Health Care Manag Sci (2012) 15:197–205
DOI 10.1007/s10729-011-9187-2

How operational research influenced the scale up of antiretroviral therapy in Malawi

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Received: 27 June 2011 / Accepted: 3 November 2011 / Published online: 24 November 2011

Abstract The national scale up of antiretroviral therapy in Malawi is based on a public health approach, with principles and practices borrowed from the successful World Health Organization "DOTS" tuberculosis control framework. The scale up of antiretroviral therapy was under-pinned by a very strong monitoring and evaluation system, which was used to audit the scale up approach and conduct operational research to answer relevant questions. Examples of research included:- i) access to antiretroviral therapy, populations and social groups served, and how the different groups fared with regard to outcomes; ii) determining whether the quality of data at antiretroviral therapy sites was adequate and whether external supervision was needed; iii) finding feasible ways of reducing the high early mortality in patients starting treatment in both Malawi and the sub-Saharan African region; iv) the causes of loss-to-follow-up, what happened to patients who transferred out of sites and whether transfer-out patients had outcomes comparable to those who did not transfer; and v) the important question of whether antiretroviral therapy scale up reduced population mortality. The answers to these questions had an important influence on how treatment was delivered in the country, and show the value of this work within a programme setting. Key generic lessons include the importance of i) research questions being relevant to programme needs, ii) studies being

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coordinated, designed and undertaken within a programme, iii) study findings being disseminated at national stakeholder meetings and through publications in peer-reviewed journals and iv) research being used to influence policy and practice, improve programme performance and ultimately patient treatment outcomes.

Keywords HIV · Antiretroviral therapy · Malawi · Africa · Health systems · Operational research

1 Background

1.1 Setting the scene and the start of scale up of antiretroviral therapy in Malawi

Malawi is a poor, land-locked country in central-southern Africa with a population of 13 million and a per capita gross domestic product (GDP) of less than USD$200 per year [1]. The country has been gripped for over 25 years by a devastating HIV epidemic, and by 2004 (at the time of starting national scale up of antiretroviral therapy [ART]) there were approximately 930,000 people thought to be HIV-infected with another 100,000 new HIV infections occurring annually [2].

In early 2004, the country embarked on national scale up of ART, at which time there were only nine facilities in the public sector delivering ART to an estimated 3,000 patients. ART delivery was unstructured, many patients had to pay for medication, very few health care workers had been formally trained, and there were no national systems of monitoring or reporting. In February 2004, a national ART scale up plan was developed and approved by stakeholders. By June 2004 after an intense period of training for health facility clinicians and nurses, ART was delivered at health facilities within the public sector, with this life-saving treatment rapidly brought to scale in both public and private sectors in the subsequent years. By 31st December 2010, [6 years after the start of scale-up], there were 417 clinics (295 static and 122 outreach) in the public and private sector that had initiated 345,598 new patients on ART [3]. Both the public and private health sectors implement the same standardised systems of delivering and monitoring treatment. By December 2010, a total of 250,987 patients were alive on ART, the majority of whom would have died within 1–2 years of diagnosis without such therapy [3].

The scale up of ART faced many challenges, for which operational research played a valuable part in analysis and problem solving. In this paper, we describe some of the operational research that was undertaken during the first few years and which had an important influence on how ART was delivered in the country, and we take away generic lessons that may be helpful to programmes in other countries.

1.2 Use of the TB-DOTS model to underpin ART scale up in Malawi

Before the start of national ART scale up, important conceptual work was carried out to define the most appropriate ways of providing ART in a resource-poor country [4–6]. Right from the start it was realised that ART delivery based around doctors providing treatment, having a wide choice of different ARV treatment regimens and using laboratory monitoring for initiating and monitoring therapy, would preclude scale up to any significant degree from taking place. The key to rapid and massive scale up in a country like Malawi was “simplicity” and “standardisation”.

In 1994, in response to unprecedented rates of tuberculosis globally and estimated annual TB case fatality rates of 1–2 million, the World Health Organization (WHO) developed a new framework for TB control called “directly observed therapy, short course” or DOTS [7]. This framework was based on pioneering work of Dr Karel Styblo in Tanzania, Malawi, Mozambique and Nicaragua, and incorporated an important five-point policy package (Table 1), which remains as the essential core of the Stop TB Strategy in use today [8]. Between 1995 and 2009, DOTS was successfully expanded to over 190 countries, a total of 41 million TB patients, most of them from poor countries, were successfully treated in DOTS programmes, and up to 6 million lives were saved [9]. One of the core components of DOTS is the registration, recording and reporting format, which is used to monitor the number of new patients enrolled for anti-tuberculosis treatment every quarter and 9–12 months later the quarterly cohort’s subsequent end of treatment outcomes. Case finding and treatment outcome data are collected first at facility level and then collated at national level to provide country level information on burden of disease and national programme performance. This rich source of routine data, which is checked and validated through regular supervision, serves as the basis for national drug forecasting and procurement, and for relevant, programmatically-useful

Table 1 Five-point policy package of the DOTS framework for global tuberculosis control

- Political commitment
- Standardised case finding using sputum smear microscopy in patients with presumptive tuberculosis
- Standardised, short-course anti-tuberculosis chemotherapy, with the initial phase of therapy given under direct observation by a health care worker, community or family member
- Uninterrupted drug supplies
- Standardised monitoring, evaluation and reporting system

Adapted from reference [7]

operational research, details of which have been previously described [10, 11].

The successful implementation of DOTS depends on simple standardised methods of diagnosis and case finding, standardised treatment using free drugs, standardised systems of monitoring and procurement, and finally in many countries the use of paramedical officers and nurses rather than doctors to deliver and monitor therapy. ART scale up was implemented in Malawi using this public health approach.

1.3 Political and institutional context for ART scale up in Malawi

For the scale-up of ART, Malawi received financial support from the Global Fund to Fight AIDS, Tuberculosis and Malaria. Malawi was not a recipient of the U.S. President's Emergency Plan for AIDS Relief, and, while this meant less money, it made it easier for the country to develop and implement a uniform policy and direction for scale-up. The Department of HIV and AIDS in the Malawi Ministry of Health (MoH) took a clear lead and assumed responsibility for national ART scale up. The rationale was clear and understood by all stakeholders: a strong moral imperative to save lives; fair geographical access to ART throughout the country; an understanding at the highest levels that preventing HIV/AIDS deaths would lead to political and economic stability [12]. In response to this strong leadership and clear rationale, other stakeholders rallied around the MoH.

The key technical inputs thought to be responsible for the success of national ART scale up are shown in Table 2. Standardised systems were adopted so that the same ways of assessing patients as eligible to start therapy, the same free treatment regimens and the same ways of recording and reporting on cohorts of patients were used at whatever level of the health service ART was being delivered (central hospital, district hospital and health centre) [13, 14]. There was a standardised system of training for health care workers and a formal accreditation of health facilities using a structured check list. No health care facility could start delivering ART until the health workers were trained and the facility had been formally accredited. Every quarter, the Department of HIV and AIDS and its partners conducted supervisory and monitoring visits to all active ART sites in the country, ensuring that national guidelines were adhered to, collecting and checking data for national reporting, conducting in-service training and recording drug stock levels.

Within 6 months of the scale up of ART in the public sector, the private sector was engaged as a willing and enthusiastic participant. The doctors, clinical officers and nurses in private sector hospitals and clinics agreed to a) undertake a modified weekend training course with a formal examination of competence, b) accept a formal accreditation of the facility and c) follow national systems including recording and reporting of cases and their outcomes. In turn, private facilities received ART drugs free of charge, but were allowed to charge patients for the drugs at a subsidised rate: some of these fees were kept as part-payment for dispending costs and the rest went into a revolving fund to pay for supervision.

Table 2 Technical inputs responsible for success of national scale up of ART in Malawi

Standardised criteria for eligibility for ART:
• Documented, positive HIV test
• Understanding of the implications of life-long ART
• Assessed as being in WHO Clinical Stage 3 or 4 or
• CD4 count below the threshold value identified for adults and children
Standardised treatment regimens:
• One first-line regimen (stavudine, lamivudine, nevirapine) for adults and children
• Two alternative first-line regimens in case of toxicity to ART drugs
• One second line regimen (different for adults and children)
Standardised quarterly cohort recording and reporting based on:
• ART patient treatment cards
• ART patient registers
• ART patient identity cards
• ART cohort analysis forms
Standardised system of procurement and distribution based on:
• Forecasting of new patients starting ART every quarter
• Forecasting of cumulative patients retained alive on ART every quarter
• Assessment of drug stock levels every quarter

ART antiretroviral therapy

During the initial years of ART scale-up, several published audits assessing numbers starting therapy, patients retained alive on therapy and 6- and 12-month survival probabilities took place which analysed how the country was performing, and this helped to inform on future strategic directions [15, 16]. The dissemination of this public health approach on the international stage and the generally favourable reception gave the MoH the much needed confidence to face critics and to continue with its implementation plans.

2 How operational research was done?

The scale up of ART was under-pinned by a very strong monitoring and evaluation system that was set up from the outset, and for which all ART clinicians, nurses and clerks were formally trained and accredited. The main tools which

were kept at each facility included the ART Patient Treatment Master Card and the ART Patient Register [6].

The monitoring system has been previously described [6, 17], and only brief details are given below. Each patient about to start ART is given a unique ART registration number which is written into the Treatment card and Register. Into both monitoring tools and against this number are written name, address, age, sex, occupation, WHO clinical stage or CD4-count at the time of starting ART, the ART regimen, and date of starting treatment. Every month the patient attends the clinic for review (rescheduled to every 2 months once the patient is stable), and the treatment card is completed for standardised treatment outcomes. These include principal outcomes (alive, dead, lost to follow-up, stopped treatment and transferred out) and secondary outcomes (drug regimens, drug adherence and functional status). Any change in outcome is recorded in the treatment card. At the start of every new quarter, the treatment cards are inspected, and the treatment outcome data from the last month of the previous quarter are used to update the treatment outcome data of the patient register. Once updated, the register data are used to conduct the quarterly and cumulative cohort analysis, and this is a task expected of each ART site every 3 months.

Each ART facility is supervised every 3 months by the Department of HIV and AIDS and its partners, and the majority of the time is spent cross-checking cards and registers to ensure that data are consistent and performing an independent cohort analysis [17]. As numbers of ART sites and patients has increased, enormous amounts of quarterly checked data become available in the treatment cards and registers which can be used for answering pertinent research questions. Between 2004 and 2008, funds were already available for quarterly supervisory visits, and therefore operational research was piggy-backed on to this system.

Research questions were formulated by the Department of HIV and AIDS, its partners and sites and short concise protocols were drawn up with data collection forms. Ethical clearance was obtained from the Malawi National Health Science Research Committee which in general gave expedited clearance for research that involved the collection of routinely collected data, provided confidentiality was assured.

3 Examples of operational research that influenced policy and practice

1. Who receives antiretroviral therapy and how do these patients fare?

In the first 2 years of scale up, questions were asked from the donor community and non-governmental organizations about who was receiving ART, as there was a perception that this service might be elitist and serve the rich. From the occupation columns in the ART register, details were obtained about characteristics of patients starting treatment. Almost 60% of patients were subsistence farmers, housewives or engaged in small-scale business (market vendors or selling fish) with the remainder being mainly health care workers, teachers, service personnel, labourers and unemployed [18, 19].

A series of studies were conducted assessing the numbers of service personnel in the police force and the defence forces [20, 21], and the number of teachers and health care workers [22, 23] accessing ART since the start of scale-up. For each of these studies, treatment outcome data were censored at a specific date, patients by this date being either classified as retained alive and on therapy or having an adverse outcome such as death or lost to follow up. The data were collected from the registers and included age, sex, occupation, reason for starting ART, date of starting ART, ART regimen, treatment outcomes at the censor date and date of adverse outcome if this occurred before the censor date. These data allowed characteristics of the different sectors of the population to be described and survival probabilities at 6-, 12- and 18-months to be calculated. Good outcome data were documented and presented at national meetings and published in journals, and this helped to convince donors that the national ART programme was pro-poor and was preserving lives in important sectors of the population.

For some sectors of the population, additional data were collected, and the published studies had broader effects beyond advocacy. In the Malawi Defence Force, data were collected on annual mortality numbers which were correlated with ART scale up [21]. ART in the Malawi Defence Force was associated with a significant reduction in mortality in the Armed Forces, persuading the army to invest its own resources into supporting ART clinics for service personnel. In the first few years of ART scale up, there was much criticism about the use of scarce health care workers to run dedicated ART clinics at the expense of other services in the health sector. For health care workers then, data were collected from each health facility on the number of clinicians, nurses and clerks employed and the number and proportion needed each week to run the ART clinics [23]. Calculations showed that 1,000 health care worker days per week were required nationally for ART service provision, but this was balanced by 250 health care worker lives saved by ART for a gain of 1,000 health care worker days at the national level. These results were important in demonstrating to a sceptical section of the community that ART contributed to health system strengthening.

One underserved group was children. In 2004 and 2005, there were no paediatric ARV formulations and paediatric

doctors were understandably nervous about giving children split-tablets in case this caused poor plasma drug levels, drug resistance and poor treatment outcomes. Because of this uncertainty, it was agreed that only paediatric doctors should treat children and their outcomes would be collected through routine data. A nation-wide survey was carried out showing that of 46,702 patients ever started on ART, 2,718 (6%) were children aged less than 15 years [24]. Six- and twelve-month cohort outcomes showed significantly more children alive compared with adults. These were reassuring results, and convinced the Department of HIV and AIDS and stakeholders that split-tablets could be administered from every site by general clinicians and nurses provided appropriate training was given. This simple operational research study, analysing routinely collected data, led to national expansion of ART services for children.

Not all such operational research showed good results. A nationwide study carried out on prisoners and ART showed that this vulnerable group was underserved by the ART programme but the study did suggest initiatives to improve the situation [25]. These were subsequently taken up and led to increasing numbers of prisoners being HIV-tested and accessing ART within the confines of prison after the research had been completed.

2. Quality of data aggregated by ART clinics

As the numbers of facilities and patients increased, the Department of HIV and AIDS had to bring in partners to assist with quarterly supervision and monitoring. Complaints increased about the time, energy and expense of conducting routine supervision, and alternative suggestions were made to abandon this activity and ask facilities to send in un-checked data at the end of every quarter. A study was designed so that the quality of quarterly aggregate summary data for April to June 2006 compiled and reported by ART sites was compared with "gold standard" facility summary data compiled independently by the MoH supervision team [26]. While most sites had complete case registration and outcome data, many did not report accurate data for several critical fields such as reason for starting ART, retention on therapy and regimen. The national summary using un-checked site reports resulted in a 12% undercount in the national total number of persons on first-line treatment. This study convinced policy makers that the accuracy of un-checked facility reports was not adequate for national monitoring and that supervision should continue. This message was reinforced when a separate study showed the necessity of having accurate patient ART retention data when making drug forecasting and drug procurement orders [27].

3. Preventing early deaths

One of the major problems encountered in the first years of ART scale up was high early mortality- defined as deaths during the first 6 months of treatment. This problem was occurring in all other countries over sub-Saharan Africa [28]. In the quarterly reports produced by the Department of HIV and AIDS, a consistent finding was that two thirds of all patients known to have died on ART did so in the first 3 months of treatment. Operational research carried out in a rural district amongst adults [29], and in a central hospital amongst children [30], confirmed these findings and showed that risk factors for early death included late stage presentation, low CD4-counts and severe malnutrition. Measures to reduce early mortality were urgently needed.

Anecdotal experience suggested that cotrimoxazole preventive therapy (CPT) given before or at the start of ART reduced early death rates, and operational research was carried out at several facilities to provide more evidence for this intervention. A retrospective cohort study of 11 ART clinics in Malawi that were or were not providing CPT was carried out, and medical record abstraction was performed for all 1,295 patients initiating ART between July and December 2005 [31].At 5 ART sites, CPT was given to patients dosed at 960 mg daily or 480 mg twice a day (according to national guidelines). When all patients lost to follow-up for > 90 days were excluded from the analysis, the 6-month mortality rate was significantly lower at ART-CPT sites (10.7%) compared with ART sites alone (18%) [6-month mortality risk reduction = 41%, p=0.0013], with survival differences apparent as early as 40 days after the start of ART. These data were consistent with subsequent reports from other African countries demonstrating a synergistic effect of CPT with ART, especially in the early months of treatment [32, 33].

The Malawi data prompted the Department of HIV and AIDS to convene a national stakeholders meeting to examine the use of CPT in PLHIV. Based on the Malawi evidence presented at the meeting and evidence from elsewhere in Africa [34–36], there was agreement to modify the previous national recommendations for CPT, and for Malawi to adopt a policy that CPT be provided free of charge to adults and children living with HIV/AIDS as part of a minimum package of care [37].

Following the adoption of the policy, the Department of HIV and AIDS instituted a number of steps that ensured practical implementation in the field and which included: a) dissemination of a rapid circular to all health facilities in the countries, b) updating the national ART guidelines, c) updating the monitoring tools, d) developing and implementing a training package, and e) integrating forecasting and procurement of CPT into the established practices for ART drugs and other commodities [38]. These activities led to widespread implementation of CPT in pre-ART and ART clinics. As of December 2010, 95% of the 250,987 patients alive on ART were on CPT [3]. Early mortality on ART

declined considerably: data from June 2006 showed that 11% of new patients died within the first 3 months of ART initiation while in December 2010, this mortality was less than 5%. This may be partly due to CPT but also due to the decline in the proportion of patients starting ART in WHO Clinical Stage 4 from 25% in June 2005 to about 10% in December 2010 [3, 38].

In the southern region of Malawi, further operational research showed that HIV-infected patients starting ART because of unexplained weight loss or unexplained fever had inferior 6-month outcomes compared with patients who started ART with a specific diagnosis [39]. This was attributed speculatively to undiagnosed tuberculosis, septicaemia or disseminated cryptococcal infection. This research provided the rationale for a successful application to USAID to study these patients in two districts in Malawi with blood cultures, mycobacterial blood cultures, cryptococcal antigen testing and induced sputum for smear and culture of *Mycobacterium tuberculosis*. This study has been completed and analysis is on-going.

4. Understanding default and transfer-out

In all ART programmes and especially with growing numbers, default or "loss- to-follow-up" is an important adverse outcome. Malawi was one of the first countries to systematically investigate the true causes of lost-to-follow-up in an operational research study in four facilities in the northern region where clinic staff attempted to trace and ascertain the true outcome status of patients identified as lost to follow-up (not seen in the clinic for 3 months or more) [40]. Data are shown in Table 3 [40], and the results were subsequently confirmed from elsewhere in Africa [41]. The study had several important policy and practice implications.

Table 3 True outcomes status of patients on ART who were classified as "lost to follow-up" from four clinics in Malawi

Outcome status	Number (%)
Classified as "lost to follow-up" in the ART register	253
Alive and on ART in same or other clinics	21 (8%)
Alive but had stopped ART[a]	37 (15%)
Dead[b]	127 (50%)
Unable to be traced[c]	68 (27%)

Adapted from reference [40]

ART antiretroviral therapy

[a] Reasons for stopping ART included:- high cost of transport to the clinic (13 patients, 35%); religious beliefs (4 patients, 11%); persuasion to stop by relatives (4 patients, 11%); other reasons (16 patients, 43%)

[b] 73 (58%) died within 3 months of last recorded attendance at the clinic

[c] Reasons for unsuccessful tracing included:- incorrect address in the register (55 patients, 81%); patient moved and family remained (7 patients, 10%); patient and family moved (6 patients, 9%)

First, half of the patients declared "lost to follow-up" had died, with most of these deaths occurring within 3 months of the last clinic visit. This led to an important appreciation that in any comparison of treatment outcomes between clinics, particularly with regard to death rates, the issue of loss to follow-up cannot be ignored. Second, most of the patients who could not be traced had an incorrect address in the register, and the Department of HIV and AIDS insisted that clinics paid more attention to writing correct and comprehensive addresses in the register, including mobile phone numbers, with contact tracing being initiated as soon as possible in the event of non clinic attendance. Third, a common reason for stopping ART was high cost of transport, and clinics were advised to consider facilitating better access to care for those with transport difficulties.

Many reports from ART programmes in sub-Saharan Africa make little mention of patients who transfer out to another facility, yet in Malawi's national figures there are transfer-out rates of almost 16% [3]. Operational research on patients who transferred out from a central hospital in the northern region of the country showed that 92% had transferred in to a new facility, with a median time of 1.3 months between transfer-out and transfer-in [42]. Survival probability was higher and deaths were lower in the transfer-out patients compared with those who did not transfer, showing that this process occurred in stable patients. These data were useful for the Department of HIV and AIDS showing that the current practice at that time of regarding transfer-out patients as being double counted in national cohorts and subtracting this number from the total national registrations to get the number of new patients started on ART was correct.

5. Impact of ART scale up on population mortality

A demographic surveillance survey used to measure mortality in a population of 32,000 in northern Malawi showed that within a year of offering ART services there was a significant reduction in mortality in adults aged between 15 and 59 years [43]. Surveillance studies are expensive to undertake and require special expertise. A more operational research study in a rural district in southern Malawi showed a similar and significant downward trend in deaths registered at traditional authorities, coffin sales and church funerals over an 8 year period that was associated with the scaling up of HIV/AIDS care and ART [44]. This study used information about population numbers and annual deaths recorded in village registers within traditional authorities, register books or receipt books kept at coffin workshops and registered funerals at churches as the sources of data, and builds on an important principle of operational research—namely, asking questions relevant to health care delivery and using routinely collected data (in this case, data collected outside of the

health sector) as the sources of evidence for answering these questions.

4 Lessons learnt

The operational research conducted around the scale up of ART provides some important generic lessons about how to successfully integrate operational research into a programme setting.

First, research questions must be relevant to programme needs and it is thus vital to have operational research leadership and coordination placed within the programme.

Second, research should be designed and endorsed with programme MoH staff in order to increase the probability that findings and recommendations from studies are accepted and implemented.

Third, the examples show that the research can and should be effectively carried out within a programme setting and routine health services. In this regard, most of the research carried out used data already being recorded in treatment cards, registers and cohort reporting forms. These data form the basis of routine monitoring and evaluation, with key data usually on case finding and treatment outcome being collected and collated for regional and national reports. However, often only a fraction of routinely collected data is used for monitoring and evaluation purposes. Most health care institutions, including Ministries of Health, in low- and middle-income countries are "data rich, but information poor". Operational research asks key questions about health care delivery and taps into this rich data source to provide information on health care systems or health care delivery. Most of the data in the studies discussed above would never have seen the light of day if it had not been for published papers, as the details were never put into the standard reports issued quarterly by the Department of HIV and AIDS. The use of these data for operational research in our opinion led to routine data becoming more accurate and reliable which in turn further increased the validity of the next studies—a win-win situation. Many of the studies were national and were carried out during routine supervision, and the costs of these pieces of work (mainly hotel accommodation and living allowances) were therefore minimal (Table 4).

Fourth, the research once completed was a) presented at national stakeholder meetings which occurred every 2 months and b) written up for publication in national or international journals. This practice led to national and international dissemination, with publication of operational research adding to the credibility of the study findings [45].

Finally, research should be done to influence policy and practice and improve programme performance and treatment outcomes. Many of the studies which have been described had an influence on policy and practice, but perhaps the most important was the study showing the reduction in early ART mortality with adjunctive use of CPT. This led to the Malawi CPT Policy of 2005, implementation of CPT on a country-wide basis and a decrease in reported early deaths [3, 38].

5 Ways forward

Malawi, along with many countries in sub-Saharan Africa, has done well with ART scale up in the last 6 to 7 years. However, formidable challenges lie ahead. The dire human resource shortages in the health sector that occur not only Malawi, but also in sub-Saharan Africa, need to be tackled, probably through task-shifting [46]. First-line ART regimens need to be changed so that they can be simpler, safer and easier to take. The current low national level of switching from first-line to second-line ART regimens reflects the lack of capacity in the country to reliably diagnose treatment failure [47], and this would be helped by the development of simple to use, point-of-care viral load tests. The small proportion of HIV-infected TB patients who are accessing ART is a problem that pervades sub-Saharan Africa and is not just confined to Malawi. Nevertheless, this issue needs address-

Table 4 Costs of implementing ART operational research projects in Malawi

Title of project	Costs in USD$
Antiretroviral therapy in children in Malawi (reference [24])	350
Antiretroviral therapy in health care workers in Malawi (reference [23])	450
Assessing quality of data aggregated by antiretroviral therapy clinics in Malawi (reference [26])	450
Antiretroviral therapy in the Malawi Defence Force, Malawi Police Force and amongst prisoners (references [20, 21, 25])	600
Antiretroviral therapy in teachers in Malawi (reference [22])	600
What happens to patients on antiretroviral therapy who transfer-out to another facility (reference [42])	1500
True outcomes of patients on antiretroviral therapy who are lost to follow-up (reference [40])	1800

Costing data taken from quarterly reports to an anonymous donor who supported ART and HIV operational research in Malawi

ART antiretroviral therapy

ing by ensuring that centres for TB diagnosis and treatment and for HIV care and treatment are located together, integrated, or better matched quantitatively and geographically [48]. Monitoring and supervision must continue, but increasing use must be made of electronic records to handle the growing number of patients on chronic long term therapy [49]. Drug procurement processes need rigorous attention so that drug supplies remain uninterrupted. Finally, HIV prevention methods, established and new, need to be scaled up and this includes the new concept of "test and treat" (namely, testing people for HIV infection, and if HIV-positive offering immediate start of ART [50]. Well conducted operational research led and coordinated by the Department of HIV and AIDS has the potential to answer some of these questions and find appropriate solutions.

Author contributions ADH wrote the first draft. All authors contributed to subsequent drafts and all read and approved the final paper.

Conflicts of interest No conflicts of interest declared.

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