Factors Associated with Successful Electronic Medical Records (EMR) Implementation in Kenya

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Abstract

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Background: Implementation of Electronic Medical Records (EMR) remains a relatively recent development in response to emerging needs to manage large volumes of data that are often associated with longitudinal care. Kenya's HIV program created a large demand for responsive data management systems that guarantee availability and quality of data necessary to manage patients and monitor the program. Subsequent support for national rollout of EMRS resulted in over 640 new implementations in public health facilities. Such large national rollouts can be expensive, especially in the context of limited resources and competing needs to focus resources on achievement of treatment targets. The utility of investments in EMRs depends upon successful uptake leading to complete and high-quality data. Systems and processes for training, supervising, and supporting health care workers tasked with using EMRs have an important role in successful uptake and use of EMRs. This study explored the hypothesis that the type of the health worker trained as a facility EMR champion and the service delivery implementing partner could be major determinants of implementation outcomes.

Methods: The researcher conducted a retrospective descriptive study to determine which factors were associated with data quality and the proportion of legacy paper records successfully migrated into the EMR. The study focused on 344 facilities supported by the International Training and Education Center for Health (I-TECH) between 2012 and 2016, which implemented the KenyaEMR system. Our outcomes of interest were data quality and proportion of records successfully migrated into the EMR. Key predicators of interest were availability and type of EMR champion and implementing partner. Key confounding variables were type of facility, number of patient records in legacy paper systems (volume), age of the champion, region of implementation, and the implementation mode. We conducted descriptive analyses of characteristics of EMR champions and health facilities, as well as exploratory bivariable and multivariable analyses using logistic and linear regression to explore the association between the outcomes and predictors of interest. We considered measures of association to be statistically significant at the $p<0.05$ level. All the analyses were conducted in STATA version 14.

Results: Of 344 facilities where KenyaEMR was implemented, 307 reported migration statuses; of these, 169 had a trained champion. 94 facilities out of the 344 had records of data quality audit. This study found no significant association between the type of champion and the proportion of data migrated at the facility. Similarly, there was no association between the type of champion and the quality of data in the facilities. However, there was significant association between the current implementation mode and data migration status. Facilities using the system as point of care were more likely to report above median data migration compared to those using it as a retrospective data entry implementation (OR 13.2; CI: 1.61-107.8; p=0.016). Similarly, by

comparing the partner with highest number of facilities to all other partners**,** there was significant association between implementing partners and quality of data after adjusting for patient volume, champion age, facility type and region. (coef. 23.9; 95% CI: 10.67-37.26; p=0.001). Regional disparities tended to follow the implementing partners within those regions. The study concluded that champion characteristics other than age and type could influence implementation outcomes. Structural factors (i.e. the partner supporting the facility) appeared to have significant influence on outcomes. There is a need to study those partner and health system characteristics to understand the variations and specific predictors of EMR outcomes.

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DEDICATION

To Jackie

Chapter 1. INTRODUCTION

1.1 BACKGROUND

Kenya has the second largest Human Immunodeficiency Virus (HIV) treatment program in the world after South Africa, with about a million patients receiving ART in 2016[1]. The national HIV program has adopted the World Health Organization (WHO) treatment goals that aim at identifying 90% of people infected with HIV, enrolling 90% of infected individuals in care and achieving viral suppression among 90% of those in treatment. The national program puts increased emphasis on scaling up effective interventions based on routine data and research.[2] Treatment programs for chronic conditions like HIV remain data intensive where subsequent patient visits are informed by data that are collected over time. These data include basic profile, clinical encounters, lab results and medication. The Kenya National Health Information System (HIS) adopted a standard HIV care data collection tool, commonly referred to as the "MOH257" or "blue card" in 2006. Prior to this policy decision, each implementer used their own set of tools resulting in disparate data across facilities in detail and definition. Key developments to manage the large volumes of data include the use of information technology. However, these systems created an environment of multiplicity, lacked interoperability and failed to collect basic information. The Ministry of Health (MOH), with support from the US Presidents Emergency Fund for AIDS Relief (PEPFAR), developed standards for HIS in 2009. These guidelines targeted the Electronic Medical Record systems (EMR) used mainly in HIV data management. They provided the foundation for a national review of EMR systems implemented in Kenya. After the assessment, four systems were selected for implementation using public resources.[3]

The University of Washington's International Training and Education Center for Health (I-TECH) supported the implementation of KenyaEMR, an open-source system based on OpenMRS, in 344 facilities across 22 counties in Kenya between 2012 and 2014. I-TECH implemented a skills-based approach where providers received training based on a curriculum that suited the required skills to perform the informatics function. Each facility nominated a provider of their own choice as champion; this person would then help others learn and use the EMR. The champion was also intended as the first line of support for the facility by performing tasks like user management and basic system troubleshooting. The champions received two extra days of training immediately following the standard users training to learn mentorship and basic system administration skills. This model of training was expected to be agnostic to the diverse professional and training backgrounds found within facilities. Consequently, users who are relatively naïve to information technology could gain necessary competence to navigate and use the EMR. The EMR champions did not receive extra compensation for their duties; however, they were the designated representatives of their facilities in county EMR review meetings, a prestigious recognition of their leadership role.

The National HIV Program considers the EMR project as an integral part of efforts to improve the quality and availability of HIV data in a longitudinal format. Similarly, EMRs were envisaged to support clinical decisions through alerts while implementing basic logic for clinical decisions. Current investments aim at supporting system use and data quality. CDC, MOH, and partners have carried out facility functional assessments to review the status of EMR implementation.

Studies indicate that over 45% of large information technology projects fail even though definitions of success or failure are themselves still subject to conceptual interpretations.[4,5] Failure or success are constructs that are used by stakeholders to describe the state of implementation of HIS. There are several theoretical underpinnings to how stakeholders view and measure success. The first school of thought views HIS as tools introduced by external people (often with authority) to improve systems or processes. They are viewed and, thus, evaluated based on their ability to create change. Often evaluations that focus on exogenous perception of HIS implementations look for dysfunctions created by systems and the level of adoption achieved by the respective users. Managers are perceived to hold exclusive power and ability to influence outcomes of HIS implementations.[6] Another school of thought views HIS as endogenous to the health systems where both managers and other users are stakeholders with influence over development and success of the system. From this perspective, the HIS is often expected to work if there is internal motivation, engagement, and desire for change. Users are perceived as competent and motivated to achieve the desired implementation results.[7] The third perspective acknowledges the complexity of the system and presents HIS as part of the complex system subject to determinants both within and outside the health system of organization implementing the system. Within this school, HIS are viewed as tools designed and used within the health sector but subject to complex factors within and outside the organization. Systems perspective will inform the methodological approach of this study. Evaluating EMRs from this perspective requires a good understanding of the ecosystem. [8,9,10]

1.2 RATIONALE

As resources for health system strengthening begin to plateau or reduce under the current PEPFAR 3.0 strategy, the investment decisions need to be made on the use of EMRs to support

monitoring of national treatment and prevention goals.[11] Functionality, human capacity and infrastructure have been identified as some of the key determinants of success in HIS implementation.[12] Evidence suggest, quite significantly, that utility of system and human/project management factors could influence adoption and use of the system.[13] The Kenyan health service delivery system remains significantly nurse-driven, but data management is often the responsibility of Health Records Officers (HRIOs) who are not available at each facility. Leadership within health facilities remains the preserve of clinical providers (i.e., nurses, clinical officers or medical officers). These clinicians also actively collect data and are the primary consumers of data that are managed using EMRs. They are more likely to be invested in quality of data, use system reporting and decision support functionality, and mentor others at clinical stations.[14] It is important to understand which modifiable factors influence the outcomes of the EMR implementation in the Kenyan health sector.

1.3 SPECIFIC STUDY QUESTIONS / AIMS

The study aimed to describe the factors associated with outcomes of EMR implementations in Kenya. This study proposed to answer the following three questions:

1. Is there an association between type of facility champion trained and EMR success outcomes, including proportion of historical data migrated to the EMR and data quality performance within the EMR?
2. Is there an association between PEPFAR implementing partner providing technical assistance to the health facility and the two EMR success outcomes (as listed above)?
3. What is the association between champion type and implementing partner and each outcome, after adjustment for other characteristics of champions and of health facilities?

Chapter 2. METHODOLOGY

2.1 STUDY TYPE

A retrospective, descriptive evaluation was conducted using secondary quantitative data collected during routine EMR implementations and assessments. This study hypothesized that there was relationship between the type of the champion and the facility data quality assessment (DQA) score or data migration status.

2.2 STUDY/TARGET POPULATION AND UNIVERSE

A total of 640 health facilities were covered by the national EMR scale-up supported by PEPFAR in Kenya. This study focused on 344 facilities supported by I-TECH because the same training methodology and curriculum was used in these trainings. The inclusion criteria for facilities were: a) having a record of at least one provider trained as a facility champion between 2012 and 2014; b) having implemented the EMR by September 2015; and c) having a record of outcome/status by 29th of October 2016.-

2.3 INDICATORS OF INTEREST

1. Primary outcome: This included the first data quality assessment (DQA) score recorded for the facility using the standard MOH/I-TECH DQA tool. Expected values of this variable were 0-100. During DQA exercises legacy paper records were compared to the EMR records for completeness and accuracy. Field staff together with facility providers drew random sample patient records and compared defined data elements between the original legacy paper record and the EMR. Data was summarized by proportion of matching and complete records; a perfect match for all patient records for each element would result in a

score of 100%. This study used reported proportion of records with matching current ARV regimen as a proxy measure of overall data quality.

2. Secondary outcome- Data Migration Status: The proportion of legacy paper data successfully transferred into the EMR system at the time of the survey. These included data ever collected in MOH 257(the HIV clinical encounter tool). The denominator was defined as all patients with at least one recorded encounter within the HIV clinic. The denominator was total count of patient records available in the EMR. This study defined completeness as evidence of that last encounter in the patient paper record was available in the EMR. Expected values were any value from 0-100, calculated from number of patient records in the system divided by total number of patients registered at the facility.
3. Exposure variable: The type of health provider trained as EMR champion. The EMR champion referred to an individual employed and working in the EMR facility trained to be the first line of support for other EMR users. EMR champion type was described in the data source, the TrainSMART data system, as Nurse, Clinical Officer, Data Clerk, Medical Officer, and Laboratory Technician/Technologist. The study did not test sensitivity of the professional training (e.g., Bachelor of Science Nurse compared to Enrolled Community Health Nurse Certificate). For the purposes of this study, champion types were reclassified into clinician and non-clinician. Some health facilities had multiple champions trained. To create a single facility-level value for champion type, the data were collapsed to indicate any presence of a champion with a given characteristic. The variable for type of champion was classified in 3 categories: 1) having one or more champions who were clinicians; 2) having one or more champions with none being a clinician; and 3) having no champions trained.

4. Mediating outcome-Current implementation mode. During the EMR implementation, the models used included retrospective data entry(RDE) or point of care(POC). Structural factors may influence the final mode that is most preferred or used. This study defined a third possible as partial POC mixed with RDE (Hybrid).
5. Confounder variable- Champion Age: It is commonly believed that existing knowledge of computers could have affected the ability to use and train others. Age was calculated from the provider data of birth and the date of training recorded in the TranSMART database. Mean age of providers were used for analysis in facilities where more than one champion was trained.
6. Confounder: Type of facility was the classification of the facility according to the Kenya Master Facility List. Expected values were: Dispensary, Health Center, Sub County, County Referral, Regional Referral and National Teaching Hospital. Facilities with no known classification were labeled "other" in the MFL.
7. Confounder- Implementing Partner: Facilities received a wide range of support for service delivery partners alongside the EMR partners. They supported part of the DQA, data migration and training of additional providers. This study coded implementing partners by alphabetical labels to avoid unintended disclosure.
8. Confounder-Region. The geographical and administrative location of the facility. The study acknowledged possible structural differences in geographical regions that could influence support in those facilities. Regions for purposes of this study followed previous Ministry of Health regional demarcation of the country (mainly by provinces). These were Nyanza, Western, North Rift and Central.

9. Confounder-Supporting Agency. The EMR project was largely supported through CDC funded partners. Expectations at the donor level could have influenced the adoption by implementing partners. The study source of funding as the US government agency that provided support to the service delivery partner in the facility where EMR was implemented. The US Centers for Disease Control (CDC), US Agency for International Development(USAID) and US Department of Defense(DoD) were the primary agencies that provided PEPFAR funding for HIV service delivery. A fourth category “other” was included for facilities which had private or unknown sources of funding.
10. Confounder- Months to outcome. Time since deployment of the system to the occurrence of outcome was an important confounder since data migration status is sensitive to the amount of elapsed time to enter legacy records. It was calculated from the implementation date and the date of the respective outcomes.

Table 1: List of Variables

Variable	Role in analysis	Source / Method of collection	Availability
Data quality	Outcome	Data quality assessment score on 0-100 scale (collected by DQA teams from Oct 2014-Jan 2016)	94 health facilities
Data migration	Outcome	Proportion of HIV patient records migrated to EMR as of September 2016 (dichotomized at median value <90% vs. >=90%)	307 health facilities
Champion type (summarizing number of champions and champions' cadre)	Main factor of interest	TrainSMART training data system (collected by I-TECH staff from 2013 to 2014)	463 people at 176 facilities
Champion age (average age of all champions trained)	Confounder	TrainSMART training data system (collected by I-TECH staff from 2013 to 2014)	463 people at 176 facilities
[1]Implementing partner	Main predictor of interest	Collected by I-TECH staff and validated from County records between 2012 and 2016	344 facilities
Current mode of system use	Confounder and mediating outcome	Point of Care (POC) vs. hybrid vs. Retrospective (RDE)-collected during facility EMR functional assessment in September 2016	3075 facilities
Facility type	Confounder	National Master Facility List data downloaded in June 2016 FL list	344 unique facilities
Region	Confounder	National Master Facility List and implementation data collected by I-TECH staff during implementations	344 Facilities
Months to outcome	Confounder	Dates of implementation recorded collected by I-TECH staff and the date of outcome collected during DQA and functionality assessment used to calculate time-to-outcome in months	305 facilities
Patient Volume	Confounder	Total cumulative HIV patients enrolled at the facility. This data was recorded by regional MOH and I-TECH regional staff during EMR readiness assessments.	Available 344 facilities

[1] Implementing partners (also referred to as Service Delivery Partners) are PEPFAR-supported non-governmental organizations (NGOs) and institutions funded to provide technical assistance and direct service-delivery support to the MOH. They reinforce quality and coverage of HIV-related health services delivery in networks of mainly public and non-profit sector health facilities

2.4 DATA COLLECTION

This study used secondary data contained in existing records collected during implementation process. Anonymized training data were obtained from the TrainSMART system to record trainee type, level of education and date of training. Data on implementation dates, type of implementation, and data migration status were obtained from the implementation monitoring spreadsheet maintained by I-TECH. These records were collected by field staff during routine field visits in a shared drive. I-TECH facility DQA reports were used for the data quality variable.[15] DQA involved visits by county health teams and implementing partners to facilities that had reported over 80% data migration or had recently received data migration support. The teams filled out a standard DQA tool, and the summary outcome reports maintained as monitoring records were used for this study. Data quality and mode of use outcomes were recorded during EMR assessment data that were collected in September 2016 as part of a national exercise to determine facility EMR status. A functional assessment of all PEPFAR-supported EMRs was carried out in September 2016, and this assessment yielded measurements for data migration status, implementation model, EMR status, number of other users mentored and number of patients variables in this analysis. The functional assessment was done by MOH-led teams who used observation key informant inquiry to complete an electronic survey tool.

2.5 DATA ANALYSIS

The analysis first summarized the data on KenyaEMR champions by type and age, using descriptive statistics.

Within the routine data sources used for this study, not all health facilities had data available on both the outcomes of interest and the exposure variables of interest. Descriptive summaries were

performed for data on facility characteristics for all KenyaEMR sites (n=-344). For the main analyses of the data migration and data quality outcomes, only health facilities with data available on either outcome were included (n=307 for data migration and n=94 for data quality). The study evaluated whether the outcomes, when treated as continuous numeric measures, were normally distributed. Where log-transformation could not achieve normality, the data were converted to a binary outcome dichotomized at the median score. Data migration status was converted to a binary outcome using the median migration score of 96%, while data quality was preserved as a continuous outcome. While bivariate analysis used available data for the respective variable, multivariate analysis used the most complete dataset that contained the respective outcomes and predictors of interest (307 and 94).

Associations between each outcome and each exposure of interest were evaluated in both bivariable and multivariable models using logistic regression for the data migration status outcome and linear regression for the data quality outcome. In multivariable models, we explored associations between the outcomes of interest and the key exposures of interest as defined by our hypothesis, with adjustment for all confounders with significant associations (at the $p<0.05$ level) in bivariable analyses.

Consequently, data migration status analysis was subjected to logistic regression while continuous variable (DQA) were analyzed using linear regression. Multivariable analysis was conducted to determine the odds of having the specific outcomes given that a clinician was trained as the champion controlling for the confounders. The coefficient (and significance) of each exposure variable was expected to influence the outcome reported alongside the final model. Stata14 (Stata Corporation, College Station, TX USA) was used for all analyses.

Chapter 3. RESULTS

3.1 CHARACTERISTICS OF CHAMPIONS

A total of 463 champion mentors were trained across facilities between 2013 and 2014 (see Table 1). 46% of the providers were nurses; clinicians (nurses, clinical officers or medical officers grouped together) accounted for 67% of all providers trained. Most of the champion mentors (282, or 69%) had a diploma level of education, and 125 had an undergraduate degree or above. Nyanza region accounted for 242 (50%) of all providers trained and Central region had the least number of people trained as champions at 8.9 %. The mean age of the providers was 32.9 years.

Table 2: Characteristics of Champions Trained (n=463)

Characteristic	**n or median**	**% or IQR**
Age	32.2	27.9 - 38.2
Provider type		
Nurse	214	46.2
Clinical Officer	97	21.0
Auxiliary	38	8.2
HRIO	36	7.8
Other	78	16.9
Education level		
Certificate	74	18.2
Diploma	282	69.3
Bachelors	49	12.0
Post-graduate	2	0.5
Region		
Central	43	8.9
North Rift	111	23.0
Western	87	18.0
Nyanza	242	50.1

3.2 CHARACTERISTICS OF HEALTH FACILITIES

Among all the 344 facilities implementing EMR, the largest number were health centers (45%), followed by sub-county hospitals (30%) and dispensaries (19%) (Table 3). 65 (18.9%) were dispensaries, 155 (45%) were health centers and 103 (29.9%) were sub-county hospitals. Most of the implementations (40%) were in Nyanza Region. Nearly half (47%) were in active use at the time of the study, while 43% were reported to be partially active. Data migration and data quality outcomes were available in 307 and 94 facilities as shown in Table 3.

Facility characteristics were comparable between the overall sample of facilities and the sub-samples with data migration and data quality outcomes. For example, dispensaries accounting for 19% of total facilities among the 344, 17% of facilities with data migration and 19% of facilities with data quality outcomes. CDC and USAD supported partners were also evenly distributes at 47% each while DOD supported 6% of all facilities. However, CDC partner supported sites contributed higher proportion (51% of 94) of all the facilities with DQA results but these differences were not significant. Among the 307 with the data migration outcome, 169 (55%) had at least one champion trained. 42% facilities trained 1-2 champions, while 13% had more than two champions trained. 45% of the facilities had no champions trained. Inactive facilities were few (1%) and all sites with DQA records were either active or partially active at the time of the study. Median number of cumulative patients (a measure of data migration burden) was 739 in the total population and DQA sites but slightly lower (708) in facilities that reported data migration. Mean number of champions trained per facility was 2 in all the facilities and facilities with DQA but lower (one) among facilities with Data migration.

Table 3: Facility Characteristics

Variable	All Facilities (n-344)		With Migration Outcome(n=307)		With DQA Outcome n=94	
	n	%	n	%	n	%
Facility type						
Dispensary	65	19%	51	17%	13	19%
Heath Centre	155	45%	151	49%	33	49%
Subcounty	103	30%	87	28%	16	24%
County	16	5%	14	5%	4	6%
Other	5	1%	4	1%	1	1%
Region						
Central	48	14%	48	16%	8	12%
North-Rift	78	23%	64	21%	14	21%
Western	81	24%	74	24%	7	10%
Nyanza	137	40%	121	39%	38	57%
Implementation mode						
POC	77	22%	77	25%	12	18%
RDE	119	35%	116	38%	27	40%
Hybrid	118	34%	114	37%	28	42%
Missing	30	9%				
Implementation status						
Active	147	43%	161	52%	34	51%
Partially active	162	47%	141	46%	33	49%
Inactive	4	1%	3	1%	0	0%
Missing	31	9%	2	1%		
Funding agency						
CDC	162	47%	147	48%	41	61%
USAID	162	47%	140	46%	22	33%
DOD	19	6%	18	6%	4	6%
Other	1	29%	2	1%		
Cumulative Patients (median, IQR)	739	351-1432	739	351-1432	708	326-1666
Champions per facility (Mean, SD)	3	2.4	1	1.7	2	2.3

Legend:
DQA-Data Quality Assessment score; **POC**-Point of Care; RDE, **CDC**-Retrospective Data Entry; **CDC**-Centers for Disease Control; **USAID**- US Agency for International Development; **DOD**- US Department of Defense

3.3 DATA MIGRATION

. Out of 307 facilities, 51% had a below median data migration score and 49% of the facilities reported above average data migration levels. Central region had the highest proportion of facilities exceeding the median data migration score (68% of 48). Nyanza had the least proportion of facilities exceeding the data migration median (49% of 121).

Table 4: Bivariate analysis of Data Migration

	OR/ Chi 2(df)	**p Value**	**95% CI**
Type of Champion compared with non-clinician	2.61		
Clinician	0.97	0.96	0.34-2.81
No champion	0.67	0.46	0.23-1.95
Facility type compared with subcounty hospitals	3.36	0.34	
Dispensary	1.16	0.67	0.58-2.34
HC	1.60	0.87	0.94-2.72
County	1.06	0.92	0.34-3.33
Implementing Partner compared with Partner A	18.52(9)	0.03	
B	2.30	0.03	1.07-4.98
D	2.30	0.03	1.07-4.98
E	2.57	0.15	0.71-9.28
G	0.86	0.76	0.31-2.34
H	1.89	0.24	0.65-5.43
J	13.20	0.02	1.62-107.84
K	1.47	0.50	0.48-4.47
M	0.52	0.20	0.19-1.41
N	1.47	0.45	0.54-3.98
Region compared with Nyanza		.	
Central	2.94	0.00	1.46-5.93
North-Rift	1.67	0.10	0.90-3.07
Western	1.25	0.46	0.70-2.24
Current Implementation mode compared with RDE	13.36(2)	0.00	
POC	3.03	0.00	1.67-5.51
Hybrid	1.67	0.06	0.98-2.83

Data migration by type of champion

Among the 307 facilities that reported data migration outcomes, 169 (55%) had a record of type of champion trained and the other 136 (45%) had no record of champion trained (results not shown). The data migration outcome was not associated with type of champion (Table 4). Similarly, the age was not associated with the data migration outcome. Compared to sub-county hospitals, dispensaries, health centers and county hospitals were more likely to have a better migration outcome (OR>1), but these differences were not significant.

Data Migration by Implementing Partner

There were significant variations in the data migration outcomes based on the implementing partner (Table 4). For example, one partner (N) had thirteen-fold odds of reporting a higher migration status compared to partner A (OR 13.2, p=0.016 CI: 1.61-107.8). Facilities that reported using the EMR as a point of care (POC) had better migration status compared to RDE model of use (see Table 4). Facilities in central Kenya were more likely to report better migration outcomes compared to western region (OR 2.90 p=0.003, CI: 1.46-5.92).

Multivariable Analysis

Our final multivariable model included data migration, champion type, implementing partner, current implementation mode, region, facility type, months to outcome, average champion age and months to outcome. All regions reported greater migration outcomes than did the Western region but these were not significant in the final adjusted only the current implementation model remained a significant predictor of the migration status with POC models recording more than fivefold increase in odds of reporting better migration status (OR 5.04; 95% CI: 1.4-17.6, p= 0.011) (Table 6).

3.4 DATA QUALITY

Among the 344 facilities implementing KenyaEMR, 94 had a data quality outcome. In unadjusted analysis, no association was found between the type or age of the provider trained as champion and the data quality outcome (Table 5). Similarly, no association was observed between data quality and time since EMR implementation (time to outcome) or volume of patients. However, significant associations based on implementing partner and regions were found. For example, partner D reported higher data quality scores compared to partner A (coif 23.9; 95% CI: 10.67-37.26, p=0.001).

Table 5: Data Quality Bivariate Analysis

	Coef/ Chi 2(F)	p Value	95% CI
Type of Champion compared with non-clinician			
Clinician	0.26	0.98	20.14-19.62
No champion	-7.57	0.47	-28.3-13.17
Facility type compared with subcounty hospitals (Chi 2)		**0.13**	4,89
Dispensary	15.92	0.05	-0.10 - 31.93
HC	0.92	0.87	-12.09 -10.25
County	7.8	0.49	-14.54 - 30.14
Implementing Partner compared with Partner A	3.02(9,83)	0.00	
B	13.46	0.10	-2.40 - 29.32
D	23.96	0.00	10.67-37.26
E	-16.84	0.11	-37.66 - 3.98
G	20.76	0.05	-0.06 - 41.58
H	19.09	0.03	1.85 - 36.62
J	9.63	0.46	-16.36 - 35.62
K	-4.54	0.69	-27.43 - 18.36
M	18.86	0.02	3.00 - 34.72
N	11.76	0.26	-9.06 - 35.58
Region compared with Nyanza Chi 2)	3.82(3,89)	0.01	
Central	10.63	0.08	-1.32 - 22.58
North-Rift	-5.95	0.38	-19.21 - 7.31
Western	-15.88	0.32	-30.34 - -1.47
Current Implementation mode compared with RDE	2.13(2,90)	0.01	
POC	12.47	0.00	10.67 - 37.26
Hybrid	8.21	0.16	-3.39 - 19.81

Multivariable Analysis

In the final adjusted model, only IP was significantly associated with the outcome (p=0.004 for joint Wald test) (Table 6). Other factors were not significant predictors of EMR data quality scores.

Table 6: Multivariate Analysis

	Data Migration	Adjusted p Value	Data Quality	Adjusted p Value
Type of Champion compared with non-clinician				
Clinician	2.74	0.25	1.373664	0.91
Implementing Partner compared with Partner A				
B	1.12	0.89	11.44	0.38
D	0.74	0.69	26.55	0.02
E	0.36	0.54	-17.29	0.15
G	0.15	0.25	28.80	0.02
H	3.69	0.12	6.05	0.53
J	5.27	0.20	13.96	0.49
K	9.81	0.08	-16.04	0.19
M	0.65	0.58	2.92	0.79
N	0.58	0.74	28.73	0.03
Region compared with Nyanza		.		
Central				
North-Rift	4.68	0.29		
Western	0.61	0.50	-2.80	0.81
Current Implementation mode compared with RDE				
POC	5.05	0.01	-12.12	0.21
Hybrid	2.48	0.07	-6.88	0.37
Months to outcome	0.95	0.39	-1.32	0.10
Champion age	0.97	0.37	-0.12	0.78
Cumulative Patients	1.00	0.43	0.00	0.11

Chapter 4. DISCUSSIONN

This study found no significant association between type or age of EMR champion and the key outcomes of EMR implementation (data migration status and data quality). While the investigator theorized that the champion type could be an important factor in the success of EMR implementation, further exploration of other characteristics of the champions (rather than type and age) that could influence the outcome of EMR implementations should be considered. In a systematic review of success factors in EMR implementation, Fritz et al (2015) reported that training and human resources were key determinants of EMR success, but the investigator did not replicate that association in this study. For example, if individual characteristics of the champion are more important than type, then type may not be a good proxy for how influential or how active a person is in the champion role. Leadership qualities have been proposed as a factor that influences adoption of change in organizations, but this study did not look at those characteristics within the facilities of interest.

While the investigator controlled for volume of data in the facilities, this did not seem to affect the overall outcome of the facilities. As expected, cumulative number of patients was marginally negatively correlated to the outcome, but the difference was insignificant. It means, therefore, that given a specific amount of time to achieve data migration, all facilities had an equal chance to achieve complete migration of data. Any difference was related to other structural factors and not to time. Other structural characteristics (i.e., level of support from IP, type of technology set up) appeared to be more important than the champion role in influencing successful EMR implementation and use. These structural factors were most apparent in the type of implementing partner supporting a region/facility. Implementing partners were not traditionally mandated to

provide EMR support, but, in most cases, it was an extension of their role in HIV care and strengthening reporting for accountability. EMR outcomes were significantly different by IP, but more work is needed to investigate the specific characteristics of IPs that determined outcomes. Although their numbers were small, there was a marked difference between non-government facilities compared to government-owned facilities. This pointed to possible leadership and governance influence on the adoption and use of EMRs in facilities. Consequently, beyond the implementing partner supporting HIV care, there could be county-specific differences that related to regions that were not investigated in this study.

Adoption of novel ideas follows a theory of change pattern where a few (champions and early adopters) lead others in embracing change. It is possible that these qualities within the champion or implementing partner influence the process and outcome of the EMR implementation process. The researcher recommends additional study to look at champion mentor characteristics and structural factors, especially IP.

4.1 LIMITATIONS

Within the context of an observational, retrospective study based upon routine monitoring and evaluation data such as this one, the evidence about key factors contributing to successful EMR performance arising from the study must be interpreted with some level of caution. The findings reflect associations but not necessarily causal relationships between the predictors of interest and the outcomes. The researcher acknowledges that a controlled study with randomized selection and assignment of champions by cadre, or randomized assignment of implementing partner is not be feasible; however, prospective cohort studies should be considered to build a base of evidence about predictors of successful EMR performance. The researcher also acknowledges the limitation

brought about by the small number of facilities reporting DQA results. These may have been a self-selected group of facilities that were generally motivated, even though their scores appeared to be normally distributed. The investigator also acknowledges possible misclassification in the key variable of interest for type of champion. Some facilities classified in the "No champion / unknown" category may have had either champion who were formally trained, but without data captured in the training database, or may have had de facto champions who were never formally trained but who nevertheless acted as champions.

BIBLIOGRAPHY

1. UNAIDS. *Global AIDS Update 2016*. Geneva; 2016. http://www.who.int/hiv/pub/arv/global-AIDS-update-2016_en.pdf. Accessed April 26, 2017.
2. Kenya Ministry of Health. *Kenya Aids Response Progress Report 2016*. Nairobi; 2016. http://nacc.or.ke/wp-content/uploads/2016/11/Kenya-AIDS-Progress-Report_web.pdf. Accessed April 26, 2017.
3. Ministry of Medical Services (Kenya), Ministry of Public Health and Sanitation (Kenya). *Standards and Guidelines for Electronic Medical Record Systems in Kenya*.; 2010.
4. Häyrinen K, Saranto K, Nykänen P. Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *Int J Med Inform*. 2008;77(5):291-304. doi:10.1016/j.ijmedinf.2007.09.001.
5. Safdari R, Ghazisaeidi M, Jebraeily M. Electronic health records: Critical success factors in implementation. *Acta Inform Medica*. 2015;23(2):102-104. doi:10.5455/aim.2015.23.102-104.
6. Singh B, Muthuswamy P. Factors Affecting the Adoption of Electronic Health Records by Nurses. *World Appl Sci J Heal Rec EMR (Electronic Med Rec HFMAHealthcare Financ Manag Assoc Heal Hum Serv Int Organ Stand*. 2013;28(11):1531-1535. doi:10.5829/idosi.wasj.2013.28.11.1899.
7. Kazley AS, Ozcan YA. Organizational and environmental determinants of hospital EMR adoption: A national study. *J Med Syst*. 2007;31(5):375-384. doi:10.1007/s10916-007-9079-7.
8. Rahimi B, Safdari R, Jebraeily M. Development of hospital information systems: User participation and factors affecting it. *Acta Inform Medica*. 2014;22(6):398-401. doi:10.5455/aim.2014.22.398-401.
9. Lakbala P, Lakbala M, Inaloo KD. Factors Affecting Electronic Medical Record Acceptance by Specialist Physicians. *Lect Notes Inf Theory*. 2014;2(4):316-321.

doi:10.12720/lnit.2.4.316-321.

10. Anderson JG, Aydin CE. Overview: Theoretical Persepctives and Methodologies for the Evaluation of Healthcare Information Systems. *Eval Organ Impact Healthc Inf Syst*. 2005:5-29.
11. US Department of State. Pepfar 3.0. 2015:1-18.
12. Fritz F, Tilahun B, Dugas M. Success criteria for electronic medical record implementations in low-resource settings: a systematic review. *J Am Med Informatics Assoc*. 2015;22(2):479-488. http://dx.doi.org/10.1093/jamia/ocu038.
13. Mandl KD, Khorasani R. Meaningful Use Of Electronic Health Records. *Health Aff*. 2012;31(6):1. doi:10.1097/HMR.0b013e3182860937.Assessing.
14. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and recommendations. *Milbank Q*. 2004;82(4):581-629. doi:10.1111/j.0887-378X.2004.00325.x.
15. Muthee V, Liku N, Puttkammer N. Institutionalization of a routine data quality assessment (RDQA) procedure for improved data quality of electronic patient medical records in Kenya. 2016. doi:10.1016/j.aogh.2016.04.264.