

Zambia Electronic Perinatal Records System

Final Technical Report (January to September 30, 2006)

Submitted to:

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Abbreviations

ART	antiretroviral therapy
CIDRZ	Center for Infectious Disease Research in Zambia
LUDHMT	Lusaka Urban District Health Management Team
PMTCT	Preventing Mother-to-Child Transmission
UAB	University of Alabama at Birmingham
UI	user interface
UTH	University Teaching Hospital
VCT	Voluntary Counseling and Testing
ZEPRS	Zambia Electronic Perinatal Records System
ARV	Anti-Retroviral

Executive Summary

Accomplishments

Dr Perry Killam, an American pediatrics physician in Lusaka, and Chris Kelley, an American software engineer in Cape Town, South Africa, are responsible for managing the deployment of ZEPRS in Lusaka. Dr. Killam and Mr. Kelley began their collaboration in January, 2006, about a month before the ZEPRS deployment started. Dr. Killam manages the clinical operations – monitoring how the clinicians interact with the applications, compiling change requests, and communicating and reviewing the change process with Mr. Kelley. Mr. Kelley, who wrote most of the ZEPRS application, manages and implements software updates. It has been a very productive working relationship. Mr. Kelley and Dr. Killam communicated almost daily about updates or bug fixes that were needed for the ZEPRS system. During this period, Dr. Killam worked with Lusaka clinicians in the deployment of ZEPRS to eleven clinics in Lusaka. Many of the changes to the system were in response to requests by clinicians or changes made to enhance a current process. To date (October 19 2006) over fourteen thousand patients have be tracked with the ZEPRS application since its debut February 2, 2006.

Most of the changes to the ZEPRS application have been routine – additions of items to dropdown menus or fields to forms. Bugs in the system were quickly identified and fixed – the most notable were a bug in EGA/ADD calculation and data errors on some of the new reports. Mr. Kelley installed new builds (updates) to the application almost every week. Mr. Kelley is able to install these updates on the Lusaka server using a secure connection over the Internet.

Some of the changes to ZEPRS are worth highlighting. These changes include the following items:

- Demographics
 - Added “Firm” field to store what UTH Firm the patient has been assigned to. When a patient is referred to UTH, she is assigned to a particular “firm” within UTH.
 - Added Adult ARV and pediatric ARV to patient ID site selection.

- Pregnancy Dating
 - Updates to how LMP/EGA are calculated. This was changed to address a bug: EGA was being calculated by the value for the current date, not by the value entered for “Date of Visit.” In cases where the form was entered after the patient visit, this “Date of Visit” value was not the current date; the calculation of EGA needed to be changed to resolve this bug.
- Safe Motherhood: Expansion of the Safe Motherhood care section shows the importance of HIV care in Lusaka.
 - Labs – Clinicians indicated that the process of adding Lab requests took too long because only one Lab request could be made at a time. We changed the way this section works: A user may now make multiple lab requests, which subsequently appear in the problem list displayed on every page. When the results are ready, the clinician clicks the item from the problem list and enters the results.
 - Results of most of the Safe Motherhood-related forms (Labs, RPR, Counsel, etc) are presented in a table to enable easy scanning of lab history.
 - RPR - For RPR, auto fill Date of RPR screen to today's date (like the HIV test).
 - ARV Regimen – added new fields to accommodate the screening with CD4 and WHO staging for severe HIV disease requiring ART and referral to the ART clinic
 - Hematology – new form
 - Chemistry – new form
 - Liver function – new form
 - Urinalysis – new form
- Delivery Summary
 - Added “Birth Weight” to add newborn widget in order to encourage increased input of this data item.
- Reports
 - Safe Motherhood Register
 - § added new fields
 - § enabled display of column headers on each printed page. Clinics print out this report almost daily and needed the column headers. The “print-only” version includes only recent patients in order to reduce the number of pages printed.
 - Delivery Register
 - § Added new fields
 - VCT/ PMTCT Register

§ Added new fields

- Partograph
 - Extended duration of Partograph based on feedback from UTH – now tracks 24 hours. The previous version did not allow enough hours in cases of long labor duration.
 - UTH now has capability to re-generate cervix decent plot. Sometimes patients are referred to the UTH from clinics. UTH now has the option to generate new action lines again from where they start treating the patient.
 - Improved time-tracking capabilities: system now displays actual times rather than hour 1, 2, 3, etc. These times are automatically created based on the time of the first data point entered. Clinicians recommended we make this change in order to keep nurses on-track with their recording and ensure accurate and honest data entry.
- Flow changes
 - After submitting a new Lab, it now returns user to Labs page in case user wishes to submit more Lab requests. This was subsequently changed to enable submission of multiple Labs.
- Printed Records
 - Printable summaries of the patient's Antenatal record were made available. This summary includes information about routine antenatal visits, coded HIV status (called the HIV Stamp), and medicine info.
 - Also the printable summary of the Pregnancy after delivery and upon discharge from the hospital– (Pregnancy Discharge Summary)
- Form rendering
 - Added capability to highlight particular fields to help user to find the most important fields. Some of the forms have many fields, and clinicians needed a way to easily identify the most commonly used fields. This new capability is currently used in the Initial Visit Physical Exam form.
- Offline mode capability – see section below
- Administration
 - Support for Offline Mode.

Offline Mode

ZEPRS was originally written to support only a traditional client-server mode - web browser clients interact w/ a single server to submit/view forms, records, and reports. Due to the fact that some clinics were having difficulty maintaining a consistent network connection we needed to look at ways these clinics could continue to use the system during such outages. In response to this need we have enabled ZEPRS to support a disconnected mode, called clinic mode, in which

a pc in the clinic can be configured to act as the local clinic server and periodically upload patient records to the main ZEPRS server. This capability is useful in circumstances where network connectivity is unreliable or impossible.

An instance of the ZEPRS application is installed on one of the clinic pc's, which is an ordinary pc except for the addition of 512 MB RAM, making a total of 1GB or RAM. All of the other pc's in the clinic use the local instance of the ZEPRS application rather than the Master version; therefore, when the site loses connectivity to the Master ZEPRS server, the users at the clinics do not notice this loss.

This clinic "server" is configured to publish an xml file, called an RSS feed, every 30 minutes. The Master ZEPRS server subscribes to this clinic feed. In the same manner, the clinic pc subscribes to the main ZEPRS server RSS feed. The RSS feed is a listing of all of the clinic's patient records in XML format, with modification dates. When the clinic pc (or master server) imports an RSS feed, it compares each record's last modified date with its own patient records. If the dates are not equal, it downloads an XML file that contains the patient record and updates the necessary data.

More information about Offline mode is available at:

<http://rtidemo.org/drupal/node/46>

Screen shots of changed pages

Screen shots of the application in development are provided in the exhibits below. In addition, Flash¹ videos of some sections of the application are available at <http://rtidemo.org/drupal/node/29>

Exhibit 1: Demographics

The following exhibit shows the system's capability to track the UTH Firm to which the patient has been assigned.

Patient Registration and Identification

DATE OF VISIT: *

GENERAL INFORMATION

Surname: *	Forenames: *	Sex: Female
NRC No.:	Safe Motherhood Number:	Firm (UTH only):
<input type="text"/> Format: 123456/78/9	<input type="text"/> (Blue Book number)	No Information

ZEPRS ID

Select the first two parts of the ID from the dropdowns. If you need a new ID, If patient already has an ID, enter last 5 digits of Patient ID and click "Check ID"

District: * 5040 *	Clinic: * 33 - Airport *	* 2 *
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Get New ID

¹ Flash is a registered trademark of Macromedia, Inc.

The addition of ARV clinic tracking fields reinforces the importance of ARV care.

ZEPRS ID
Select the first two parts of the ID from the dropdowns. If you need a new ID, press "Get New ID."
If patient already has an ID, enter last 5 digits of Patient ID and click "Check ID".

District: * 5040 *	Clinic: * 33 - Airport *	* 2 *	Get New ID
If patient already has an ID, enter last 5 digits:	ZEPRS ID: *		Check ID
Birth Date: [4]	Age at First Attendance: *	Education Status: No Information	
Residential Address:	Community or Compound:	Date of Residence Change: [4]	
Marital Status: No Information	Occupation: No Information	Religion: No Information	
Nearby Place of Worship: (use to locate patient's neighborhood)	02 - UTH D block 02 - UTH-Adult ARV 02 - UTH-Peds ARV		

Exhibit 2: Lab Tests

A lab must be requested before any data may be entered. The following screenshots show how multiple Labs may be requested.

+ REQUEST A LAB TEST

Date of Lab Request:

Type of Lab:

Current Selections: CD4 Count, Blood Type

Choices: CD4 Count, RPR, Blood Type, Rhesus Status, Hb - 1st screen, Hb - 2nd screen, Cervical Smear, Sickle Cell Screen, Malaria Test, Hematology

Select up to 8 items.

<< Add Item << >> Remove >>

Password:

The system creates “Missing Lab Results” notification in the Active Problems section:

Problem List

Active Problems	
Problem	Date
MISSING LAB RESULTS	
CD4 Count	
Blood Type	

Clicking on the link takes the clinician to the page associated with the request, whereupon she may enter the results.


Lab Results may be accessed from links at the top of the Safe Motherhood section.

ZEPRS Airport	Staff User, ZEPRS Admin	Patient Patient5191,Basic80294	NRC Number
	Safe Motherhood Labs RPR Counsel ARV Hematology Chemistry Liver Function Urinalysis		

Exhibit 3: ARV care (Regimen given Today form)

Exhibit 3 shows the addition of more fields to accurately track ARV care.

Regimen Given Today

Date of Regimen Visit:  19/10/2006	Received Regimen?: <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> N/A	Regimen: No Information ▾	# of Days of AZT given: <input type="text"/> days
Phase of Pregnancy: No Information ▾	Tested for CD4?: <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> N/A	WHO Screen: No Information ▾	Referred to ART Clinic?: No Information ▾ No Information Yes - Urgent referral w/in 1 week Yes - Urgent referral w/in 2 weeks Yes - Non-urgent appointment in 1-2 months Yes No

Password:

Exhibit 4: Lab Results display

Lab and drug dispensation records are presented in a table that can also be used for data entry..

General Lab Studies Records

If you are entering the results of a lab request, enter the results in this table by double-clicking on the field in the record's row.

Date of Lab Request	Type of Lab	Date of Lab Results	Results	Reasons for not treating	Treatment	Comments	Del.
2006-10-19	CD4 Count	2006-10-19	180				X
2006-10-19	Blood Type	2006-10-19	A				X
2006-10-19	Hb - 1st screen	2006-10-19	<input type="text"/>				X

Display of ARV Regimen Records:

Regimen Given Today Records

Phase of Pregnancy column is only used for the mother. Please disregard for infant records.

Date of Regimen Visit	Received Regimen?	Regimen	# of Days of AZT given	Phase of Pregnancy	Tested for CD4?	WHO Screen	Referred to ART Clinic?	Del.
2006-10-19	Yes	NVP + AZT	28	Antenatal	Yes	Positive	Yes - Urgent referral w/in 1 week	X

It was noted earlier in this document that results are accessible from links at the top of the Safe Motherhood section pages. The system indicates if no records are available.

[Safe Motherhood](#) | [Labs](#) | [RPR](#) | [Counsel](#) | [ARV](#) | [Hematology](#) | [Chemistry](#) | [Liver Function](#) | [Urinalysis](#)

Hematology**Hematology Records**

No records

Exhibit 5: Pregnancy Dating

Estimated gestational age can be evaluated and reported.

Pregnancy Dating


Date of Visit	Planning/Contraception	Dating Method Data Entry	EGA	EDD	Dating Method
16/05/2005		Reliability of LMP: Certain LMP: 2005-02-05	19, 4/7	2005-11-12	LMP
16/05/2005		Reliability of LMP: Certain LMP: 2005-03-23	13, 1/7	2005-12-28	LMP
 16/05/2005	Planned Pregnancy: <input type="radio"/> Yes <input type="radio"/> No	Reliability of LMP: <input type="text" value="Certain"/> LMP: <input type="text" value="March"/> <input type="text" value="20"/> <input type="text" value="2005"/>	13 4/7	25/12/2005	<input checked="" type="radio"/> LMP <input type="radio"/> Uterine size <input type="radio"/> Ultrasound EGA: 13 4/7 EDD: 25/12/2005
Uterus size in weeks (4-44): <input type="text" value="11"/>			11	12/01/2006	
EGA from Ultrasound Results: <input type="text" value="18, 3/ 7"/>			18 3/7	21/11/2005	
Password: <input type="password" value="*****"/> <input type="button" value="Submit"/>					

Exhibit 7: Delivery Summary

Addition of “Weight” field to Newborn widget was added to encourage data entry of birth weight. It was previously entered only in the Newborn Summary form.

Delivery Summary

Date of Visit: *  19/10/2006

 **NEWBORN DELIVERY DATE, TIME, AND SEX**

Delivery Date:	Time of Birth:	Sex:	Weight:
 19/10/2006	-- <input type="text" value=""/> -- <input type="text" value=""/> (Current Time)	<input type="radio"/> Female <input type="radio"/> Male	<input type="text" value=""/> <input type="button" value="Enter"/>

Exhibit 8: Partograph

System now presets the timing based on the time of first data entry.

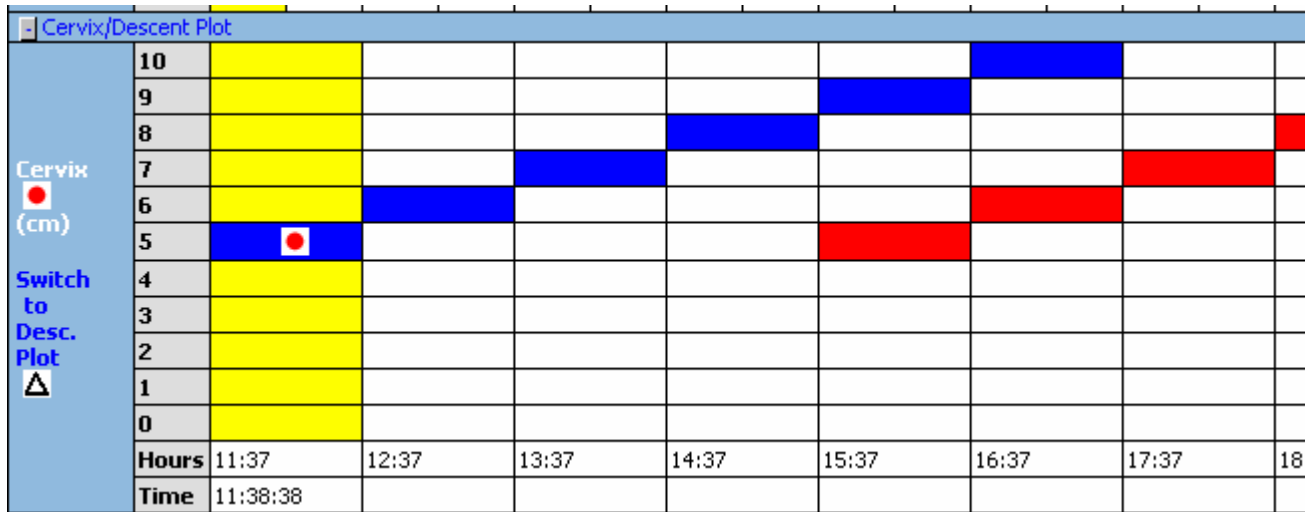


Exhibit 9: Antenatal Monthly Summary Report

This report has been refactored to help with quality assurance (QA) with the missing ANC forms column.

Antenatal Monthly Summary Sheet for Kalingalinga 2006

"New ANC Client" value is calculated from the total of "Initial Visit exam" forms submitted. All patients should have Routine Antenatal visit exams. Dates with values in "Missing ANC visit" in links to the incorrect patient records.

Date	New ANC Client	Missing ANC visit	Revisits	Counseled New ANC	Counseled Revisit	Total ANC Attendees	Pre-Test Counseled
TOTAL	21	2	8	16	0	29	16
2006-08-01	13	2	3	9	0	16	9
2006-08-02	7	0	2	7	0	9	7
2006-08-03	0	0	3	0	0	3	0

Clicking on one of the "Missing ANC visit" fields provides links to the associated patient records:

Date	New ANC Client	Missing ANC visit	Revisits	Cou Ne
TOTAL	21	2	8	16
2006-08-01	13	2 Missing: 9563 9581	3	9
2006-08-02	7	0	2	7

The following fields are now tracked in this report: Date, New ANC Client, Missing ANC Forms, Revisits, Counseled New ANC, Counseled Revisit, Pre-Test Counseled, HIV Tested New ANC, HIV

Tested Revisit, Total Tested, Refused Testing, Received Results, Uncollect. Results, HIV Positive:, HIV Negative, HIV Indeterm., Referred ARV Clinic, Maternal NVP, Maternal AZT, Infant NVP, RPR Tested, RPR Positive, RPR Negative, Syphilis Treated, Hgb done, Hgb < 10, SP1, SP2, SP3, TT1, TT2, TT3, TT4, TT5, TT Protected, TT Complete, First visit 1st Trim, First visit 2nd Trim, First visit 3rd Trim, Vermox.

More information about ZEPRS Reports may be found in the ZEPRS Documentation site at the following URL: <http://rtidemo.org/drupal/node/37>

Exhibit 10: Printed Records

Clinicians now always print out a summary of the patient’s antenatal visits with each patient visit.

Antenatal Card: [redacted] Report Date: 2006-[redacted]

Patient Name	Patient Id	Age	Birth Date	Address	Husband	Clinic Name		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Kalingalinga		
LMP	EDD	EGA (weeks/days)	Dating Method	Gravida	Parity	ABO Group	Rh Status	Height
				4	3			164 cm

Previous Pregnancies							
Month/Year	Duration	Health During Pregnancy	Mode of Delivery	Type of Labor	Birth Weight	Outcome	Puerperium
1 / 19	Full Term		Spontaneous Vaginal	Spontaneous	Infant 1: 2.5	Alive	Postpartum Infection: None
1 / 19	Full Term		Spontaneous Vaginal	Spontaneous	Infant 1: 3.0	Alive	Postpartum Infection: None
12 / 19	Full Term		Spontaneous Vaginal	Spontaneous	Infant 1: 2.3	Alive	

Lab Tests						RPR					
Date Request	Lab Type	Date Results	Results	Site	Clinician	Screen Date	Result	Treat. Date	RPR Drug	Dosage	Comments
2006-0	Hb - 1st screen	2006-0	12.6	Kalingalinga	[redacted]	2006-0	Non-Reactive (Negative)				

Safe Motherhood Care				Drug Interventions						
ITN?	Yes	PCR	TR	MGA	Date Given	Folic	Iron	Deworming	SP	Other
TT1		PCR	TA 2006-0	MRA	2006-0	X	X	X	SP1	
TT2		PCR	R	IGA						
TT3		PCA 2006-07-19	NR 2006-0	INGA						
TT4	2006-0		I	IFB						
TT5				IFR						


Current Pregnancy Started 2006-07-19														
Routine Antenatal Visits														
Date	Site	EGA	Fundus	Lie	Present.	Engaged	FHR	BP	Oedema	Weight	Urinal.	Next Visit	in Z?	Remarks
2006-0	Kalingalinga	29, 3/7	27	Longitudinal	Cephalic	No	120 - 160	110 / 80	0	60.4		2006-0		
								/						
								/						

A larger version of this image is available at <http://rtidemo.org/drupal/node/50>

Exhibit 11: Form rendering enhancement: Highlighting

The following examples show new field highlighting capabilities used to direct attention to commonly used fields. Not so much commonly used but instead it was meant to highlight what should be routinely documented (largely based on existing written documents but also based on medical importance). The goals were to make documentation more uniform and efficient.

Initial Visit Physical Exam

Date of Visit: *  19/10/2006

Height: <input type="text"/> cm	Temperature: <input type="text"/> ° C (xx.x)
HE/ENT: <input type="text" value="No Information"/> ▼	
Teeth: <input type="text" value="No Information"/> ▼	
Thyroid: <input type="text" value="No Information"/> ▼	Breasts: <input type="text" value="No Information"/> ▼
Respiratory System: <input type="text" value="No Information"/> ▼	
Heart: <input type="text" value="No Information"/> ▼	
Pulse: <input type="text" value="No Information"/> ▼ bpm	

Problems and Remedial Actions

During the ZEPRS deployment, CIDRZ experienced problems with equipment and staffing shortages that had a negative impact upon network reliability. Some of the clinics experienced poor connectivity to the ZEPRS network during Q1 and Q2 2006 that inhibited their ability to use the ZEPRS application. Chris Kelley implemented an offline mode system, described earlier in this document, to enable two of the clinics (Kalingalinga and Matero Ref) to use the ZEPRS application while disconnected to the network. Now that network connectivity is improving in Q3 2006, ZEPRS is considering moving these two sites back to normal online operations in order to simplify technical management. The offline mode capability provided the necessary support while it was needed, but would need further development to deploy across the whole ZEPRS network. The offline mode software installation needs to be made simpler, the software used to manage the offline sites could use some improvement, and the clinic wireless installations may need a re-design to permit independent operation while disconnected from the network. Chris Kelley created a “proof-of-concept” standalone client called “Zephyr” that could be used to simplify installation of offline mode clients. More information on Zephyr: <http://rtidemo.org/drupal/node/85>

Using ZEPRS for direct entry of patient data is successful; nurses are able to conduct their usual patient examinations and perform the necessary data entry into ZEPRS at the same time. This approach is called “Data-entry first.” Dr. Perry Killam meets with clinicians on a weekly basis to identify any issues with the application. Most of the change requests have been of a technical rather than functional nature: to fix bugs in the application or to make minor changes to form fields.

Dr. Killam did identify a couple of changes that needed to be made in order to practically accommodate the “data entry first” approach into the work process. First, antenatal records are now printed at each patient visit only at UTH. At the clinics, they only print the antenatal card during the first visit then both write on the card and update ZEPRS. This process is counter to the original intentions of ZEPRS: to eschew any printing of records by clinicians due to the high cost for printer paper at the

inception of the project. This goal proved to be unrealistic, especially while ZEPRS is not deployed across all Lusaka clinics. Patients needed a record of antenatal care when visiting non-ZEPRS clinics. Adding this printout capability provided the necessary remedy. The second change was in regards to the partograph. Nurses on midnight duty must accommodate a heavy patient load; they were having real difficulties entering data on 20 deliveries at the same time. At the moment they are entering on paper first and then entering in to the ZEPRS system as time permits. CIDRZ has created a new paper form, based on two ZEPRS forms. This new paper form features Labor Admission on front and the Partograph on the back for this new process.

Transition to a new system

CIDRZ has been working with the CDC since November, 2005 on a patient tracking system for anti-retroviral therapy. This system has been mandated by the Zambian government to become the official ARV care system for the whole country. This system is now planning to include support for perinatal care and will ultimately replace the ZEPRS application. Dr. Killam and Mr. Kelley will work with the CDC's software engineers to duplicate the ZEPRS application functionality into this new application. This new system is expected to be deployed mid-2007.