HIV EMR Proposal

Report prepared by:

Dr John Haskew, Director Uamuzi Bora

November 2013

ABSTRACT

- Uamuzi Bora is a medical project that supports the Ministry of Health (MoH) and partners in Kenya to implement an electronic medical record to improve clinical and public health decision-making. The EMR is built using free, open source software and is based on the Open Medical Record System (OpenMRS) platform, increasingly being adopted in developing countries around the world.

- Uamuzi Bora has implemented an HIV EMR in Western Kenya since 2009 and more than 17,000 patients are now registered across five sites, including Kakamega PGH, which has the largest caseload in all of Kakamega County.

- Among other indicators, a 77% reduction in patients eligible for ART but not on ART has been documented and more than 3,700 patients previously lost to follow up have been traced using the EMR in the past 12 months.

- The budget will facilitate implementation of the HIV EMR by MoH to cover at least 25,000 people living with HIV across 25 health facilities (including Kakamega Provincial General Hospital, Vihiga District Hospital and 3 health facilities currently supported in Kakamega County). Technical support and training will be provided within the budget to support MoH ownership and sustainability for the long-term.

- The budget assumes that MoH staff costs (at national, county, district and facility levels) are covered by the MoH themselves, as use of the EMR will become part of the daily work of public health and clinical staff. These staff costs include data entry and routine use of the EMR, as well as attendance at training.

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The HIV electronic medical record (EMR) is built using free, open source software and builds on common platforms and previous work, notably that of Open Medical Record System (OpenMRS).

The HIV EMR uses a cloud-based model of deployment that only requires a single server to be maintained centrally, with no infrastructure required by the individual clinic (Figure 1 and 2). The EMR uses a secure, encrypted virtual private network (VPN) with Safaricom, a mobile phone provider in Kenya, to which the server and clinic computers can connect securely. The VPN is air gapped from the internet and only computers that have been registered by the project can access this secure private network.

Each clinic only requires a single computer to run the EMR and the Google Chromebook has been selected as the clinic computer of choice. Chromebooks function as a laptop and are capable of hosting a SIM card to connect directly to a mobile data network. In this manner, each clinic can connect securely to the EMR server via the VPN on the mobile data network.

The cloud-based model allows health information to be shared in real-time between different levels of care to improve clinical and public health decision-making (Figure 3). Every 24 hours, the database of individual patients (which remains encrypted and secure and only accessible to clinics) is copied and all patient-identifiable information is removed. This anonymous version of the database is then used to provide health information to different users at different levels of health care.

Figure 1. Features of a local clinic model of EMR implementation

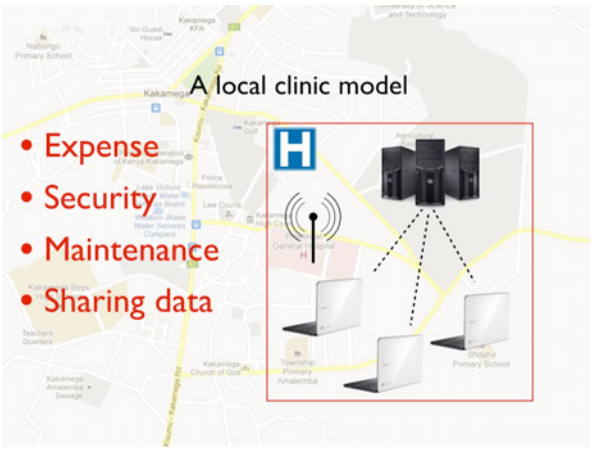


Figure 2. The Uamuzi Bora model of EMR implementation

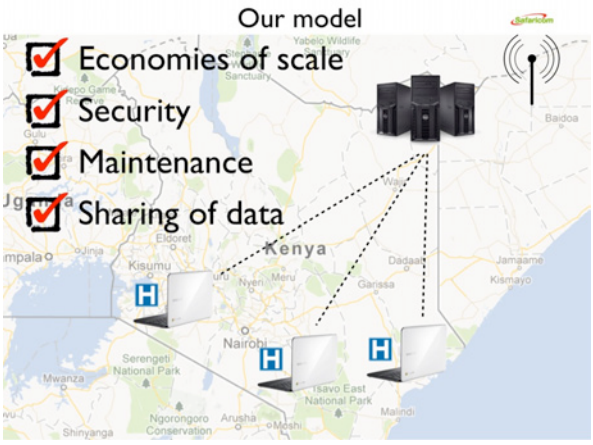
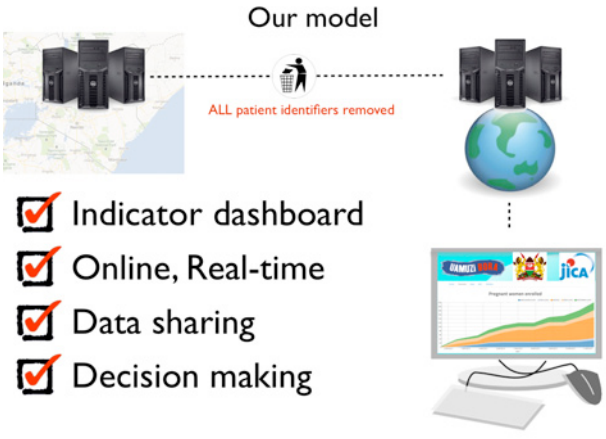


Figure 3. The Uamuzi Bora model of EMR implementation



1.1 Features of the EMR

1.1.1 Data Entry

Data is entered from the paper record to the electronic medical record either by the clinician or a data entry clerk.

During the first phase of Uamuzi Bora EMR implementation in a new clinic, the existing paper-record is entered into the electronic database. Clinic data clerks are trained in data entry and Uamuzi Bora data entry assistants support data entry and supervision in high volume sites.

Once the "backlog" of historical patient data is entered, prospective new patients and clinic visit data continues to be entered. Depending on the site, this data entry can proceed in two ways:

1. Data is entered during the patient consultation by the clinician
2. Data is entered after the patient consultation has finished by a data entry clerk

1.1.2 Data Verification

Data checks are run automatically on all data collected in the electronic medical record to ensure data is valid, accurate and complete.

Once data is entered into the HIV EMR, the system automatically reviews all data every 24 hours and produces a data verification report to indicate if pertinent data is missing from the record. Individual patient records are also flagged to highlight which data is missing. Clinic data clerks can then review these reports and flags to correct missing data from the patient record.

1.1.3 Clinical Decision Support in Care

Clinical reminders and decision support is designed to ensure standardised care is provided that will improve the quality of care delivered.

Adherence to clinical guidelines is essential for ensuring a high standard of health care provision. The HIV EMR automatically reviews the database every 24 hours to generate a clinical verification report and flag patients who have not received care according to

standardised guidelines and protocols. Clinicians then regularly review the clinical verification report and individual patient flags to review appropriate management plans.

1.1.4 Follow Up and Retention in Care

A successful outpatient program must ensure continuity and retention in care

Continuity of care and retention in care remain particular challenges for many health services in resource-constrained settings. The HIV EMR can automatically flag and provide a list of patients who have not attended clinic or missed a clinic appointment. The EMR can also automatically send out SMS text message reminders to these patients or a phone call can be made from the clinic to ensure patients are retained in care and followed up appropriately.

1.1.5 Reporting

Standardised reports can be automatically generated to enhance the monitoring and evaluation functions of the clinic, as well as district and provincial health management.

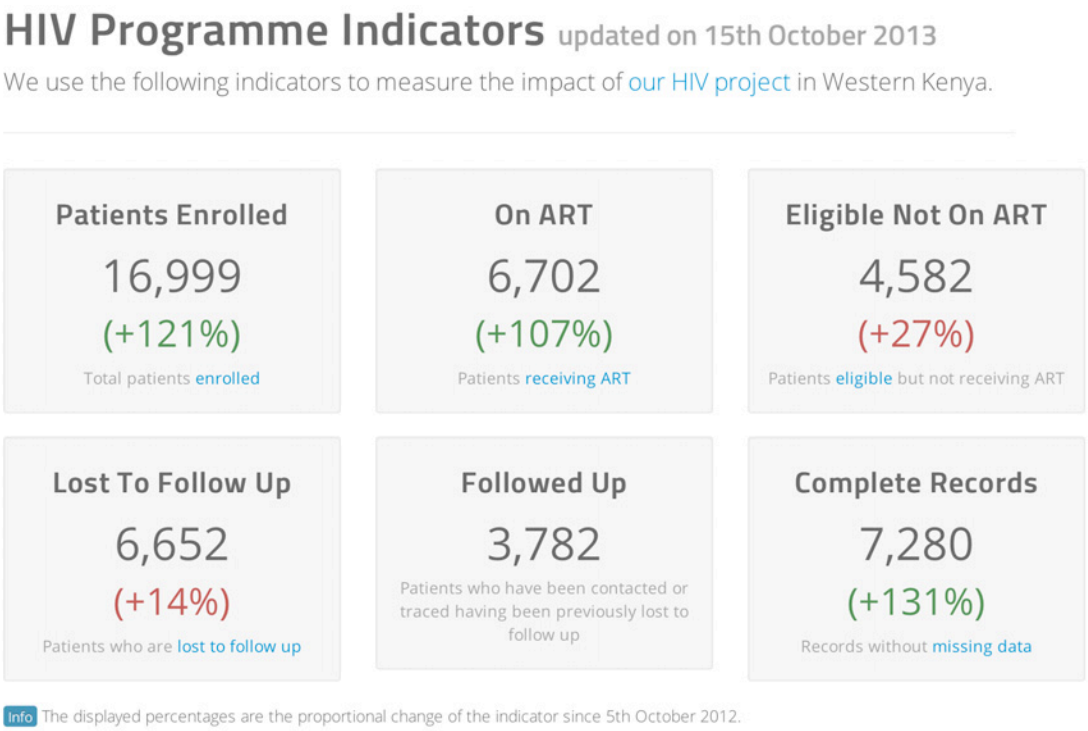
The HIV EMR provides standardised reporting to the Ministry of Health and partners, for example the MOH711a report, MOH731 report and NASCOP HIVQual report. Both external and internal reporting is essential to determine the success of programming and the HIV EMR provides the ability to generate such reports quickly and accurately. Reports can be generated via the EMR itself. Online aggregated data tables are also available via the following web address:
https://uamuzibora.org/reports/hiv

1.1.6 Indicator Dashboard

A real-time online indicator dashboard provides feedback and monitoring at all levels of health management and decision-making.

The HIV EMR improves access to and use of health information at all levels of public health and clinical decision making, from the clinic to national level, through the use of an online indicator dashboard. An example view is shown in Figure 4. The indicator dashboard can be accessed at the following web address:
https://uamuzibora.org/data/hiv

Figure 4. The Uamuzi Bora HIV EMR indicator dashboard



1.2 System Infrastructure

1.2.1 Network

Uamuzi Bora utilises a secure, encrypted virtual private network (VPN) with Safaricom, a mobile phone provider in Kenya, to which the server and clinic computers can connect securely. The VPN is air gapped from the internet and only Chromebooks and SIM cards that have been registered by the project can access the secure, private network.

1.2.2 Server

The physical server is hosted for Ministry of Health by Uamuzi Bora, and is currently located in Kakamega. It uses a WiMAX radio connection to connect to the VPN.

The Uamuzi Bora server runs a customised version of OpenMRS 1.9: a Java application running on top of Apache Tomcat 7, using MySQL 5.5 as a database server, and run behind Nginx as a reverse proxy server, on a server running Ubuntu 12.04 LTS Linux. Regular security updates are applied to the system from the main Ubuntu repositories.

The BIOS is password protected. The hard drives are encrypted using *dm-crypt* and a key file is used to decrypt the hard drives at boot time. The key file is stored on a separate USB

memory stick that is required to be plugged into the server to boot. The USB stick is then removed after booting and stored in a locked cabinet elsewhere in the building.

The server runs a fully patched version of Ubuntu using only packages from official Ubuntu stable repositories. Only ports 80, 443, and 22 are open; the rest firewalled. SSH has a stringent configuration to resist brute force attacks and root login is disabled. MySQL has been secured from its default configuration, and only accepts connections from the localhost. Tomcat only serves pages over HTTPS: it redirects all port 80 traffic to port 443 and uses SSL/TLS with our own self-signed certificate.

All server processes are owned by non-privileged users and are sandboxed. OpenMRS user accounts have permissions relevant to their roles and may only access relevant data, as per principle of least privilege. A strong password policy is enforced.

1.2.3 Clinic computers

Clinic computers are Google Chromebooks, which use a 3G mobile internet connection to connect directly with the VPN. The 3G mobile internet connection does not permit access to the internet, and Wifi and Ethernet networking on the client machines is disabled.

Clinicians and data clerks use the Chromebooks to search, view, edit and create electronic patient records and access verification reports and clinical reminders within the OpenMRS web application.

1.3 Data Management

1.3.1 Data Protection

Uamuzi Bora stores patient data confidentially and, in accordance with best practices, data are protected through a variety of mechanisms.

The server is physically secured in a locked office in Kakamega, and physical access is limited to select Uamuzi Bora staff. An alarm is triggered if the server case is tampered with and the BIOS requires a password to continue booting. Patient identifiable information (such as the MySQL database) is stored on an encrypted file system that is decrypted at boot time using a USB key, which is then stored in a different secure physical location to the server.

Connections between the clinic computers and the server use exclusively HTTPS over an IPsec VPN. Core Uamuzi Bora staff can also connect to the server from the internet using public-key authenticated SSH over the IPsec VPN. All connections and connection attempts to the server are logged and audited.

1.3.2 Data transfer and backup

Encrypted backups are made of patient identifiable data. These backups are encrypted using GnuPG to a private key, which is split between four lead Uamuzi Bora staff using Shamir's Secret Sharing in a (2,4)-threshold scheme. This means that no-one person can decrypt the backup - it requires two people to combine their shares of the private key to decrypt it.

Encrypted backups are transferred to long-term storage on Amazon Glacier over the VPN and held for a period of 6 months for the purpose of disaster recovery after which time they are securely deleted. All backups are protected with strong encryption. Only the project's public keys are on the server; the corresponding private keys are held out of country by the research team. Temporary files are immediately securely deleted after encryption is completed.

1.3.3 Anonymisation

In addition to backups for the purposes of disaster recovery, regular anonymised versions of the database are created automatically by the server, which contain no patient identifiable data. This anonymous database is encrypted with a different key to the main backup and is held by all core project members.

The anonymisation process is automated by a backup script and does not involve any human intervention. It occurs on the same physical machine as OpenMRS, so data are anonymised at point of source.

Patient identification numbers, names, data of birth, relations, first line of address and free-text fields are considered represent patient identifiable data and these are deleted as part of the anonymisation process, apart from date of birth which is rounded to the nearest year. Our anonymisation process thus performs the following functions:

- Deletes the UPN (the unique patient identification number).
- Deletes the patient's forename(s) and replaces it with 'Unknown'.
- Deletes the patient's surname and replaces it with 'Unknown'.
- Deletes the patient's middle names (if applicable).
- Deletes the patient's maiden name or previous surnames (if applicable).
- Deletes any prefixes or suffixes of the patient's name (if applicable).
- Deletes the first line of the patient's address
- Deletes the patient's telephone number
- Rounds the patient's date of birth to the nearest month (e.g. 14/07/1970 would be come 01/07/1970)

- Deletes all details of the patient's treatment support (names, phone numbers and addresses)

The anonymous database is used to create aggregated data that is transferred over a VPN to a public webserver for use in the dashboard indicators and application programming interface (API), which allows partners to access aggregated data.

2. Objectives, Outputs and Activities

2.1 Principal Objective

To improve clinical care of people living with HIV through implementation of an electronic medical record.

2.2 Specific Objectives

- The Ministry of Health maintain and implement an HIV electronic medical record for public health and clinical decision-making.
- At least 25,000 people living with HIV are enrolled and registered in the HIV electronic medical record across 25 health facilities (including Kakamega Provincial General Hospital and Vihiga District Hospital)
- All patients registered in the HIV electronic medical record are reviewed daily to ensure clinical care delivered is standardised and appropriate.

2.3 Outputs and activities

Output 1: An HIV electronic medical record is implemented and co-ordinated by Ministry of Health

Activities:

A1. Server and network infrastructure
A server and virtual private network is registered, implemented and maintained by Ministry of Health for implementation of the HIV electronic medical record.

A2. HIV EMR reporting and updates
Regular reporting and updates are provided on the status and outcomes of implementation of the HIV electronic medical record at national, county and district levels.

Output 2: At least 25,000 people living with HIV are enrolled and registered in the HIV electronic medical record across 25 health facilities (including Kakamega Provincial General Hospital and Vihiga District Hospital)

Activities:

A1. National, county and district EMR training
National, county and district training is completed on the role of the HIV electronic medical record in public health decision making and reporting.

A2. Health facility EMR training
HIV electronic medical record training is completed in 25 health facilities on the role of the HIV electronic medical record in clinical decision making, record keeping, retention in care and follow-up.

A3. Data entry
Data entry of at least 25,000 people living with HIV into the HIV electronic medical record is completed across 25 health facilities.

Output 3: Quality of record keeping, clinic attendance and retention in care is improved through implementation of the HIV electronic medical record

Activities:

A1. Record keeping
All patient records are screened daily to ensure missing administrative and demographic data is complete.

A2. Retention in care
All patient records are reviewed daily to ensure that patients who have missed a clinic appointment are reviewed and followed up.

Output 4: Quality of clinical care is standardised and improved, according to predefined clinical reminders and indicators through implementation of the HIV electronic medical record

Activities:

A1. Clinical Care
Patient records are reviewed daily to ensure that all patients receive appropriate care, for example flagging patients eligible for ART (based on CD4 count or WHO stage) but who are not on ART and patients lost to follow-up.

3. Logical Framework Matrix

	Intervention Logic	***Objectively Verifiable Indicators***	***Sources of Verification***	***Risks and Assumptions***
Principal Objective: **(IMPACT)**	To improve clinical care of people living with HIV through implementation of an electronic medical record	People living with HIV enrolled and registered in the EMR People living with HIV attending HIV services	MoH reports Health facility data HIV EMR database	
Specific Objective: ***(OUTCOME)***	The Ministry of Health maintain and implement an HIV electronic medical record for public health and clinical decision-making. At least 25,000 people living with HIV are enrolled and registered in a HIV electronic medical record across 25 health facilities. All patients registered in the HIV electronic medical record are reviewed daily to ensure clinical care delivered is standardised and appropriate	At least 80% of patient records are complete At least 80% of people living with HIV are patients in care 100% of patients eligible for ART are on ART	HIV EMR database	Funding is available to support activities Co-ordination and capacity is available

OUTCOME: At least 25,000 people living with HIV are enrolled and registered in a HIV electronic medical record across 25 health facilities				
Results R1: Co-ordination ***(OUPUTS)***	1. An HIV electronic medical record is implemented and co-ordinated by Ministry of Health	A functioning HIV EMR and network is hosted by MoH	Observation MoH Reports	Funding is available to support activities Co-ordination and capacity is available
Results R2: Registration ***(OUPUTS)***	2. At least 25,000 people living with HIV are enrolled and registered in the HIV electronic medical record across 25 health facilities	At least 25,000 patients are registered in the HIV EMR	MoH reports Health facility data EMR database	
Results R3: Record Keeping ***(OUPUTS)***	3. Quality of record keeping, clinic attendance and retention in care is improved through implementation of the HIV electronic medical record	At least 80% patient records are complete At least 80% of patients are retained in care	MoH reports Health facility data EMR database	
Results R4: Clinical Care ***(OUPUTS)***	4. Quality of clinical care is standardised and improved, according to predefined clinical reminders and indicators through implementation of the HIV electronic medical record	100% of patients who are eligible for ART are on ART 100% of HIV patients receive appropriate care and support	MoH reports Health facility data EMR database	

RESULT 1: An HIV electronic medical record is implemented and co-ordinated by Ministry of Health				
Activities R1 ***(INPUTS)***	**<u>Activities associated with R1</u>** **A1. Server and network infrastructure** A server and virtual private network is registered, implemented and maintained by Ministry of Health for implementation of the HIV electronic medical record. **A2. HIV EMR reporting and updates** Regular reporting and updates are provided on the status and outcomes of implementation of the HIV electronic medical record at national, county and district levels.	**Means** Human resources Server, network, database Technical support IT and Program Consultants Developer/ Programmer	**Costs** Staff costs Transport costs Server, network, database	Funding is available to support activities Co-ordination and capacity is available
RESULT 2: At least 25,000 people living with HIV are enrolled and registered in the HIV electronic medical record across 25 health facilities				
Activities R2 ***(INPUTS)***	**<u>Activities associated with R2</u>** **A1. National, county and district EMR training** National, county and district training is completed on the role of the HIV electronic medical record in public health decision making and reporting. **A2. Health facility EMR training** HIV electronic medical record training is completed in 25 health facilities on the role of the HIV electronic medical record in clinical decision making, record keeping, retention in care and follow-up. **A3. Data entry** Data entry of at least 25,000 people living with HIV into the HIV electronic medical record is completed across 25 health facilities.	**Means** Human resources Technical support	**Costs** Staff costs Transport costs Training costs Data entry costs	Funding is available to support activities Co-ordination and capacity is available
RESULT 3: Quality of record keeping, clinic attendance and retention in care is improved through implementation of the HIV electronic medical record				
Activities	**<u>Activities associated with R3</u>**	**Means**	**Costs**	Funding is available to

R3 ***(INPUTS)***	**A1. Record keeping** All patient records are screened daily to ensure missing administrative and demographic data is complete. **A2. Retention in care** All patient records are reviewed daily to ensure that patients who have missed a clinic appointment are reviewed and followed up. .	Human resources Technical support	Staff costs Transport costs Server, network, database	support activities Co-ordination and capacity is available
RESULT 4: Quality of clinical care is standardised and improved, according to predefined clinical reminders and indicators through implementation of the HIV electronic medical record				
Activities R4 ***(INPUTS)***	**<u>Activities associated with R4</u>** **A1. Clinical Care** Patient records are reviewed daily to ensure that all patients receive appropriate care, for example flagging patients eligible for ART (based on CD4 count or WHO stage) but who are not on ART and patients lost to follow-up.	**Means** Human resources Technical support	**Costs** Staff costs Transport costs Server, network, database	Funding is available to support activities Co-ordination and capacity is available

4. Budget

The budget will facilitate implementation of the HIV EMR by Ministry of health (MoH) to cover at least 20,000 people living with HIV across 25 health facilities (including Kakamega Provincial General Hospital, Vihiga District Hospital and three facilities currently supported in Kakamega County). Technical support and training will be provided within the budget to support MoH ownership and sustainability for the long-term.

The budget assumes that MoH staff costs (at national, county, district and facility levels) are covered by the MoH themselves, as use of the EMR will become part of the daily work of public health and clinical staff. These staff costs include data entry and routine use of the EMR, as well as attendance at training.

5. Letters from Health Facilities regarding the HIV EMR

5.1 Kakamega Provincial General Hospital

MINISTRY OF HEALTH

Telegram: "PROVMED", Kakamega.
E-mail: wpgh15@yahoo.com
Telephone: Kaka mega 056-30050/1/2
When replying, please quote:

REF:PGH/KAK/ST/18/VOL.II/62

PROVINCIAL GENERAL HOSPITAL
P.O. Box 15-G.P.O-50100
KAKAMEGA

DATE: 1ST NOVEMBER, 2013

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RE: UAMUZI BORA EMR SUPPORT

I write this to appreciate the support that has been given to us by Uamuzi Bora Project for the last one and a half years. It has been of great help as far as data and service provision to our clients is concerned.

We therefore agree to give the necessary support and to embrace the project in future to keep the service at its best.

Thank you.

Dr. John A. Akoto
For Medical Superintendent
PGH KAKAMEGA

5.2 Vihiga District Hospital

MINISTRY OF HEALTH

Telegram: "Medical" VIHIGA
Tel: 056-51558
E-mail: vihigahospital@yahoo.com
Mobile No: +254-723103564
Ambulance +254-722915987

OFFICE OF THE MEDICAL SUPERINTENDENT
VIHIGADISTRICTHOSPITAL
P. O. BOX 1069
MARAGOLI

Date 23ND OCT, 2013.

TO: UAMUZI BORA

RE: APPRECIATION FOR PARTNERSHIP

Vihiga District Hospital would like to thank Uamuzi Bora for partnering with our facility in enabling the process of Electronic Medical Records (EMR) start in our Comprehensive Care Centre, the process is on-going.

The Hospital would appreciate more if the data clerks and follow up team (Defaulter tracing team) could be continually supported as before.

Yours faithfully,

Dr Francis Odira
Medical Superintendent
Vihiga District Hospital

MEDICAL SUPERINTENDENT
VIHIGA DISTRICT HOSPITAL
P. O. Box 1069
MARAGOLI

5.3 Bushiri Health Centre

MINISTRY OF HEALTH

BUSHILI RURAL HEALTH DEMONSTRATION CENTRE
P.O BOX 750 -50100 KAKAMEGA

17TH OCTOBER 2013

Our Ref.....
Your Ref.....

Dear sir

REF: APPRECIATION FOR THE PARTNERSHIP BETWEEN FACILITY & UAMUZI BORA PROJECT.

On behalf of the entire Bushili staff and community we would like to thank the partnership that has made significant improvement in clinical indicators of our patients.

I therefore agree to support the covering of staff as much as possible where we can.

Yours faithfully,

Janerose Juma
Nursing in charge
0721 712 413

5.4 Emusanda Health Centre

REPUBLIC OF KENYA

MINISTRY OF HEALTH

EMUSANDA HEALTH CENTRE

P.O. BOX 1922-50100 KAKAMEGA E-mail: emusandahealth@yahoo.com

Your Ref: .....

Our Ref: .....

Date: 18/10/13

TO UAMUZI BORA
0789696188

REFF: APPRECIATION FOR THE UAMUZI BORA SUPPORT

We kindly appreciate the uamuzi bora medical project for the support through HIV electronic medical record (EMR) that has improved clinical and public health decision making.

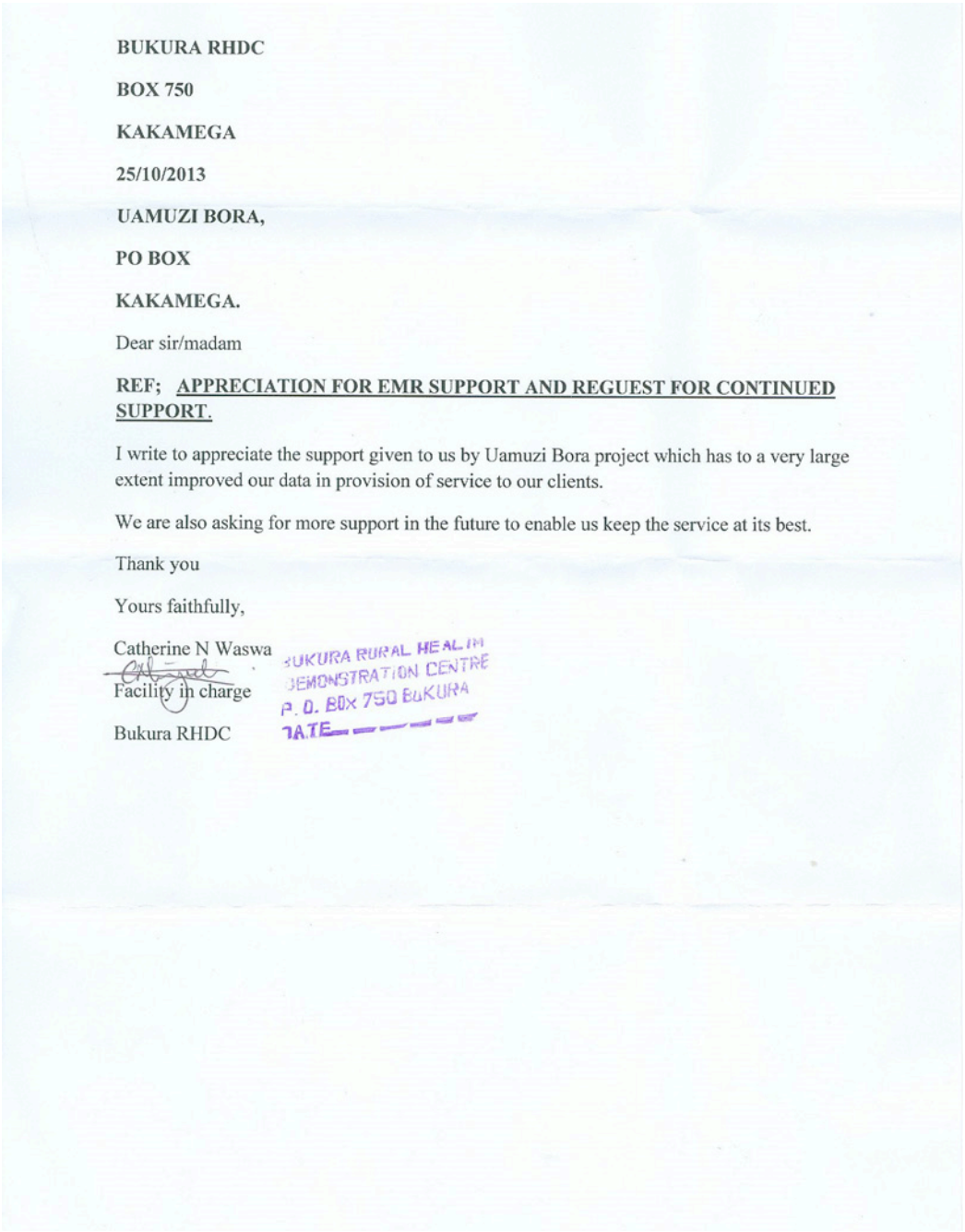
The HIV EMR has enable us to to know our weakness that include filles missing who stages, CD_4 counts, eligibility to ART and have not been started.

It our sincerely hope that you continue supporting us

Thanks in advance

Yours faithfully
Makori
Joycelyne Makori

5.5 Bukura Health Centre



BUKURA RHDC

BOX 750

KAKAMEGA

25/10/2013

UAMUZI BORA,

PO BOX

KAKAMEGA.

Dear sir/madam

REF; **APPRECIATION FOR EMR SUPPORT AND REGUEST FOR CONTINUED SUPPORT.**

I write to appreciate the support given to us by Uamuzi Bora project which has to a very large extent improved our data in provision of service to our clients.

We are also asking for more support in the future to enable us keep the service at its best.

Thank you

Yours faithfully,

Catherine N Waswa
Facility in charge
Bukura RHDC

BUKURA RURAL HEALTH
DEMONSTRATION CENTRE
P. O. BOX 750 BUKURA
DATE