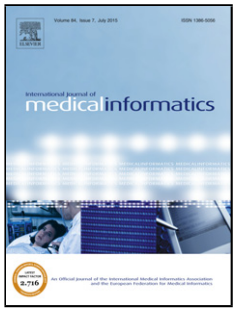

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SCALING-UP HEALTH INFORMATION SYSTEMS TO IMPROVE HIV TREATMENT: AN ASSESSMENT OF INITIAL PATIENT MONITORING SYSTEMS IN MOZAMBIQUE

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ABSTRACT

Introduction: The rapid scale-up of HIV care and treatment in resource-limited countries requires concurrent, rapid development of health information systems to support quality service delivery. Mozambique, a country with an 11.5% prevalence of HIV, has developed nation-wide patient monitoring systems (PMS) with standardized reporting tools, utilized by all HIV treatment providers in paper or electronic form. Evaluation of the initial implementation of PMS can inform and strengthen future development as the country moves towards a harmonized, sustainable health information system**.**

Objective: This assessment was conducted in order to 1) characterize data collection and reporting processes and PMS resources available and 2) provide evidence-based recommendations for harmonization and sustainability of PMS**.**

Methods: This baseline assessment of PMS was conducted with eight non-governmental organizations that supported the Ministry of Health to provide 90% of HIV care and treatment in Mozambique. The study team conducted structured and semi-structured surveys at 18 health facilities located in all 11 provinces. Seventy-nine staff were interviewed. Deductive *a priori* analytic categories guided analysis.

Results: Health facilities have implemented paper and electronic monitoring systems with varying success. Where in use, robust electronic PMS facilitate facility-level reporting of required indicators; improve ability to identify patients lost to follow-up; and support facility and patient management. Challenges to implementation of monitoring systems include a lack of national guidelines and norms for patient level HIS, variable system implementation and functionality, and limited human and infrastructure resources to maximize system functionality and information use**.**

Conclusions: This initial assessment supports the need for national guidelines to harmonize, expand, and strengthen HIV-related health information systems. Recommendations may benefit

other countries with similar epidemiologic and resource-constrained environments seeking to improve PMS implementation.

BACKGROUND AND SIGNIFICANCE

Since antiretroviral therapy (ART) scale-up began in sub-Saharan Africa in 2004, ministries of health, international donors and technical assistance partners in the region have worked to develop and implement patient monitoring systems (PMS) to support quality HIV care and treatment. PMS is an umbrella term used for either paper-based or electronic systems to track a patient's care over time.[1] Many countries have expanded HIV services and related systems with funding from the US Government's President's Emergency Plan for AIDS Relief (PEPFAR) and other international donors.

Functional PMS are essential for quality HIV/AIDS care and treatment. Antiretroviral treatment requires ongoing monitoring of clinical outcomes such as CD4 and viral load[1], daily medication adherence, and long-term retention in HIV clinical services.[2] PMS help health care providers initiate and monitor patients on treatment, facilitate identification and tracking of patients with missed appointments, and assist in following a patient's status and outcomes over time.[3-4] PMS can generate information for program managers to use for evidenced-based planning and program management. At the population level, effective PMS can contribute to the prevention of HIV drug resistance and reduced incidence of HIV transmission.[5-6] While PMS require significant infrastructure and human resource investments to establish and maintain, they have the potential to maximize the individual and population health benefits of HIV treatment.

In 2004, Mozambique began rapidly expanding HIV care and treatment programs and accompanying PMS. The Ministry of Health (MOH) in Mozambique, as in many countries, has the mandate to define policies and standards in areas that support HIV service delivery, including health information systems. To this end, the MOH in Mozambique established national,

[1] Both CD4 and Viral Load are key clinical laboratory test used in monitoring the status of HIV-infected individuals. CD4 cells (often called T-cells or T-helper cells) are a type of white blood cells that play a major role in protecting your body from infection; as HIV disease progresses, the level of CD4 in the blood typically decreases, suggesting a progression of the disease. Viral load tests measure the amount of HIV's genetic material in a blood sample.

standardized paper-based data collection and reporting tools for HIV services, routine training for all clinicians, and a data flow protocol to aggregate HIV data from the clinic level to the district and provincial level to national-level MOH.

As HIV services began to scale-up in many sub-Saharan countries including Mozambique, health systems were weak and faced challenges to expand HIV care and treatment programs. To support scale-up of HIV services, international donors including the US Government PEPFAR program, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and others prioritized financial and technical assistance to the MOH to strengthen human resources, laboratory and diagnostic systems, patient care/service delivery, commodities and health information systems. Often this funding and technical assistance was implemented through international and local non-governmental organization (NGO) clinical partners who supported public health facilities to strengthen the health system to support quality service delivery, including PMS.

In Mozambique, these clinical partners facilitated implementation of paper-based and electronic systems for individual patient care and routine aggregate reporting of key HIV indicators, as part of their overall support to MOH to strengthen systems for HIV service delivery. Because the need for robust patient data outpaced the development of national guidelines for PMS implementation during ART scale-up, clinical partners developed a number of disparate PMS. Although most of these systems responded to the Mozambican MOH reporting requirements, there was no framework or governance to oversee and harmonize the various PMS. Decisions around development and implementation of electronic or paper-based PMS depended on the resources and technical knowledge available within each clinical partner.

Significant progress has been made in scaling up HIV treatment in Mozambique. By the end of 2015, a reported 738,000 of adults living with HIV who were eligible for ART were receiving treatment, representing 83% coverage—a substantial increase from 30% in 2009. [7-8] Mozambique plans to continue to rapidly expand services as part of its National Acceleration

Plan as well as meeting UNAIDS 90/90/90 Goals and PEPFAR's efforts to achieve an “AIDS free Generation.”[9] In this context, highly functional PMS that produce quality data that can be used at multiple levels for planning and monitoring continue to be of critical importance.

This paper delineates results from a 2009-2010 assessment of PMS in Mozambique, which was conducted to support the Mozambican MOH’s Strategic Plan for Health Information Systems.[10] Results from this assessment create a baseline against which subsequent and future progress in PMS development and implementation can be compared. Aside from this assessment, no other baseline data exist, limiting the potential to measure progress in concrete terms. Findings are presented amidst ongoing efforts to harmonize existing systems, strengthen national governance and ownership of patient-level electronic systems, and improve the quality and use of data. Recommendations in this paper have implications for other high-prevalence, low-resource areas that need to establish, upgrade, or harmonize existing PMS within their own healthcare systems.

OBJECTIVES

Using structured surveys and semi-structured interviews, this assessment aimed to evaluate PMS functionality, offer evidence-based recommendations for improvement, and identify next steps for PMS policy and implementation to achieve scale-up of a well-functioning, standardized data system.

MATERIALS AND METHODS

This study employed structured surveys and semi-structured interview guides to understand PMS implementation at selected health facility sites. The study protocol received approval from the U.S. Centers for Disease Control and Prevention (CDC), the University of California, San Francisco (UCSF) Committee on Human Research, and the Mozambican Bioethics Committee. All study participants gave their written informed, voluntary consent.

Participating facilities and staff

Eight clinical partners supporting the Mozambican MOH to implement ART services participated in this study. These included six PEPFAR[2] and two non-PEPFAR[3] partners. At the time of assessment, approximately 90% of the 170,198 patients on ART [1] in Mozambique received care at a MOH site supported by one of these clinical partners(*Patient monitoring system assessment: Mozambique; Phase I of project;* Project Report, University of California San Francisco, 2010).

Study sites and participants were purposefully selected from a range of health facility environments and staff to reflect the diversity of contexts in which ART is implemented in the public health sector. Selected sites included representation based on the following criteria: environment (urban and rural) in all 11 provinces; facility type (health center, rural/district hospital, provincial/central hospital); length of time the facility had provided ART (new and well-established); and the facility ART patient volume (large and small). Interview participants were selected to represent the variety of PMS users at facilities. This included staff involved in data collection and management, including the receptionist, clinic manager, and clinician. Where electronic systems existed, the monitoring and evaluation (M&E) coordinator, data entry staff, and information technology (IT) coordinator were also interviewed.

Data collection

[2] The six PEPFAR clinical partners were CARE International, Health Alliance International (HAI), Vanderbilt University Friends in Global Health (FGH), Columbia University International Center for AIDS Care and Treatment Programs (ICAP), Family Health International (FHI), and the Elizabeth Glaser Pediatric AIDS Foundation (EGPAF).

[3] The two non-PEPFAR clinical partners were Médecins Sans Frontières (MSF) and Drug Resource Enhancement against AIDS and Malnutrition (DREAM) Project.

A team comprised of representatives from the Mozambique MOH, PEPFAR Mozambique, CDC, UCSF, and informatics students and staff from the Mozambique Open Architecture and Standards for Information Systems (M-OASIS) of the Eduardo Mondlane University in Maputo conducted data collection. The team utilized multiple structured assessment tools during the data collection process (Table 1). Tools were tailored to the health facility or partners' national headquarters level. A structured technological assessment survey gathered details on the electronic PMS technology at sites with electronic monitoring systems. Three structured surveys assessed design and implementation of the PMS. Items assessed included: training and human resources; data collection standards; flexibility; data integration; reporting and analytic capacity; and clinical partner support, and included additional questions for sites with electronic PMS. Job specific, semi-structured surveys were used to interview clinical, administrative and data entry staff on clinic practices and policy, training received, use of system, ease of use, work flow, any interruptions in use of system, and system support. A clinical observational assessment form was used to standardize the recording of observations of patient record filing systems, patient registration systems, patient flow throughout the clinic, use of patient records, and reporting.

Table 1: Assessment Tools

Focus of Assessment Tool	Tool Used	Assessment Content
Technological Assessment	Structured technological assessment survey	Detailed intake of electronic PMS technology: • System platform • Interface • Database / storage • Data analysis / reporting • Data transmission

System Design and Implementation Assessment	Semi-structured System Survey (Health Facility) Headquarter System Functionality Assessment Headquarter System Survey	All PMS: • Training and human resource capacity • Data collection standards • PMS Flexibility • Data integration • Reporting and analytical capabilities • Partner support Electronic PMS: • Architecture and interfaces • Hardware & software • Guiding HIS policies
Staff Interviews	Semi-structured interview guides, job-specific	Interviews with clinical, administrative, and data entry/IT staff: • Clinic practices and policy • Training received • Use of system • Ease of use • Qualitative description of work flow • Interruptions in use • System support
Clinic Observation Assessment	Observational assessment form	Description of information flow through clinic • Patient record filing system • Patient registration system • Use of patient records during visit • Data entry of patient records • How patient info is used for reporting

Data collection instruments and study procedures were piloted at two health facilities, supported by different clinical partners. Study instruments and the protocol were then revised to improve response clarity before starting data collection. All data were gathered in the respondent's preferred language, either Portuguese or English. Team members received training in interview methods and on survey and observational forms prior to data collection.

Data analysis

After data collection, all Portuguese responses from the survey and semi-structured interviews were translated into English for analysis. During the review of the data, bilingual team members resolved any discrepancies in translation. The clinic observation data were linked with the survey and interview data for analysis. The survey and semi-structured interview guides asked questions in five areas: 1) system implementation; 2) system functionality; 3) human resources; 4) infrastructure; and 5) policies and procedures. Using recursive analysis techniques, we applied these five deductive thematic categories *a priori* and entered the data into an Access

database to facilitate analysis. Finally, a second-stage thematic analysis yielded category organization into three cross-cutting areas: System Standards and Governance; Systems Implementation and Functionality; and Resources (Table 2).

Table 2: Summary Table of Thematic Areas in Assessment

Area	Thematic Category	Component
System Standards and Governance	Policies and procedures	Presence and dissemination of written protocols;
System Implementation and Functionality	System Implementation System functionality	Use and usefulness of systems Data capture, hardware and software, analysis capabilities
Resources	Human resources Infrastructure	Staffing, training and support Technology and other resources

RESULTS

A total of 18 public health facilities participated in this assessment (Table 3). Sixteen (89%) of the participating health facilities received support from clinical partners. This support was usually in the form of technical assistance to provide quality clinical services, to develop and implement PMS, and to evaluate system implementation. Two facilities were exclusively clinical partner supported, while two other facilities received no clinical partner support.

Table 3: Overview of Participating Health Facilities

Facility Province	Facility Type	Type of PMS	Clinical partner Support?	Patient Volume
Tete	Urban Health Center	Paper	Yes	30 patients/day
Tete	Rural Hospital	Paper/electronic	Yes	50-60 patients/day
Gaza	Urban Health Center	Paper	No	40 patients/day
Nampula	Rural Health Clinic	Paper	No	10-15 patients/day
Manica	District Hospital	Paper/electronic	Yes	25-75 patients/day
Sofala	Central Hospital	Paper/electronic	Yes	Unknown
Zambezia	District Hospital	Paper/electronic	Yes	10-50 patients/day
Zambezia	Rural Hospital	Paper/electronic	Yes	50 patients/day
Maputo	Urban Health Center	Electronic	Yes	80 patients/day
Maputo	Urban Health Center	Electronic	Yes	100-150 patients/day
Niassa	District Hospital	Paper	Yes	Unknown
Niassa	Rural Hospital	Paper	Yes	Unknown
Inhambane	Rural Hospital	Paper/electronic	Yes	Unknown

Inhambane	Rural Health Center	Paper/electronic	Yes	45-50 patients/ day
Maputo	District Hospital	Paper/electronic	Yes	40-80 patients/day
Cabo Delgado	Provincial Hospital	Paper/electronic	Yes	Unknown
Maputo	General Hospital	Paper/electronic	Yes	100 patients/day
Nampula	District Hospital	Paper/electronic	Yes	20-40 patients/day

In total, 79 health facility personnel, responded to structured and semi-structured surveys (Table 4). Of the personnel interviewed, the majority was MOH clinic staff, meaning that their salaries and training were provided by the Mozambican government, even if the facility received technical assistance from a clinical partner. A few personnel, typically data entry clerks and some clinical staff such as counselors and laboratorians, were hired, funded, and trained by the clinical partner.

Table 4: Overview of Interviewed Health Facility Staff

Health Facility Staff Titles	# Interviewed
HIV Counselors	4
Data Entry Clerks	12
Lab Techs	1
Medical/Clinical Directors	17
Monitoring & Evaluation / Information Officers	7
Nurses	8
Pharmacists	3
Receptionists	10
Statistics / Information Technicians	7
Total	**79**

A. System Standards and Governance

A set of MOH-issued paper-based forms and tools that collect the required data elements for patient care and healthcare indicators served as the basis for all implementation models of PMS. These included patient forms, registers for aggregating data, and monthly reporting forms. Findings from this assessment suggested wide variation in the implementation of paper and electronic systems. Assessment results identified three PMS implementation models: paper-only, paper-to-electronic, and electronic-only PMS. In the paper-to-electronic PMS, data clerks first documented patient visits with paper tools. Data were entered retrospectively into electronic-PMS, typically the following day. In electronic-only PMS, a

computer was present in each clinical consultation room and clinical staff entered patient data directly into the system at the point of care.

Across the 11 sites with electronic systems, health facility providers with the support of NGO clinical partners implemented three distinct platforms. Two out of five clinical partners used platforms that another partner had developed. There were no written national guidelines or standards for the development or implementation of electronic patient level systems at the time of the assessment. Of the three electronic systems being implemented, one system was built on a Microsoft Access database and two employed a SQL database. One of the systems was open-source, while the other two were built on a proprietary platform (Microsoft Access) with the database and additional programming available to other clinical partners.

Little harmonization or common standards existed among implemented systems. A lack of a platform or standard for data exchange between the various electronic systems prevented aggregation of information across sites. No standards existed for partners to share patient data electronically across systems to facilitate longitudinal patient tracking, in the event of a patient transfer from a site supported by one partner to a site supported by a different partner.

B. System Implementation and Functionality

Written policies and procedures

Very few health facilities had written policies and procedures regarding PMS implementation available to staff. Nine facilities, or 50% visited, indicated they had written policies and procedures available on topics such as form completion, data entry, and report generation. Most of these policies were only available at the clinical partners' headquarters and not at the facility level. While several clinical partners reported using automatic validation of data entered (e.g., programmed logic checks), no facilities had written procedures on data quality assurance (DQA) practices. No universal or standardized DQA practices were in place across facilities. Most facilities lacked written policies and procedures on physical security of data to

guide storage of patient files and protect privacy of information throughout the data flow. Only one facility had a written policy on data security that established procedures on how to conduct data backup and data transfer. While usernames, passwords and backups operated at all facilities, procedures to conduct these activities were not written, making it difficult to systematize across facilities and over time. No facilities had written policies and procedures on how to document changes made to paper or electronic PMS.

Data management and analysis

In sites with electronic PMS, data entry typically occurred the day after a patient's medical visit, posing challenges to data accuracy and completeness. Data entry clerks reported varying amounts of time spent to enter each patient record, depending on the type of services a patient received and the quality of the paper records for retrospective entry. In some cases, data entry clerks had to clarify illegible, incomplete, or illogical data with the individual who had originally recorded the data; resolving such data issues, however, was not always possible, given the time lapse between data collection and entry.

MOH required clinics to send standardized aggregate summary reports on important health indicators (e.g. ART follow-up, ART initiation, patient volume and demographics) on a monthly basis. Some facilities sent these reports directly to MOH while others sent the data (either in paper or electronic form) to the clinical partner headquarters, which then compiled and submitted reports. In the five paper-only facilities, managers manually extracted and aggregated data from clinic registers, using basic math or a hand-calculator to generate reports. Managers described this process as time-consuming and error prone, since data are aggregated long after patient visits and missing or incorrect data cannot be cross-checked or validated. Personnel at facilities with paper-to-electronic and electronic-only PMS produced MOH monthly reports more quickly and with fewer errors.

Electronic PMS sites generated reports to monitor service delivery, improve the quality of care, and track inventory. Data entry staff reported that standard pre-programmed reports were easy to run in the electronic PMS, provided no modifications were required. Additional reports were often produced at the clinical partners' headquarters rather than within the individual clinic. Data were stored on a central server at partner headquarters with expertise for report generation also located there. Additionally, some electronic PMS included the capacity to generate individual patient reports for clinician use during patient visits.

Capacity to produce *ad hoc* reports varied across health facilities. Various *ad hoc* reports can assist providers in managing patient care, yet the majority of clinics with electronic PMS did not have someone onsite capable of customizing such reports. Instead, facilities relied on technical staff at the provincial or national level to respond to site-specific data queries.

Data transmission

The method of monthly report transmission to MOH varied among our sample. Twelve of the 18 health facilities printed or handwrote monthly reports to submit on paper. Eight of the 13 electronic PMS facilities continued to aggregate data manually from paper registries, due to a combination of adhering to national guidelines to use MOH tools to generate reports and difficulties generating reports using the electronic PMS. Printer and computer issues frequently prevented facilities from electronically generating and submitting reports. Only two health facilities reported regularly using facsimile to transmit reports. Others had done so in the past, when a fax machine and line had been available and functional. Four of the facilities that employed hand delivery or fax reported using flash drives as an alternative to submission of paper reports, when possible. Other means to transmit reports included email and direct database transfer to the clinical partner headquarters, via shared server or transport of deidentified data from the electronic PMS. In these cases, HQ personnel generated and emailed reports to MOH authorities at the province level.

Data use

In most cases, health facilities did not utilize electronic data to inform clinical care decisions, forecast supply, or manage staffing. Most commonly, electronic data were used as reference or back-up to generate patient reports if a paper chart were lost. Some facilities used electronic PMS to help track patients who had missed appointments. With the exception of the one clinical partner implementing the electronic-only system, most facilities had yet to engage electronic patient data to plan and deliver services.

C. Resources

Human resources

Staffing varied based on clinic patient volume. Each health facility was typically staffed with one or two clinicians, three to five nurses, one counselor or psychologist and one receptionist. Facilities implementing electronic PMS generally had one data entry clerk. At the health facilities with paper-only PMS, the clinic manager was responsible for overseeing implementation of PMS, and staff usually received basic training in form completion.

In nine of the 11 facilities with paper-to-electronic PMS, data entry responsibilities rested with one data entry clerk. These staff usually had basic data entry and management skills, but little to no analysis capacity. Several clinical partners noted that there was no official job category or cadre within the national MOH human resource structure for data entry staff, presenting a challenge to hiring this skill set within the national structure. Over half of the participating facilities either reported or demonstrated a shortage in data entry staff.

Surveys further revealed limited training around data entry and electronic PMS report generation. Training for data entry staff typically occurred during initial electronic PMS implementation, without ongoing structured refresher trainings. Data entry clerks were often the only staff at the site to receive formal training on electronic PMS implementation. While

receptionists at medium-sized and large facilities assisted in data entry in the event of a data clerk's absence or to help with backlog, most receptionists reported limited computer literacy and no formal PMS training. When new data or reception staff were hired, they reported being trained by their peers or learning by trial and error. Training materials were not standardized across implementing partners. This created a range in breadth and depth of training, depending on the clinical partner supporting a site. Many clinical staff and managers expressed a lack of understanding of the electronic PMS at their site, and stated a desire for more training on how to better utilize the system.

Infrastructure

The assessment found that many health facilities faced infrastructure challenges affecting PMS implementation. Most facilities had limited physical space, including secure storage space for patient records. Sites with paper-to-electronic systems often lacked dedicated, secure space for data entry, leading to data clerks sharing space used by providers for patients' visits, intruding on patient confidentiality. Physical security varied from site to site, with most facilities keeping the computer in a locked room. MOH paper forms and registries were sometimes out of stock, resulting in nonstandard data collection and a lack of a consistent standard data source for data entry clerks to use for needed information.

While all assessed facilities had electricity, many experienced minor power outages on a regular basis. At least two health facilities and two clinical partner headquarters lacked power surge protection and universal power sources, precautions necessary to protect data during power outages or surges. Telephone lines for facsimile or data transmission were rarely available. Most facilities had cellphone coverage, though no facilities reported transmitting data over the cellular network. When power outages occurred, most sites relied on paper-based systems for patient care and resumed use of the electronic PMS when the power returned.

Survey results point to limited technological infrastructure. Clinical partner headquarters possessed local area networks (LAN), but only six of the 13 facilities with electronic PMS had a LAN. All servers had firewalls and some type of virus protection software, though four of the 13 facilities did not keep virus protection up to date. All electronic PMS required usernames and passwords for access, yet only two had role-based access, which would restrict access to patient and administrative information based on type of user. Only one system included a partial audit trail to track modification of patient data. All facilities conducted regular back-up activities, typically on a CD or external flash drive stored at the same site, however no facilities had redundant back-up systems to prevent against loss or damage of data.

Importantly, surveys revealed that some facilities that had necessary infrastructure, such as computers and printers, were unable to use them reliably due to lack of routine maintenance. Two clinics reported having computers intended for electronic PMS use but were no longer used, due to a virus or other technical issue. Additionally, five clinics reported not being able to complete a necessary reporting responsibility due to a lack of printer or toner to copy forms.

Key findings and recommendations in the three thematic areas are presented in Table 5.

Table 5: Summary Table of Key Findings and Recommendations

Area	Key Findings	Recommendations
System Standards and Governance	• Standard set of paper tools used but wide variation in how paper- and electronic systems implemented • Three different platforms for electronic systems in HIV • No harmonization among systems implemented • Systems currently implemented were developed and managed by partners, not by MOH	• Formalize national standards on data collection and management within patient-level system platforms to ensure system functionality, harmonization, and system sustainability • Formalize national standards for HIV data elements, to allow for interoperability of data across systems • Ensure national governance structure to ensure systems are aligned with standards and standards evolve as appropriate
System Implementation and Functionality	• No written SOPs or procedures in place related to system implementation • Data management: Variability in how/when data entered • Data management: Limited/inconsistent	• Develop written SOPs for data management specifying frequency of data entry and procedures for report generation and data transmission • Develop written SOPs for data use and decision-making • Develop community of practice to review

	method/standard for monthly report generation • Data Transmission: Limited/no electronic data transmission of aggregate data • Data Reporting/Use: Limited capacity for ad hoc report generation/data query • Data reporting/Use: Limited use of data for decision making / program improvement	existing and develop new "best practices" and other standards of practice to optimize system implementation and functionality
Resources	Human Resources • Reported need for more data entry staff, including standardized cadre of this type of staff to ensure adequate training, supervision • Reported need for more training on data entry, reporting, use of data Variability / inadequate Infrastructure • Lack of adequate, secure space to store patient health information • Unreliable power / communication lines • Limited data security measures in place at the facility level related to data access and storage • Lack of standardized maintenance of systems available for all systems/sites	Capacitate Human Resources • Identify needed HR at each level for adequate staff for workload • Standardized cadre for data entry, hiring, training, supervision, MOH ownership • Develop/standardize capacity building program (formal, mentoring) Ensure Adequate Infrastructure • Ensure minimum standards are developed and included in project plans • Develop and disseminate written policies and procedures for key areas including data access and security

DISCUSSION

This study presents key findings from our initial assessment of HIV patient monitoring systems in Mozambique. This baseline assessment can serve as a foundation for strengthening PMS in Mozambique over time. Recommendations proposed in this section were created based on the following criteria: addressing gaps identified in the assessment results; aligning recommendations with existing evidence from the literature; and considering system context to ensure sustainability of recommended implementation and functionality strategies. A summary of recommendations is presented in Table 5 and detailed in the sections below.

Establish Standards and Governance Structures

At the time this assessment was conducted, health facilities across Mozambique used diverse, non-standardized PMS; resulting in disparate approaches to data collection and reporting and minimal data use. This variation likely results in part from the absence of national normative guidelines, governance, and minimum standards against which systems could be developed and evaluated. This finding echoes conclusions from similar research in other low resource contexts.[14-15]

To increase the utility of PMS in Mozambique policy makers could consider advancing national ownership and sustainability by establishing standards and governance structures to harmonize PMS development and implementation. The term 'harmonization' suggests an approach that allows for variation in systems across health facilities based on patient volume, available resources and clinical implementation needs. The recommendation for a harmonized, rather than uniform, approach to electronic and paper-based PMS development in resource-limited settings allows for systems to respond to resource constraints through phased implementation and to different contexts.[11-13] Ideally the development of standards would precede electronic PMS development and implementation. However *post hoc* development and implementation of norms could include a review of existing systems and implementation experiences to identify areas where they can be modified to align with new national guidance, and subsequent assessment of systems against the norms developed.[11] Wherever possible, national guidelines for data elements within electronic and paper-based PMS should draw on international standards or best practices,[15-18] such as SNOMED or ICD-10 for clinical health information data codes;[19-20] aligning national standards with existing international standards would facilitate interoperability between systems. Alternatively, countries such as Mozambique could define a governance process for creating a standard data dictionary and data exchange standards to be used across systems.

Strengthen implementation and functionality

In general, results from this assessment found that systems meet the basic functions of data capture and routine reporting, although functionality could be improved in several areas. Notably, few sites used PMS data to improve patient care or HIV program management, likely due in part to the lack of written guidance and staff trained to produce or interpret analytic reports at clinical sites. Non-standard data management procedures increased the probability of introducing errors, for example if data entry was incomplete or monthly reports were generated in different ways depending on staffing. The lack of standard written guidance posed challenges to maintaining and evaluating system support (e.g. no records of system back-up, system maintenance.) With the frequent changes in personnel that sites reported, the lack of written or standard guidance implies the need for greater resource investment to train and retrain staff. In some areas such as data security (e.g. frequency of back-ups), policies were reported to exist, although they were almost exclusively verbal and not documented in written form. Making written policies available at the site level could increase the utility of existing PMS to manage and utilize data, rather than primarily using data to report up to MOH.

Given the significant investment and potential of PMS to affect patient care, written policies and standard operating procedures for key aspects of system use should be available at all levels of PMS use. Defining procedures would help to ensure that minimum standards are in place in all contexts. Ideally, guidelines would include operational policies and procedures in key areas such as data security, data quality, interoperability, human resources, minimum data set, data use / reporting, and technical aspects of implementation. These guidelines should align with international standards or recommendations where they exist. When “best practices” are not known, especially as systems emerge and evolve; a community of practice or other similar forum could be created to be able to identify and share these best practices, similar to some existing implementers’ networks.[21]

Ensure adequate human and infrastructure resources for system implementation

Findings highlight inadequate human resources and infrastructure to effectively implement PMS at many health facilities in Mozambique. Investments in training, system updates, and ensuring adequate physical and information technology infrastructure to maintain effective PMS are vital for sustaining the system and growth as the systems expand to larger patient populations. These challenges have been cited in the electronic medical record implementation literature that focuses on resource-constrained environments and Sub-Saharan Africa in particular.[22-26] Without adequate human and technical resources to support PMS at multiple levels, the potential of these systems is difficult to realize. Given the variability in the staffing and training available to support PMS, results suggested a need to better define minimum standard human resource needs for different levels/types of facilities; this could led by the MOH to ensure national standards exist and be based on patient volume or other available data to estimate the level of effort at each level. Standard training curricula and supervision/mentoring resources could be developed to reflect the initial and ongoing training needs of personnel at different levels of staffing. Similarly, the MOH with support from partners could define minimum infrastructure needs to implement and maintain PMS, with established written policies and procedures on maintaining these. Partnerships with NGOs or universities at sub-national levels could be considered to support these human and infrastructure planning and support needs, as in the implementation model put forth by Ware and colleges, to help mitigate the financial burden on MOH to support training.[27] Agreements with partners to ensure adequate resourcing could be part of a strategy to ensure national ownership of systems.

Limitations

This assessment is subject to some limitations. Firstly, sites were purposefully sampled and may not be nationally representative, though the goal of this type of sampling was to understand the full range of experiences in implementation of PMS. Secondly, given the

qualitative nature of our assessment, respondent bias is a risk. Additionally, given the significant investment needed to develop and implement PMS, no information on cost of systems was included, as the complexity of costing PMS, this merits its own study/assessment. Lastly, this assessment was conducted in 2009 and it is likely that data reported do not represent the current state of systems and national context; however these findings may serve as a baseline against which other data may be collected to assess changes since the assessment was conducted.

CONCLUSION

This initial assessment of patient monitoring systems in Mozambique provides key insight into strategies needed to strengthen and improve utilization of health information for HIV care and treatment. The findings of this assessment highlight the challenges of implementing a nation-wide monitoring system, primarily run in public health facilities in a resource-limited setting. Findings can support key stakeholders to harmonize and strengthen both paper-based and electronic PMS. Recommendations from this assessment can benefit programming and policy-making in resource-constrained countries with high HIV burdens as they seek to incorporate electronic functionality into national sustainable HIS and harmonize systems across facilities with varying capacity. Finally, conducting assessments of health information systems on a periodic basis can help to target where investment can have the greatest impact.

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DISCLAIMER

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