Engineering CD4 Testing Capacity in Lusaka, Zambia
Final Report

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Team 1: HIV/AIDS Diagnostics and Monitoring
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Executive Summary

The purpose of this report is to provide an assessment of our research on obstacles to CD4 Count Testing (CD4C) in Lusaka, Zambia and lay out our recommendations for improvement.

The Government of Zambia, with funding from Global initiatives like PEPFAR and the Global Fund, hopes to scale up HIV treatment through comprehensive prevention, treatment and care programs that include the provision of Anti Retroviral Therapy (ART) to 100% of the population. The responsibility for this initiative falls largely on the Center for Disease Research in Zambia (CIDRZ). CIDRZ is a Zambian-based non-governmental organization (NGO) charged with the monumental task of coordinating and implementing the Zambian ART scale-up program. They currently operate 18 government health clinics, where HIV testing, counseling, prenatal care, and ARTs are available to all patients free of charge.

However, Zambia's aim of 100% provision of ARTs hinges on its CD4C capability. CD4Cs are the current yardstick to measure when an HIV patient should begin treatment, and efficacy of treatment once begun. The WHO treatment guidelines require that an HIV-positive person receive a CD4 count before treatment is initiated, in the absence of obvious clinical signs of Stage IV AIDS. Therefore, distribution of ARTs heavily depend on CD4Cs.

Our research on Lusaka, the capital of Zambia, yielded two key obstacles to CD4C capability:

(1) Lack of CD4C Facilities: Lusaka has only four facilities with CD4C capability[1]. Only one of these, the CIDRZ-Kalingalinga diagnostic lab, provides treatment free of charge. The other facilities include a military hospital not accessible to civilians and two facilities that charge approximately $21 per test (well beyond the means of the average Zambian) and require an appointment outside of the government health system (where free ARVs are distributed).

(2) Extensive Turn-around Time: "Turn-around Time" is calculated as the difference between time of collection of blood sample and time when results are

[1] Information from Peter Mack and students in the UNZA seminar (???)

communicated to the patient. At Kalingalinga, CIDRZ currently reports a 1-2 week turn-around time.

We would like to focus on decreasing turn-around time for CD4Cs. In this report, we will evaluate the reasons for extensive turn-around time and possible solutions. Most importantly, we propose to send a team of MIT students to study the existing system over Summer 2006. We intend to solicit funding from the MIT Public Service Center. Primary area of focus will be a systems analysis of CD4C process surrounding Kalingalinga. Ultimately, we hope that the on-site assessment and the implementation of the solutions proposed by the MIT team will reduce the turn-around time to at least one-day.

1.0 Problem Statement

Although HIV/AIDS is the number one cause of death in Zambia and Africa, the disease can be chronic, rather than fatal, for patients who initiate and receive anti-retroviral therapy (ART). According to WHO treatment guidelines, CD4 enumeration technologies are crucial to initiate and monitor ART for patients who do not exhibit signs of Stage IV AIDS. Of the four CD4 facilities in Lusaka, Zambia, the Center for Infectious Disease Research in Zambia (CIDRZ) runs a diagnostic lab in the Kalingalinga clinic that offers free CD4 testing to 18 government clinics, with an average turn-around time of 1 to 2 weeks. Current delays in delivering diagnostic results to patients delay initiation of ART, thereby increasing patient mortality risk. To reduce this testing delay to under a day, we propose to improve the logistical and technological aspects of the testing process, beginning from sample collection, transport, tracking, and testing to maximize the CD4 testing capacity and turnover in Lusaka while minimizing cost.

2.0 Background on HIV/AIDS and Current Situation in Lusaka, Zambia

2.1 HIV/AIDS in Zambia

Zambia is one of the countries in Africa most affected by the HIV/AIDS pandemic. At the end of 2003 about 920,000 adults and children were living with HIV and AIDS. Currently there are an estimated 800,000 AIDS orphans in Zambia[2] and 470,000 women of child-bearing age are now HIV positive, leaving the potential increase for future HIV-positive births or yet-unborn orphans to be massive.[3] Young women are particularly vulnerable, with 11 per cent of women in the 15-24 age group infected, compared to three per cent of men in the same age group. According to UNAIDS, an estimated sixteen per cent of the adult population in the country is living with HIV. Prevalence is about twice as high in urban areas as in rural areas.

2.2 Government Commitment

In 2004, in response to the escalating epidemic, the government of Zambia created a plan to roll out a national HIV/AIDS programs. One of the key elements of the program became access to ARVs and the government took actions to improve the availability of ARVs in the country. Thus in September 2004, in line with WTO/TRIPS regulations, the government declared HIV/AIDS a national emergency in a bid to start manufacturing generic AIDS drugs.[4] The declaration, which extends from August 2004 to July 2009, allowed for the government to issue licenses to local firms to begin to manufacture generic AIDS drugs. Consequently, the government awarded a locally based pharmaceutical company, Pharco Limited, a license to manufacture a generic antiretroviral drug combination.

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[2] UNAIDS Zambia webiste: http://www.unaids.org/en/Regions_Countries/Countries/zambia.asp. Accessed 7 March 2006.

[3] WHO website http://www.who.int/3by5/en/cp_zmb.pdf, Accessed on September 20, 2005.

[4] Reuters, "Zambia Declares AIDS Emergency to Produce ARVs", 3 September 2004. Accessed at http://www.accessmed-msf.org/prod/publications.asp?scntid=12112004174478&contenttype=PARA& on September 20, 2005.

In June 2005, the Zambian government declared its commitment to provide antiretroviral drugs (ARVs) for all people in Zambia who need treatment.[5] The program plans to provide free ARVs in public health institutions. 200,000 people require ARVs and the immediate target is to put 100,000 people on antiretroviral drugs by the end of 2005. There are currently more than 12,000 people receiving ARVs through the public health care sector and up until recently most of these patients were receiving treatment at a heavily subsidized price of US $8 per month.

Before the implementation of the new initiative of the government, the Central Board of Health (CBOH) provided treatment at more than fifty clinics and healthcare centers. In addition, treatment was also available in a large number of private clinics accessible to those who could afford to pay for services. Furthermore, free care has been historically provided in some rural areas by civil society organizations such as Medecins Sans Frontieres (MSF).

Treatment roll-out in Zambia is supported by the Global Fund to Fight AIDS, Tuberculosis and Malaria, which has recently approved a US$ 253 million grant. The World Bank granted Zambia US$ 42 million under the second Multi-Country HIV/AIDS Program for Africa. Zambia is also a beneficiary under the US Presidential Emergency Plan for AIDS Relief (PEPFAR), of the Bell and Melinda Gates Foundation. In addition, Zambia has been granted debt cancellation. Therefore, the government has determined that abolishing the cost of ARVs in public health facilities is a moral obligation with great public health benefits.

2.3 When to start treatment?

In order to implement effective HIV/AIDS treatment the progression of disease has to be monitored. Measurement of the CD4 T lymphocytes in the blood is probably the most important laboratory assay for evaluation and monitoring of patients with HIV. The CD4 count is critical for determining the clinical stage of HIV infection, for deciding when to start antiretroviral therapy (ART), and for evaluating the efficacy of treatment.

[5] IRIN PlusNews. "Community benefits from free ARVs." 13 September 2005. http://www.plusnews.org/AIDSreport.asp?ReportID=5234&SelectRegion=Southern_Africa&SelectCountry=ZAMBIA. Accessed 7 March 2006.

The World Health Organization's HIV treatment guidelines for resource-limited settings simplifies the requirements for treatment monitoring, relying heavily on clinical symptoms. However, it is important that patients in developing countries receive adequate monitoring to ensure good treatment outcomes, prevent drug resistance and manage side effects. Thus, using CD4 counts to inform line of treatment should become a critical component of ARV programs especially in places where targets for substantial scale-up efforts exist.

2.4 CD4 count[6]

CD4 cells are a type of lymphocyte that coordinate the immune system's response to certain micro-organisms, including viruses and more specifically HIV. HIV infects and kills CD4 cells. In order to monitor the change of the CD4 cell count in the body due to the progression of the disease, a CD4 count test is administered. The test calculates the number of CD4 cells per cubic millimeter of blood. It measures the number of CD4 cells circulating in the blood, which is approximately only 2% of their total number in the body. The majority of CD4 cells are to be found in the lymph nodes.

The absolute CD4 cell count measures the number of CD4 cells in each cubic millimeter of blood. A normal count in a healthy, HIV-negative adult can vary but is usually between 500 and 1500 cells/mm^3. In very young children the normal CD4 count is much higher.

[6] NAM & aidsmap, CD4 Cell Count, http://www.aidsmap.com/en/docs/83E1467F-61F9-445A-B851-F5B06B094295.asp, Accessed on October 18, 2005

2.5 WHO HIV/AIDS Staging Guidelines[7]

Not significant immunosuppression	>500/mm^3
Mild immunosuppression	350 – 499/mm^3
Advanced immunosuppression	200 – 349/mm^3
Severe immunosuppression	<200/mm^3

Table 1: CD4 levels in relation to the severity of immunosuppression.

Clinical stage	ART
4	Treat.
3	Consider treatment: CD4, if available, can guide the urgency with which ART should be started.
1 or 2	Only if CD4 <200/mm^3.

Table 2: Clinical and immunological criteria for initiating ART in adults and adolescents.

The treatment of patients with WHO Stage IV disease (clinical AIDS) should not be dependent on a CD4 cell count determination. However, where available, this test can be helpful in categorizing patients with Stage III conditions with respect to their need for immediate therapy. For Stage III conditions a threshold of 350/mm^3 has been chosen as the level below which immune deficiency is clearly present such that patients are eligible for treatment when their clinical condition portends rapid clinical progression. For patients with Stage I or Stage II HIV disease the presence of a CD4 cell count <200/mm^3 is an indication for treatment.

[7] WHO, Interim WHO clinical staging of HIV/AIDS and HIV/AIDS case definitions for surveillance: African Region, 2005, http://www.who.int/hiv/pub/guidelines/clinicalstaging.pdf

3.0 Possible Solutions

There are several different ways of approaching this problem. Most of the information provided here is based on research conducted online in the United States, talks with Dr Keller and Dr Rodriguez as well as information from the UNZA team in Lusaka.

1. *Increasing CD4 Testing Capacity*: One of the most obvious problems is the lack of CD4 testing sites. Only one site is available for the general public in Lusaka. In order to improve ART access, CD4 testing capacity must be improved. This can be done by increasing the number of CD4 testing equipment in hospitals and clinics with ART access, increasing the number of labs themselves and/or using satellite to increase communication between labs.

2. *Same Day Testing Policy*: Since transportation is a significant issue for most Zambians, it would help if a "same-day testing and treatment" policy be implemented, so that people who come in can be quickly shuttled through the process without having to return in between. During their down-time, they can undergo "opt out" counseling ensuring the education of HIV/AIDS. In addition, this step might ensure better tracking of patients and that eligible patients are immediately put on ART. In addition doctors will be less burdened by "pending" cases.

3. *Quick Diagnosis or Triage Techniques*: This suggestion came from Dr Mukherjee's talk on October 11, 2005. She suggested that where CD4 tests are not available, doctors can sometimes visibly triage HIV/AIDS cases. For example, people obviously showcasing symptoms of advanced HIV/AIDS such as full-blown opportunistic infections, rapid weight loss, etc can be immediately started on ARTs and later sent to a CD4 site when possible.

4. *Information Systems*: Employing computing/electronic facilities into CD4 testing can significantly improve efficiency. These can include:

a. *Web Communication:* For example, web communication can ensure patient progress. "Molly[8]" may conduct a test or progress report in the field far away and get instant feedback from labs and clinics without having to immediately return. This will allow "Molly" extended time in field while maintaining communication with a medical provider. Another example is a patient who might have tested at the Kalingalinga hospital, but is able to pick up his or her results and medication from a clinic within walking distance of home, as opposed to returning to the hospital.
b. *Bar Coding/Physical Tracking*: Bar coding of samples can be used to facilitate sharing of patient information between labs and the field. Bar coding will ensure patient confidentiality as well as reduce errors between patient sample and results. Currently, lab samples are tracked with a low-tech paper/pencil system, and bar coding might greatly improve efficiency and decrease errors in this system.
c. *Electronic Communication*: Since cell phones are the preferred form of communication in developing countries, results/progress/questions can be communicated through text messages. For example, the same patient who had tested in the Kalingalinga hospital can return home knowing that results will be sent to him/her on her phone.

While many of these solutions are feasible, there are other issues that need to be taken into consideration. Web communication, for instance, will require a "Molly" who is functionally and computer literate. The same can be said of lab and clinic staff. They must be open to the idea of incorporating technology into their system. Currently there is an electronic tracking system in the Government Clinics and hospitals, but the extent to which they are being utilized is largely unknown.

[8] "Molly" As defined by Dr Bill Rodriguez as being the generic Field Worker in a developing country

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