Outcomes after two years of providing antiretroviral treatment in Khayelitsha, South Africa

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Background: A community-based antiretroviral therapy (ART) programme was established in 2001 in a South African township to explore the operational issues involved in providing ART in the public sector in resource-limited settings and demonstrate the feasibility of such a service.

Methods: Data was analysed on a cohort of patients with symptomatic HIV disease and a CD4 lymphocyte count $< 200 \times 10^6$ cells/l. The programme used standardized protocols (using generic medicines whenever possible), a team-approach to clinical care and a patient-centred approach to promote adherence.

Results: Two-hundred and eighty-seven adults naive to prior ART were followed for a median duration of 13.9 months. The median CD4 lymphocyte count was 43×10^6 cells/l at initiation of treatment, and the mean $\log_{10}$ HIV RNA was 5.18 copies/ml. The HIV RNA level was undetectable (< 400 copies/ml) in 88.1, 89.2, 84.2, 75.0 and 69.7% of patients at 3, 6, 12, 18 and 24 months respectively. The cumulative probability of remaining alive was 86.3% at 24 months on treatment for all patients, 91.4% for those with a baseline CD4 lymphocyte count $\geqslant 50 \times 10^6$ cells/l, and 81.8% for those with a baseline CD4 lymphocyte count $< 50 \times 10^6$ cells/l. The cumulative probability of changing a single antiretroviral drug by 24 months was 15.1% due to adverse events or contraindications, and 8.4% due to adverse events alone.

Conclusions: ART can be provided in resource-limited settings with good patient retention and clinical outcomes. With responsible implementation, ART is a key component of a comprehensive response to the epidemic in those communities most affected by HIV.

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Introduction

The benefits of antiretroviral therapy (ART) at an individual level are incontrovertible [1,2]. The potential benefits at a population level of successful ART programmes in those countries worst affected by the HIV pandemic are widely argued [3,4]. Even where universal access to ART for those who could benefit from it is not possible, many have argued strongly for ART to be an important component of an integrated

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response to the epidemic in resource-limited countries [3,5].

The publication by the World Health Organization (WHO) of guidelines for the scaling up of antiretroviral therapy in resource-limited settings [6] signals a convergence of clinical thinking that should, in theory, facilitate the rapid expansion of ART in these settings. Evidence of the effectiveness of public sector ART programmes in those countries with the largest HIV-morbidity and mortality burdens has, however, been slow in emerging. Many interventions have relied on private or out-of-pocket funding of treatment, [7] and where policies exist to provide treatment in the public sector, uptake has been slower than anticipated [8].

The aim of this analysis is to present the early clinical outcomes for adults in a public-sector ART programme in a primary care setting in a poor urban community in South Africa.

Methods

Setting

Khayelitsha is a township with an estimated population of 400 000 [9]. Housing is both formal and informal. Most residents rely on health services delivered by the state, with unemployment levels considerably higher that the national average [10]. The HIV-1 seroprevalence in public-sector antenatal clinics in this health district in 2002 was 24.9% [11]. Tuberculosis incidence in 2001 was 1062 per 100 000 [12]. In 1999, the first routine programme in South Africa to prevent the transmission of HIV from mother to child was initiated at the two health centres in Khayelitsha that provide maternity services [13]. Dedicated services for adults and children with HIV were established in April 2000 through a collaboration between the provincial government and the international non-governmental organization (NGO) Médecins Sans Frontières (MSF). Three dedicated HIV/AIDS clinics were opened within Khayelitsha's community health centres providing a full package of prophylaxis and treatment of opportunistic infections. In May 2001, the HIV/AIDS clinics began to offer ART. Patients receive ART free of charge. MSF provides the antiretroviral medicines, the HIV RNA tests, and half of the clinical staff, whilst the remaining costs are carried by the provincial government. The study has ethical approval from the South African Medical Association. By the end of July 2003, over 600 adults and children had started ART as part of the programme.

Patient preparation and selection

Selection criteria required that patients be symptomatic (WHO clinical stage III or IV [14]) and have a CD4 lymphocyte count of $< 200 \times 10^6$ cells/l. Patients were required to meet a number of additional criteria including: nominating a 'treatment assistant' to assist with adherence; receiving a home-visit to verify the family environment, evidence of disclosure and that the patient was indeed resident in Khayelitsha; and, attendance on time for at least three previous appointments over a minimum of 4 months. Each candidate's folder was anonymously presented to a community selection committee.

Clinical services and regimens

Clinical services are provided in each of the three clinics by a team comprising a doctor, two nurses and two counsellors, with good continuity of care. Reasonable referral networks exist with local hospitals and other primary care services such as tuberculosis services. The consultation frequency for those on ART is determined by the clinical protocol; weekly for the first 2 weeks, then fortnightly until 2 months on ART, monthly until the first year on ART, and 2–3-monthly thereafter. Patients are seen more frequently if clinically indicated. Doctors are mainly responsible for treatment initiation, regimen changes and dealing with specific problems, whilst nurses provide most of the routine patient follow-up for those on ART according to standardized protocols. Plasma HIV RNA measurements are performed at baseline, 3 and 6 months, and CD4 lymphocyte counts are carried out at baseline and 6 months. Both tests are conducted 6-monthly thereafter. Standardized flowchart algorithms for the management of adverse events and virological failure guide doctors and nurses in safety monitoring and when and how to change treatment.

The clinical protocol stipulates that patients begin treatment on zidovudine, lamivudine and either efavirenz or nevirapine. Generic zidovudine, lamivudine, a fixed dose combination of zidovudine and lamivudine, and nevirapine were all procured from the Brazilian state manufacturer FarManguinhos under a compassionate use agreement with the South African Medicines Control Council. The remaining antiretroviral drugs that were used were all fully registered with the Medicines Control Council.

A strong patient-centred approach is used to promote adherence. This includes a comprehensive counselling infrastructure providing for one-on-one individual counselling with trained lay-counsellors, and regular support groups. A treatment access NGO, the Treatment Action Campaign, is active in all three of the clinics, and their activities contribute to the treatment literacy of patients.

Methods

All adult patients naive to prior ART who started antiretroviral treatment between 29 May 2001 and 31 December 2002 were included in the analysis. Mothers who had received up to 1 month of zidovudine antenatally for the prevention of mother-to-child transmission were included. Patients were considered non-naive and were excluded from the study if they had received more than 1 month of ART as treatment prior to joining the programme. The cohort is ordered and analysed by duration on treatment.

CD4 lymphocyte counts were performed by flow-cytometry. Plasma HIV RNA levels were measured using the nucleic acid sequence-based amplification procedure (NASBA) Nuclisens HIV-1 QT assay (Bio-Merieux, Boxtel, the Netherlands).

Product-limit estimates (Kaplan–Meier) of survival were determined for all patients irrespective of subsequent discontinuation of therapy. Patients alive and in care on 31 July 2003 were right-censored on the date of their last visit prior to this date. Patients who had not attended services for 3 months or more beyond their last scheduled appointment and who could not be traced were classified as being lost to follow-up and statistically were considered as deaths on their last recorded visit to the clinics. Patients who had ceased attending the clinic but were known to be alive on 31 July 2003 were right-censored on their last visit to the clinic, as were those patients who negotiated their transfer to a different province. The same analysis was repeated stratified by initial CD4 lymphocyte count category, with the log-rank test used to compare survival between the two groups. Cox proportional hazards regression was used to calculate univariate and adjusted hazard ratios (AHR) and confidence intervals (CI) for survival for a number of variables.

Other outcomes included median changes in absolute CD4 lymphocyte counts and the percentage of patients with plasma HIV-RNA measurements < 400 copies/ml at various durations on treatment. Baseline laboratory tests were considered valid if performed within 1 year prior to the initiation of therapy, although most fell within the month prior to ART initiation. Subsequent laboratory outcomes were allocated to the appropriate durations on treatment for all patients on ART at the time of the investigation. A single HIV RNA $\geqslant 400$ copies/ml at any duration on treatment was recorded as being above this value, whilst in instances where HIV RNA measurements were repeated in short succession to confirm elevated levels, and were subsequently found to be below this value, the result for that duration on treatment was recorded as being < 400 copies/ml.

Estimates of the percentage of patients changing treatment were calculated as product-limit estimates. Weight changes were calculated as median increases compared to baseline.

An independent analysis of cause of death developed a functional classification of cause based on data available in the clinical records held at the primary care level for those patients for whom sufficient data was available.

Analyses were performed using STATA software (version 8.0; Stata Corp., College Station, Texas, USA).

Results

The analysis included 287 adults started on ART (Table 1). One patient was excluded from the analysis due to prior ART. The median follow-up time was 14.9 months for those surviving after starting ART, and 13.9 months for all patients. More women than men accessed treatment (70%). Patients began treatment with advanced disease–the median CD4 lymphocyte count at baseline was 43×10^6 cells/l [interquartile range (IQR), $13–94 \times 10^6$ cells/l], with 52% having a prior AIDS diagnosis. These characteristics did not change significantly over the enrolment period. The mean HIV RNA on initiation of treatment was $5.18 \log_{10}$ copies/ml [standard deviation (SD) $0.68 \log_{10}$ copies/ml]. Sixty per cent of patients began treatment on zidovudine, lamivudine and efavirenz, and 38% on zidovudine, lamivudine and nevirapine (Table 1).

Survival and patient retention

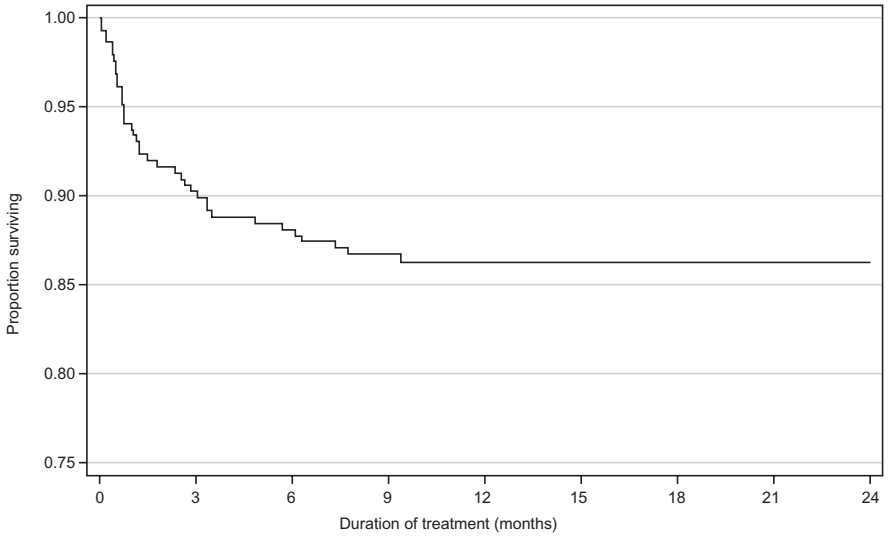
One patient was lost to follow-up soon after commencing treatment. An additional six patients had stopped ART at the time of the analysis but were still attending services. Three patients had transferred to other provinces, and three patients had stopped attending the clinics but were confirmed to still be alive on the 31 July 2003.

Thirty-eight patients died after starting ART. All except two deaths were attributed to HIV, and occurred before 12 months of follow-up (71% before 3 months duration on ART), yielding a product-limit estimate of survival at 24 months of 86.3% (95% CI, 81.7–89.8%) (Fig. 1). One-hundred and fifty-five patients (55%) began treatment with a CD4 lymphocyte count of $< 50 \times 10^6$ cells/l. Estimates of survival at 24 months stratified by initial CD4 lymphocyte count were 81.8% (95% CI, 74.7–87.0%) for those initiating treatment with a CD4 lymphocyte count $< 50 \times 10^6$ cells/l and 91.4% (95% CI, 84.9–95.1%) for those with initial CD4 lymphocyte counts $> 50 \times 10^6$ cells/l ($P = 0.0171$) (Fig. 2).

Table 1. Characteristics and starting regimens of patients beginning antiretroviral therapy.

All patients	n = 287[a]
Median age [years (IQR)]	31 (28–37)
Female [n (%)]	201 (70%)
CD4 lymphocyte count at baseline ($\times 10^6$ cells/l)	
Median (IQR)	43 (13–94)
Count $< 50 \times 10^6$ cells/l [n (%)]	155 (55)
Prior AIDS diagnosis	
AIDS diagnosis (%)	148 (52)
Follow-up time (months)	
Median for all patients (IQR)	13.9 (9.2–18.1)
Median for those surviving (IQR)	14.9 (11.0–19.5)
HIV RNA level at baseline ($\log_{10}$ HIV RNA copies/ml)	
Mean (SD)	5.18 (0.68)
Initial antiretroviral regimen	
ZDV/3TC/EFV [n (%)]	n = 173 (60)
ZDV/3TC/NVP [n (%)]	n = 108 (38)
ZDV/3TC/IDV (± RTV) (%)	n = 4
d4T/3TC/NVP (%)	n = 1
d4T/3TC/EFV (%)	n = 1

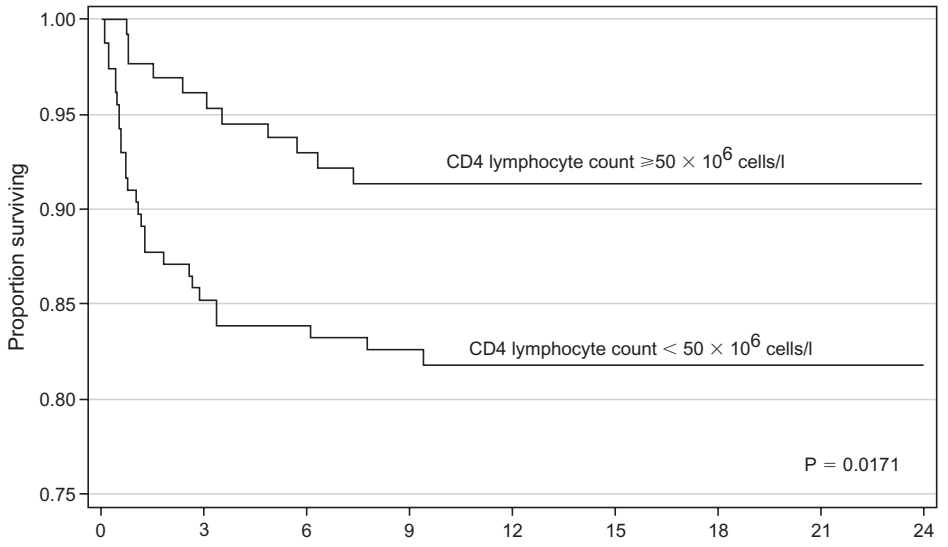
[a]A baseline CD4 lymphocyte count was unavailable for three patients (n = 284) and a baseline HIV RNA level was unavailable for 16 patients (n = 271). IQR, Interquartile range; SD, standard deviation; ZDV, zidovudine; 3TC, lamivudine; NVP, nevirapine; IDV, indinavir; RTV, ritonavir; d4T, stavudine; EFV, efavirenz.



Number at risk	287	257	251	219	168	123	74	54	34
All deaths		27	6	4	1	0	0	0	0
Lost to follow-up		1	0	0	0	0	0	0	0
Stopped attending (alive 31/07/03)		0	0	0	0	0	3	0	0
Transferred to another service		2	0	0	1	0	0	0	0
In care but not on ART		3	7	4	3	3	2	2	0
On second-line regimen		0	0	1	1	5	3	3	3
Percentage surviving		**90.2**	**88.1**	**86.7**	**86.3**	**86.3**	**86.3**	**86.3**	**86.3**
95% confidence interval		86.2–91.4	83.8–90.1	82.2–89.8	81.7–89.8	81.7–89.8	81.7–89.8	81.7–89.8	81.7–89.8

Fig. 1. Survival of adults on antiretroviral treatment.

In multivariate analysis of baseline variables against survival (Table 2), CD4 lymphocyte count (categorical variable as described above) and a diagnosis of Kaposi's sarcoma (n = 16) were found to be significantly associated with outcome (Table 2)—the AJR of death or loss to follow-up was 2.41 (95% CI, 1.20–4.87) for those in the lower initial CD4 lymphocyte count category compared to the higher category, and 4.82 (95% CI, 2.12–10.97) for a previous diagnosis of Kaposi's sarcoma.



Baseline CD4 ($\times 10^6$ cells/l)										
At risk	⩾ 50	129	123	119	109	84	57	34	23	13
	< 50	155	133	132	109	82	66	41	33	22
Deaths & loss to follow-up	⩾ 50		5	4	2	0	0	0	0	0
	< 50		23	2	2	1	0	0	0	0
Survival (%) 95% CI	⩾ 50		**96.1**	**93.0**	**91.4**	**91.4**	**91.4**	**91.4**	**91.4**	**91.4**
			90.9–98.4	86.9–96.3	84.9–95.1	84.9–95.1	84.9–95.1	84.9–95.1	84.9–95.1	84.9–95.1
	< 50		**85.2**	**83.9**	**82.5**	**81.8**	**81.8**	**81.8**	**81.8**	**81.8**
			78.5–89.9	77.1–88.8	75.6–87.7	74.7–87.0	74.7–87.0	74.7–87.0	74.7–87.0	74.7–87.0

Fig. 2. Survival of adults on antiretroviral treatment stratified by initial CD4 lymphocyte count.

Table 2. Cox proportional hazards models of potential associations between baseline characteristics of patients and survival.

	Univariate analysis		Multivariate analysis	
	Hazard ratio for death (95% CI)	*P*	Hazard ratio for death (95% CI)	*P*
Baseline CD4 lymphocyte count ($\times 10^6$ cells/l)	2.28 (1.13–4.58)	0.021	2.41 (1.20–4.87)	0.013
Baseline HIV RNA ($\log_{10}$ copies/ml)	1.2 (0.73–1.96)	0.456	–	–
AIDS diagnosis	1.26 (0.67–2.38)	0.468	–	–
Kaposi's sarcoma	4.48 (1.97–10.17)	< 0.001	4.82 (2.12–10.97)	< 0.001
Choice of NNRTI nevirapine	0.52 (0.25–1.07)	0.079	–	–
Age in years	1 (0.96–1.04)	0.795	–	–
Male sex	1.92 (1.02–3.63)	0.042	–	–

In the review of cause of death, 20 deaths were classified as being due to very advanced disease at the time of starting ART, with continued deterioration on treatment. None of these deaths were thought by the reviewer to be attributable to immune-reconstitution disease. The median CD4 lymphocyte count in this group was 7×10^6 cells/l (IQR, $4–25 \times 10^6$ cells/l), and the median duration on treatment when they died was 21 days (IQR, 14–31 days). Three patients died as a result of tuberculosis (duration on ART of 6, 145 and 241 days), and three from probable Kaposi's sarcoma (duration on ART of 45, 70 and 79). One patient died after 104 days on ART due to intractable cytomegalovirus colitis that predated ART. Six patients experienced disease progression due to treatment interruption or documented poor adherence. The non-HIV related deaths included a 29-year-old woman with underlying mitral stenosis who died of a cerebrovascular insult 7 months after starting ART, and a 46-year-old man with a squamous cell carcinoma of the lung who died 9 months after starting ART. No deaths were attributed to antiretroviral treatment.

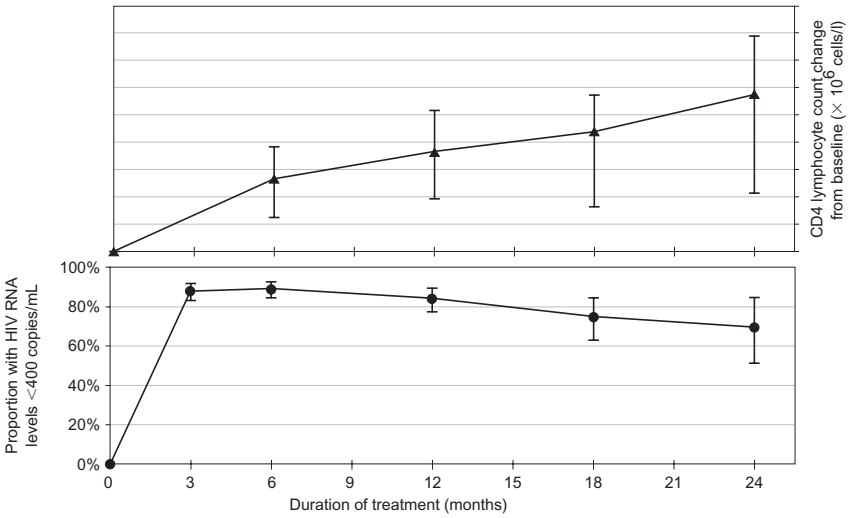
Other clinical outcomes

The median weight gain at 6 months on treatment was 5.0 kg (IQR, 1.5–9.6 kg) and 9.0 kg (IQR, 4.0–14.3 kg) at 12 months. The percentage of patients with HIV RNA measurements < 400 copies/ml (Fig. 3) was maximal at 6 months (89.2%; 95% CI, 84.4–92.9%), with 84.2% (95% CI, 77.5–89.5%) of patients still having measurements within this range at 12 months, and 69.7% (95% CI, 51.3–84.4%) at 24 months.

The CD4 lymphocyte count increased rapidly compared to the pre-treatment level in the first 6 months on treatment (Fig. 3), increasing by a median of 134×10^6 cells/l (IQR, $76–206 \times 10^6$ cells/l). Although the gain in CD4 lymphocyte count in subsequent intervals was lower than this, by 24 months on ART the median increase in CD4 lymphocyte count compared to baseline was 288×10^6 cells/l (95% CI, $181–470 \times 10^6$ cells/l), with a median absolute CD4 lymphocyte count at this duration on treatment of 323×10^6 cells/l.

Regimen durability

The highest percentage of changes in regimen (Table 3) le 3) due to adverse events attributed to an individual antiretroviral was for nevirapine for which 8.8% (95% CI, 4.8–15.8%) (product-limit estimate) of patients had changed to efavirenz at 24 months. The equivalent percentage for zidovudine was 4.7% (95% CI, 2.6–8.0%) of patients changing to stavudine. No patients were changed from lamivudine for any agent-specific reason, and only two patients could not tolerate efavirenz. For all regimens combined, 8.4% (95% CI, 5.6–12.5%) of patients had an intolerance-driven change to their first regimen cumulatively by 24 months. Most changes occurred soon after treatment was started (median 42 days; IQR, 28–56 days). A further 10 patients switched from nevirapine to efavirenz due to a new episode of tuberculosis as efavirenz was the only non-nucleoside reverse transcriptase inhibitor recommended for co-administration with rifampicin, [15] and three patients from efavirenz to



Number on treatment	287	254	244	165	72	34
Number with CD4 lymphocyte counts			226	150	63	31
Median change from baseline			**134**	**184**	**220**	**288**
Interquartile range			(76–206)	(108–271)	(153–358)	(181–470)
Number with viral load results		227	231	158	68	33
Percentage < 400 copies/mL		**88.1**	**89.2**	**84.2**	**75,0**	**69.7**
95% confidence interval		(83.2–92.0)	(84.4–92.9)	(77.5–89.5)	(63.0–84.7)	(51.3–84.4)

Fig. 3. Laboratory outcomes by duration of treatment.

Table 3. Changes to the initial treatment regimen.

	Zidovudine	Nevirapine	Efavirenz	All
Number ever to start on antiretroviral	285	114	197	288
Number changed due to side-effects	12	10	2	23
Time to change in days [median (IQR)]	53 (35–74)	20 (15–42)	day 8 & 262	42 (28–56)
Changed by 24 months [% (95% CI)][a]	4.7 (2.6–8.0)	8.8 (4.8–15.8)	1.2 (0.3–4.9)	8.4 (5.6–12.5)
Changed due to contraindications (n)	0	10[b]	3[c]	13

[a]Product limit estimate for those changing due to side-effects. [b]Changed due to a new episode of tuberculosis. [c]Changed due to pregnancy or desire for pregnancy. IQR, Interquartile range; CI, confidence interval.

nevirapine due to pregnancy or a wish to become pregnant. Including these latter switches, 15.1% (95% CI, 10.7–21.1%) of patients on the first-line regimen had a regimen change due to adverse events or contra-indications by 24 months. Twelve patients had changed the entire regimen due to treatment failure by the end of July 2003.

Discussion

This analysis is limited by the short duration of follow-up and by the small numbers at risk in the analysis beyond 1 year on treatment. The early results of this programme are, however, comparable with data from observational settings in both developed and developing countries. This programme builds on results reported for other African settings in demonstrating the feasibility of successful ART programmes in these contexts [7,16]. In spite of differences in reporting, patients in Khayelitsha initiated therapy with more advanced disease than reported in Uganda [7] and Senegal, [16] and using survival as an end-point, have responded to treatment at least as well, if not better. Furthermore, this programme represents one of the first attempts to integrate ART as part of a comprehensive government response to HIV/AIDS in a geographically-defined health district. Previous work in Cape Town indicates that median survival without ART for those with CD4 lymphocyte counts $< 50 \times 10^6$ cells/l would be less than 12 months [17]. This highlights the likely benefit of the intervention in this population where the survival estimate for the same subgroup of patients at 12 months duration on ART was 81.8%.

Survival outcomes in this programme are comparable to those reported for patients initiating ART with very low CD4 lymphocyte counts in two observational studies in Canada and the USA [18]. Although the observation periods for these cohorts include years where dual therapy was provided, the point estimates of survival are very similar to those observed in Khayelitsha, ranging from 64.6% to 79.5% for those initiating treatment with CD4 lymphocyte counts $< 50 \times 10^6$ cells/l, and from 78.1% to 90.0% for those initiating treatment with CD4 lymphocyte counts above this value. At 24 months duration on treatment the stratified survival estimates from Khayelitsha exceed the upper end of these ranges.

In many of those countries worst affected by the HIV pandemic, scarcity of resources and capacity will mean that not everyone with the potential to benefit from ART will be able to access it, with a tendency for the sickest patients to access treatment first. The difference in survival in the Khayelitsha cohort between those starting treatment with CD4 lymphocyte counts of 50×10^6 cells/l or more compared to the group with CD4 lymphocyte counts below this level, suggests that one of the major challenges in contexts such as Khayelitsha is to ensure a fair balance between providing access to ART for those presenting very late, whilst preserving the opportunity for a better prognosis for those who have enrolled in the programme in a timely manner. Given that survival in those presenting with CD4 lymphocyte counts $< 50 \times 10^6$ cells/l is nevertheless markedly improved compared to the anticipated natural history, the programme does not consider CD4 lymphocyte count an exclusion to ART if the Karnofsky score is above 40%. It may in future be possible to identify strategies to further improve survival in this early period for those with extensive immune suppression at presentation.

The stratification of survival by a CD4 lymphocyte count of 50×10^6 cells/l was motivated by the potential to compare to other studies that have used these categories. However, the data suggested that the survival experience in this context would be more powerfully discriminated by a dichotomous categorization at a lower CD4 lymphocyte count.

The exploration of an association of a previous diagnosis of Kaposi's sarcoma (KS) with survival was prompted by reports of an association in other MSF projects. A mortality review suggested that in only three out of eight cases could the cause of death be directly linked to KS. Clinical details of the nature and extent of KS were not available. A more thorough exploration of this association is warranted as the numbers on treatment in the project increase. Although only three deaths were linked to new episodes of tuberculosis following initiation of ART, tuberculosis poses constant challenges in this setting. A full incidence study of tuberculosis prior to ART and on ART is currently underway. Innovative approaches to managing tuberculosis that extend beyond the provision of ART are urgently required. The occurrence of a number of deaths very soon after initiating treatment is most likely due to the extreme disease advancement of many patients by the time they were able to access treatment.

The high proportion of patients with HIV RNA measurements < 400 copies/ml in the first year on treatment further underpins the fact that adherence rates, comparable to those in rich countries, are achievable in resource-limited settings [19]. The proportions of patients with HIV RNA measurements < 400 copies/ml at various durations on treatment compare favourably with those reported in other African settings, [7,16] and are similar to those from rich countries in spite of differences in reporting [20–22]. CD4 lymphocyte count gains were impressive and are similar

in magnitude at 1 year on treatment to those reported elsewhere, [23] in spite of the relatively late initiation of treatment.

Although this paper has not sought to explore the costs of treatment, at $60 (USD 1 = ZAR 8) per test, HIV RNA testing is a significant expense to the programme relative to drug costs. A generic triple-therapy regimen was being purchased at the end of 2002 for $1.08 per day. This highlights the importance of campaigning for lower prices of HIV RNA testing together with antiretroviral drugs, or of validating approaches that do not include HIV RNA testing.

Rates of treatment change due to adverse events were uniformly low, and comparable or lower than those published for other cohorts [24]. This is a reflection of the incidence of severe adverse events in general, and demonstrates that with standardized regimens, monitoring and clinical management algorithms as is the case in Khayelitsha, ART can be safely used in resource-constrained settings. The most common contraindication resulting in a treatment change was in patients who developed tuberculosis after starting ART and who were switched from nevirapine to efavirenz, due to concerns about the co-administration of nevirapine with rifampicin.

With the recent declaration by the WHO of the failure to deliver AIDS medicines to those who need them as a global health emergency, exploring the programme design choices that impact on clinical outcomes in developing countries is urgent. There are a number of important lessons emerging from this programme. Careful preparation of patients is essential, extending beyond applying clinical eligibility criteria. This, together with treatment in a primary care setting, and as part of an integrated package of services for HIV, maximizes the potential impact of treatment programmes. With a patient-centred approach and a strong support programme involving specifically trained lay counsellors and peer support mechanisms, good adherence to treatment is achievable. With support, nurses can diagnose and treat most opportunistic infections and deliver ART in line with standardized protocols.

Although there are a number of factors that have promoted programme success, including the involvement of an international NGO, most treatment advocates would envisage new resources accompanying the introduction of ART in resource-constrained settings. Khayelitsha represents one of the most marginalized urban communities in South Africa, with extensive co-morbidity and health-system challenges. These findings provide encouragement to those seeking to provide similar services in poor communities where HIV morbidity and mortality are high.

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