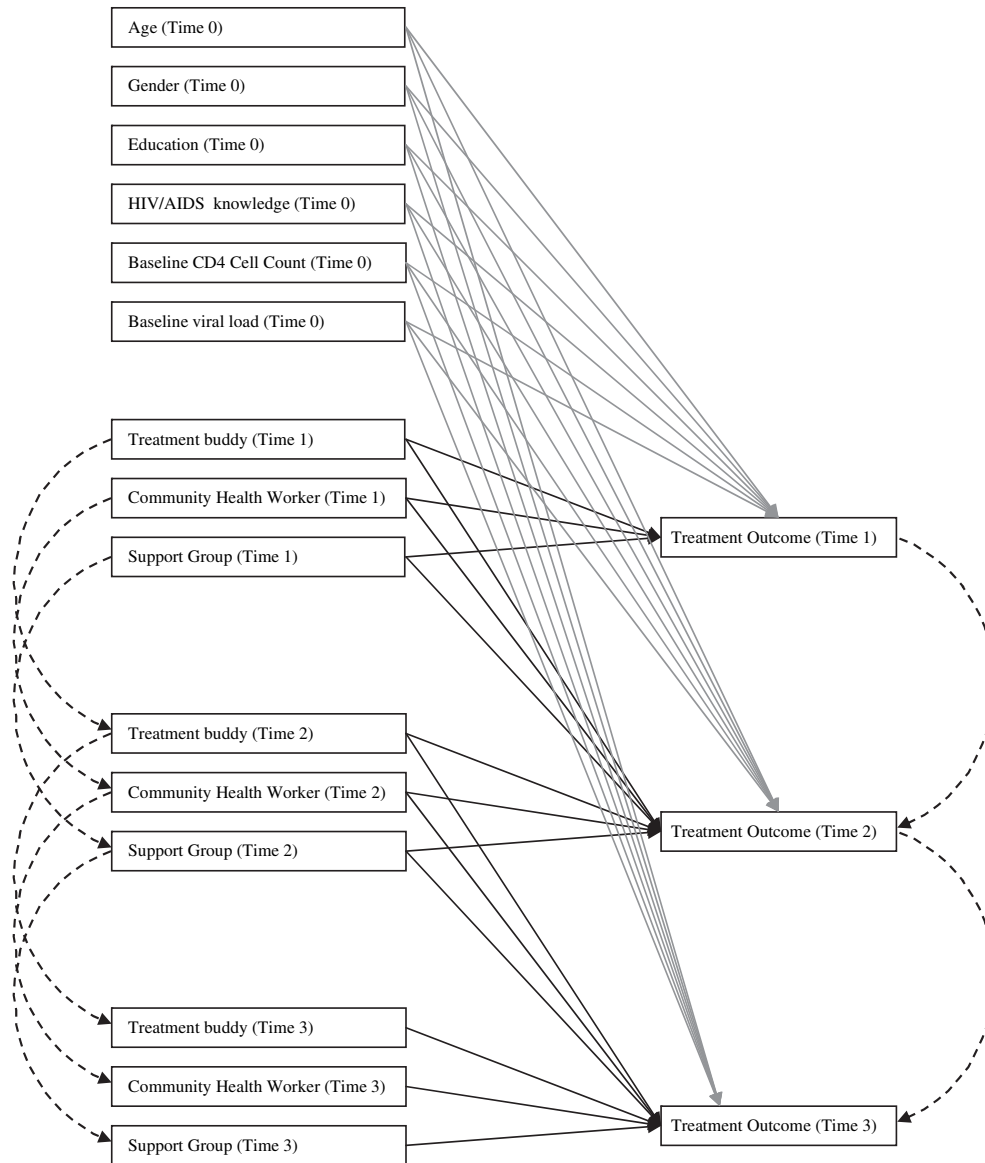


Fig. 1. The fully cross-lagged regression model with the hypothesized relationships between patient characteristics, baseline health, health literacy, support of a treatment buddy, community health worker, or support group, and treatment outcomes across three time points.

Attrition analysis

Long-term patient retention is essential for the program's success. In this study, attrition was defined as the discontinuation of ART for any reason, including death, loss to follow-up, and the cessation of ART while remaining in care. Patients who refused an interview or moved to another district while remaining in care were not considered to be subjects of attrition. The attrition rate of 8.2% (22 patients) between the first two interviews can be mainly attributed to death ($n = 15$) and loss to follow-up ($n = 6$). Only one patient voluntarily withdrew from the ART program. The reasons for attrition at time 3 (10.2%, 25 patients) were similar: death ($n = 19$) and loss to follow-up ($n = 6$). A series of bivariate analyses indicated that having a treatment buddy, CHW, or support group at time 2 positively influenced patient retention at time 3. Differences in the sociodemographic measures (age, sex) and the study variables (baseline health, health literacy, treatment buddy, CHW, and support group) between the responders and nonresponders at the other time points were not significant, possibly because the

number of discontinuations was small. When we studied the clinical parameters, the patients lost to death had a significantly lower mean baseline CD4 cell count (mean difference = 32 cells/ μ L, $P < 0.05$) than that of the surviving patients. Patients who refused to be interviewed at time 2 (after 12 months of ART) had a significantly higher viral load six months earlier (after six months of ART) than did the retained patients (mean difference = 171,913 copies/mL, $P < 0.05$). Given the potentially disturbing influence of attrition on the impact of community support on ART outcomes, a detailed sensitivity analysis was performed, which confirmed the findings of the original model.

Model statistics

The results for model fit are shown in Table 2. The root mean square error of approximation (RMSEA) indicates the close fit of the overall model, with reasonable errors of approximation in the population. Other goodness-of-fit statistics suggest that the structural model not only fits adequately, but also withstands the tests of

Table 1
Baseline characteristics, health literacy, community support, and clinical outcomes in a sample of ART patients ($n = 268$).

Demography				
Male, %				34.7
Age, mean (SD)				37.9 (8.6)
Health literacy				
Education, %				
No education				3.7
Primary education				28.7
Some secondary education				47.8
Grade 12				15.3
Tertiary education				4.5
HIV/AIDS & ART knowledge				
Mean (SD) ^a				3.7 (0.40)
Variance explained (%)				31.4
Cronbach's α				0.873
	Baseline	Time 1 ($n = 268$)	Time 2 ($n = 232$)	Time 3 ($n = 203$)
Community support				
Treatment buddy, %	—	51.5	50.7	31.7
CHW, %	—	7.5	6.9	3.8
Support group, %	—	14.8	17.5	18.0
Virological and immunological response				
CD4 count (cells/ μ L), mean (SD)	109 (68)	236 (158)	275 (140)	393 (207)
CD4 gain (cells/ μ L), mean (SD)	—	+ 127 (130)	+ 39 (101)	+ 118 (259)
<200 cells/ μ L, %	95.9	44.8	30.3	17.3
\geq 200 cells/ μ L, %	4.1	55.2	69.7	82.7
Viral load (copies/mL), mean (SD)	299,090 (628,028)	34,488 (221,029)	5833 (36,128)	8855 (42,976)
<400 copies/mL, %	3.3	83.5	84.7	85.6
\geq 400 copies/mL, %	96.7	16.5	15.3	14.4
Treatment outcome				
Treatment failure, %	—	9.6	8.5	7.5
Partial treatment success, %	—	44.3	27.4	16.1
Treatment success, %	—	46.1	64.1	76.4

^a Minimum score = 0 meaning no HIV/AIDS knowledge, and maximum score = 4 meaning perfect HIV/AIDS knowledge.

parsimony (RSMEA = 0.0376, comparative fit index = 0.945, parsimonious normed fit index = 0.511).

Predictors of treatment outcomes at six, 12, and 24 months

Table 2 presents the significant paths and standardized regression coefficients of the proposed model, investigating the impacts of baseline health literacy, patient characteristics, and community support initiatives on ART outcomes.

Baseline health

During the first six months of ART, the treatment outcomes were significantly influenced by baseline health. Patients with low baseline CD4 cell counts had a greater risk of virological and immunological failure compared with those of patients with high baseline CD4 cell counts ($\beta = 0.25$, $P < 0.001$). Similar results were observed among patients with low baseline viral loads, insofar as baseline viral suppression increased the patient's chance of being a treatment success by 0.18 standard deviations ($P < 0.001$). Approximately six months later, baseline CD4 cell values and baseline viral loads still significantly influenced treatment outcomes. However, pre-ART health had a much weaker impact on ART outcomes at this stage of treatment. After two years of ART, the

impact of baseline health on ART outcomes became even weaker. Baseline CD4 cell count ($\beta = 0.05$, $P < 0.05$) was significantly associated with ART outcomes at this stage of treatment, but there was no significant association between baseline viral load and ART outcome. In other words, the significance of baseline health as a predictor of ART outcome diminished as the duration of ART increased.

Patient characteristics

Treatment outcome after six months of ART was not strongly associated with patient characteristics. Virological and immunological outcomes were weakly associated with the respondent's age: greater age increased a patient's chance of being a treatment success by 0.09 standard deviations ($P < 0.01$). Sex did not have a significant impact on the ART outcomes at time 1. Approximately six months later, there was no significant association between patient characteristics and treatment outcomes. Neither the age of the patient nor his/her sex significantly affected the ART outcomes at 12 months. After two years of ART, only the sex of the patient ($\beta = 0.09$, $P < 0.05$) was significantly associated with the ART outcomes. Among our sample of patients, female patients had more favorable ART outcomes at 24 months than those of male ART patients.

Health literacy

Health literacy only briefly and very moderately predicted ART outcomes. The patient's educational level contributed significantly but weakly to the explanation of the variance in ART outcomes ($\beta = 0.07$, $P < 0.05$) at time 1. Higher education was associated with a better ART response. Knowledge about HIV/AIDS and ART did not significantly affect the treatment outcomes at this stage of treatment. Approximately six months later, neither the patient's educational level nor his/her knowledge about HIV/AIDS and ART was associated with a better ART response. After two years of ART, both health literacy measures again did not significantly affect ART outcomes.

Community support

Community support emerged as an important predictor of treatment success during the first six months of ART. Patients with a treatment buddy ($\beta = 0.17$, $P < 0.001$) had significantly better treatment outcomes than patients without such support. The treatment response was significantly higher ($\beta = 0.11$, $P < 0.01$) among patients with an assigned CHW, and participation in a support group also had a significant positive effect ($\beta = 0.13$, $P < 0.05$) on the selected virological and immunological measures. Overall, the CD4 cell count was significantly higher among patients who had high levels of community support. This group of patients was also more likely to achieve and maintain viral suppression.

One year into treatment, the importance of community support in achieving durable treatment success was even greater. When we analyzed the impact of community support at times 1 and 2 on treatment outcomes at time 2, community-based support initiatives showed a significant correlation with the one-year treatment outcomes. The cross-lagged paths indicated that having a treatment buddy ($\beta = 0.13$, $P < 0.05$) or a CHW ($\beta = 0.11$, $P < 0.05$) at time 1 significantly increased a patient's chance of having a CD4 cell count above 200 cells/ μ L and achieving viral suppression at time 2. Participating in a support group had no significant cross-lagged impact on treatment outcome. At time 2, all three community support measures were positively associated with the one-year treatment outcome. Patients with a treatment buddy had a greater chance ($\beta = 0.17$, $P < 0.001$) of treatment success than patients who lacked such support. The services of a CHW significantly increased a patient's chance of treatment success by 0.16 standard deviations

Table 2
Impact of patient characteristics, baseline health, health literacy, and community support initiatives on treatment outcomes: standardized regression coefficients (minus relative stability paths) and model summary of the fully cross-lagged model ($n = 268$).

Path	Path coefficient	<i>t</i> value	<i>P</i> value	
Age	→ Treatment outcome (T1)	0.090	2.723	0.01
Sex	→ Treatment outcome (T1)	-0.022	-0.743	NS
Education	→ Treatment outcome (T1)	0.074	2.035	< 0.05
Knowledge HIV/AIDS and ART	→ Treatment outcome (T1)	-0.035	-0.456	NS
Baseline CD4 cell count (T0)	→ Treatment outcome (T1)	0.251	6.989	< 0.001
Baseline viral load (T0)	→ Treatment outcome (T1)	-0.179	-5.342	< 0.001
Treatment buddy (T1)	→ Treatment outcome (T1)	0.172	4.112	< 0.001
Community health worker (T1)	→ Treatment outcome (T1)	0.107	2.588	< 0.01
Support group (T1)	→ Treatment outcome (T1)	0.125	2.237	< 0.05
Age	→ Treatment outcome (T2)	0.045	1.231	NS
Sex	→ Treatment outcome (T2)	0.022	0.439	NS
Education	→ Treatment outcome (T2)	0.101	1.277	NS
Knowledge HIV/AIDS and ART	→ Treatment outcome (T2)	0.071	0.738	NS
Baseline CD4 cell count (T0)	→ Treatment outcome (T2)	0.061	2.366	< 0.05
Baseline viral load (T0)	→ Treatment outcome (T2)	-0.065	-2.001	< 0.05
Treatment buddy (T1)	→ Treatment outcome (T2)	0.133	2.226	< 0.05
Community health worker (T1)	→ Treatment outcome (T2)	0.109	2.169	< 0.05
Support group (T1)	→ Treatment outcome (T2)	0.055	0.563	NS
Treatment buddy (T2)	→ Treatment outcome (T2)	0.165	6.372	< 0.001
Community health worker (T2)	→ Treatment outcome (T2)	0.159	2.837	< 0.01
Support group (T2)	→ Treatment outcome (T2)	0.124	3.399	< 0.001
Age	→ Treatment outcome (T3)	0.087	0.838	NS
Sex	→ Treatment outcome (T3)	0.022	2.038	< 0.05
Education	→ Treatment outcome (T3)	-0.067	0.987	NS
Knowledge HIV/AIDS and ART	→ Treatment outcome (T3)	0.113	1.432	NS
Baseline CD4 cell count (T0)	→ Treatment outcome (T3)	0.045	2.165	< 0.05
Baseline viral load (T0)	→ Treatment outcome (T3)	-0.022	-1.645	NS
Treatment buddy (T2)	→ Treatment outcome (T3)	0.099	2.443	< 0.05
Community health worker (T2)	→ Treatment outcome (T3)	0.112	2.088	< 0.05
Support group (T2)	→ Treatment outcome (T3)	0.120	2.321	< 0.05
Treatment buddy (T3)	→ Treatment outcome (T3)	0.183	4.577	< 0.001
Community health worker (T3)	→ Treatment outcome (T3)	0.102	1.673	NS
Support group (T3)	→ Treatment outcome (T3)	0.133	2.998	< 0.01
Test for fit	Model		Criteria for good fit	
RMSEA	0.0376		< 0.05	
Normed Fit Index (NFI)	0.933		> 0.90	
Non-Normed Fit Index (NNFI)	0.921		> 0.90	
Comparative Fit Index	0.945		> 0.90	
Parsimony Normed Fit Index (PNFI)	0.511			

NS, not statistically significant.

($P < 0.01$). Participating in a support group also had a positive effect on the treatment outcome, because these patients were significantly more likely ($\beta = 0.12$, $P < 0.001$) to have an undetectable viral load and a CD4 cell count above 200 cells/ μ L than were patients who did not participate in a support group.

Finally, after 24 months of ART, community support was again the most important predictor of ART outcome. The support of a treatment buddy at times 2 ($\beta = 0.10$, $P < 0.05$) and 3 ($\beta = 0.18$, $P < 0.001$) significantly increased a patient's chance of treatment success at time 3. Having a CHW at time 2 ($\beta = 0.11$, $P < 0.05$) significantly influenced the virological and immunological outcomes at time 3. Patients with a CHW were significantly more likely to be a treatment success after 24 months than were patients without such support. There was no significant association between having a CHW at time 3 and ART outcome at this stage of treatment. Finally, participating in an HIV/AIDS support group at time 2 ($\beta = 0.12$, $P < 0.05$) and at time 3 ($\beta = 0.13$, $P < 0.01$) both significantly improved the ART response. The support of peers significantly increased a patient's chance of treatment success. Overall, the ART outcomes were significantly better among patients who had high levels of community support.

Explained variance

The squared multiple correlation coefficient, R^2 , for the regression model predicting ART outcomes increased from 0.21 at time 1

to 0.23 at time 2 and to 0.25 at time 3, indicating that an increasing amount of the variation in the treatment outcomes was explained by the patient characteristics, baseline health, health literacy, and most importantly, community support.

Community support activities and functions

Finally, we looked briefly at how and why these community support initiatives positively influenced the ART outcomes. Data were gathered on the characteristics of the community support providers. A series of open-ended questions assessed the kinds of support provided by these community support initiatives, according to the ART patients. First, the vast majority of treatment buddies were female (75.0%) and unemployed (60.7%). Approximately nine of every 10 treatment buddies (89.3%) were either a relative or a close friend of the patient. The mean age of the treatment buddies was 38.3 years. Female patients were more likely to have a male treatment buddy than were male patients (although most female patients also had a female treatment buddy). Male patients usually opted for a female treatment buddy. This difference can probably be explained by the fact that many patients chose their partner as their treatment buddy. The tasks performed by the treatment buddy included household work, accompanying the patient to the health facility, and reminding the patient to take his/her ARV drugs. The great majority of study participants (75.9%) reported that their

treatment buddy helped their compliance with every dose of treatment. These results demonstrate convincingly that treatment buddies provide continuous support for patient adherence to treatment, which can have—according to the results of the quantitative analysis—a positive impact on ART outcomes.

Second, the majority of the CHWs were female (91.2%) and their mean age was 37.7 years. CHWs had less contact with the study participants than did treatment buddies. Only 28.6% of participants reported that CHWs visited them on a daily basis. However, the large majority of respondents (92.9%) met their CHW at least once a week. The mean duration of these visits was 1 h and 10 min. When the patients were asked what the CHW usually did during such a visit, 60.7% of them mentioned lifestyle counseling or emotional or motivational support. Whereas treatment buddies predominantly provided adherence support, CHWs talked about HIV/AIDS and ART and encouraged adherence by motivating the patients and providing emotional support.

Finally, the majority of support groups met at the clinic (67.3%). Other meeting places included church buildings (6.0%), the home of a group member (9.7%), or a hospice (3.9%). Most of these support groups met at least once a week (59.6%), whereas 21.2% met 2–3 times a month and the remainder (19.2%) only once a month. The support groups were established by the Department of Health (59.6%), an NGO (21.2%), one of the group members (11.5%), a church (3.8%), or a clinic sister (3.8%). Most of the support groups were composed of a mixture of people: apart from people on ART (like the respondents), 71.2% of the support groups also included HIV-positive people not on ART, and 53.2% of support groups even included at least one HIV-negative person. Whereas treatment buddies provided day-to-day adherence support and CHWs provided much-needed emotional support, the majority (89.9%) of support group members reported that these support group meetings helped them to adapt to life with HIV/AIDS and life on ART by offering the opportunity to share their knowledge and experiences. The feeling of not being the only person with HIV/AIDS and/or on ART enhanced their capacity to cope with their new lives. An interesting finding was that 68.4% of the participants not attending a support group reported that they would like to attend such a group. The main inhibiting factors were a fear of being recognized and stigmatized by the community, lack of time (work, family life), transport costs, and bad health.

The vast majority of patients rated the support of a treatment buddy (99.3%), CHW (85.0%), or HIV support group (85.7%) as “good” or “excellent”.

Discussion

This analysis of 268 patients, performed over the first two years of public-sector ART in one of the provinces of South Africa, shows that 76.4% of patients were classified as treatment successes (CD4 cell count ≥ 200 cells/ μ L and viral load < 400 copies/mL) after 24 months of ART. As many as 92.5% of patients responded at least partially to treatment after two years of ART. The survival rate was a staggering 88.4% during the first 24 months of treatment, with most deaths following very low baseline CD4 cell counts (mean CD4 cell count = 77 cells/ μ L in this subsample of patients). Such favorable outcomes are similar if not superior to those reported in industrialized societies (Akileswaran, Lurie, Flanagan, & Mayer, 2005; Ferradini et al., 2007; Moatti, Spire, & Kazatchkine, 2004). This longitudinal study provides evidence that this South African public-sector ART program is effective in delivering sustained viral suppression, confirming the success of universal treatment access as a key policy priority.

However, there is no room for complacency because there are still numerous challenges to be met in sustaining a high-quality

ART scale-up in a resource-poor setting (Gill, Hamer, Simon, Thea, & Sabin, 2005). High levels of treatment success and survival are only possible with an adequate human resource base, because although ART is highly effective, its management is complex. The data from our cohort of 268 public-sector ART patients show that community support initiatives, in this case the availability of treatment buddies, CHWs, and support groups, significantly and consistently improved the patient's chance of treatment success (CD4 cell count ≥ 200 cells/ μ L and viral load < 400 copies/mL) throughout the first two years of treatment. This association became even stronger as the duration of ART increased and the impact of baseline health diminished. The patient's educational level and knowledge about HIV/AIDS and ART only very moderately influenced the ART outcome, indicating that community support is a more important predictor of ART outcome than health literacy.

These findings build on our previous work, which demonstrated the short-term impact of community support on ART outcomes (Wouters, Van Damme et al., 2008). However, the present study extends the existing literature because it increases our understanding of the longitudinal relationships between community support and ART outcomes by establishing the positive effect of community support after two years of ART. These data stress the importance of community support in achieving durable treatment success. In light of the growing mismatch between large patient numbers and the insufficient human resources available for healthcare, the findings of this study indicate that communities should be considered an ‘underexploited resource’, which could play an important role in ART scale-ups (Standing et al., 2008; Zachariah et al., 2006). Although our understanding of the impact of community support on clinical outcomes in ART patients is still preliminary, these observations are similar to those of studies performed by Zachariah et al. (2007), Coetzee et al. (2004), and Koenig et al. (2004) (Coetzee, Hildebrand, Boule et al., 2004; Koenig, Léandra et al., 2004; Zachariah, Teck, Buhendwa et al., 2007).

The emphasis of this study also differs from that of other studies in that it tested the influence of oft-cited social determinants of health (community support and health literacy) on ART outcomes simultaneously, on a long-term basis (Rose, 2000). Regression-based estimates of their impact suggested that community support is a more important predictor of ART success than health literacy—as applied in this study. Strengthening and encouraging these community support initiatives is what Pronyk et al. (2008) calls “generating social capital”, which has been shown to have a positive effect on people's health (Pronyk, Harpham, Busza, et al., 2008). Health literacy did not consistently improve ART outcomes throughout the first two years of treatment. This is possibly because the patients must complete drug-readiness training before commencing ART. By providing information on positive living, the basics of HIV/AIDS, opportunistic infections, ART adherence, and the adverse effects of ART, drug-readiness training is intended to enable individuals to take ownership of their own health and to prolong their lives (Department of Health, 2003). Consequently, almost all respondents showed very high levels of HIV/AIDS and ART knowledge, causing a skewed distribution of this health literacy measure and leading to ceiling effects, which hampered its predictive power in a regression analysis. Consequently, our analysis is still preliminary and further longitudinal research is required to fully clarify the complex interrelationships between community support for patients, health literacy levels, and ART outcomes.

The strengths of this study include its longitudinal character and the availability of information on an understudied population. To the best of our knowledge, this is one of the first studies to assess, in a quantitative manner, the impact of both community support and health literacy on public-sector ART outcomes in a high-HIV-

prevalence, resource-limited setting (Zachariah et al., 2007). However, there are some limitations to our study. First, it is possible that treatment buddies, CHWs, and support groups improve their patients' health literacy by sharing their training and/or experiences with them. The ability of patients to use community support to improve their health literacy could have disturbed the analysis. Second, differences between the patients lost to attrition and the retained patients could potentially entail an overestimation of the impact of community support on ART outcomes, because it is expected that patients who do not respond to treatment are more likely to drop out of care. Therefore, our findings are more appropriately interpreted as being conditional on remaining in care for two years. Third, although the analysis focused on the impact of different forms of community support for patients on virological and immunological outcomes, the regression model offers an incomplete explanation of the treatment outcomes. Patient characteristics (age, sex) were tested as predictors of treatment success but only age at baseline and sex at the second follow-up significantly influenced the treatment outcomes. Other potentially relevant psychosocial and sociobehavioral factors were not available in the dataset. Finally, the study did not use a true experimental design because the patients were not randomly assigned to the treatment groups (treatment buddy, CHW, or support group). This self-selection potentially weakens the causal relationship between community support and ART outcomes. It is possible that accessing a community support mechanism is an expression of being better connected, better informed, or taking better care of your health, and is thus an underlying determinant of a better outcome.

This analysis has both theoretical and practical implications. From a theoretical point of view, the immediate and long-term impact of community support on treatment outcomes draws attention to the role of community participation in ART scale-up. This study thus provides evidence from the field to support the suggestion made by Standing et al. (2008) and Van Damme et al. (2008) to mobilize the community in the scaling-up of ART in sub-Saharan Africa. We only tentatively studied how the community support initiatives improved treatment outcomes, but tracing defaulters (CHWs), reminding patients to take their pills (treatment buddies), and creating a safe environment in which to discuss adherence issues (support groups) probably had an effect on ART adherence. Furthermore, the increasing impact of patient support groups and the diminishing impact of CHWs on ART efficacy could possibly be ascribed to the roles of these support entities. CHWs predominantly provide lifestyle counseling at the start of treatment to enable the patient to manage his/her treatment, whereas support groups provide the continued support needed to achieve durable ART success. However, further research is required to fully clarify the mechanisms by which community support initiatives improve treatment outcomes.

From the perspectives of practical policy and management, our cross-lagged findings are of relevance to other high-prevalence regions that are embarking on scaling-up ART in circumstances similar to those in the Free State. First, the longitudinal study provides evidence that the South African public-sector ART program is effective in delivering sustained immunological restoration and viral suppression. It highlights the urgent need for increasing ART coverage because the results indicate that delayed ART initiation (low baseline CD4 and high viral load) significantly reduce the chance of ART success. Second, our findings supply policy makers with a tool that can potentially overcome the dire human resource shortages in high-HIV-prevalence resource-limited settings. Community support initiatives are also seen to be adding value and meeting new needs, rather than simply substituting for professionals. ART has transformed HIV/AIDS into a chronic illness, necessitating an appropriately comprehensive

care model. Our study results suggest that communities are an unexploited resource, which can be used to supply chronic disease care by bridging the gap between clinics and communities. However, the community should not be considered merely an entity to which activities can be delegated, but community support initiatives such as treatment buddies, CHWs, and patient support groups should be given a recognized role in achieving durable ART success when the roles of healthcare professional are restricted to medical tasks.

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