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THESIS

Title: Assessment of the quality of HIV data in an electronic system in a health sub-district in the Eastern Cape

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Key words: accuracy**,** antiretroviral treatment**,** completeness**,** data quality, HIV/AIDS, HIV electronic system, health information system, TIER.Net

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Abstract

Introduction: In South Africa, public health facilities provide free antiretroviral treatment (ART) mainly via primary healthcare (PHC) nurses. To streamline data collection an electronic HIV information system (TIER.Net), was introduced in 2010. Data originates in paper-based records completed by clinicians with the data from these paper systems then being captured into TIER.Net by clerical data capturers. TIER.Net is designed to effectively monitor outcomes of the ART programme and generate information for planning, management and decision making. For Enock Mgijima sub-district to attain these functions, it is imperative that data collected at the 21 PHC facilities in the sub-district be of good quality. There has been uncertainty around the quality levels of the data collected through the paper records and TIER.Net, and it was unclear which factors promote or inhibit improved data quality.

Aim: To assess the level of accuracy and completeness of HIV and ART data through the transmission chain, from initial paper-based patient records to TIER.Net, and to determine factors influencing the degree of accuracy and completeness of data collection.

Methodology: The study used a combination of a cross-sectional descriptive study design to assess the prevalence of data completeness and accuracy, and an ecological study design to assess the factors affecting data completeness and accuracy. Data on the prevalence of accuracy and completeness was collected via retrospective record reviews, while interviewer-administered questionnaires were used to collect data on potential factors affecting the degree of accuracy and completeness.

Results: The overall HIV data quality in Enock Mgijima sub-district was inadequate for evidence-based decision making, given the low completeness score for the paper-based records (45%). Although TIER.Net had nominally high completeness (82%), because it allows data capturers to capture '*Unknown or Not Sure'* for most of the variables, it had a far lower effective completeness with definitive data. However, adequate data concordance (90%) was noted for variables completed in both the HIV clinical records and in TIER.Net, indicating accurate abstraction of available data from the paper records into the electronic system.

The effect of behavioural factors on data quality was pronounced, by the fact that despite 86% of participants claiming that they can perform health information systems (HIS) related tasks, the actual skills assessment indicated that only 23% could do so. Stratifying by staff category, nursing staff were more confident in performing HIS tasks (94%), compared with data capturers (68%). However, data capturers were more competent (57%) in performing HIS tasks

and more knowledgeable in checking data quality (62%) as compared to professional nurses, at 8% and 25% respectively. Knowledge of HIS rationale was positively correlated with training, an indication that attending HIS trainings positively influences the staff's view on the value of information.

The impact of organizational factors on data quality was noted through the positive association of perceived empowerment & accountability and sense of responsibility; suggesting that empowering staff in decision making and holding them accountable for poor performance can improve staff awareness of their obligations. The effect of technical factors on data quality was demonstrated by many nurses and data capturers (48%) perceiving availability of HIV paper records in their facilities as inadequate, even though they considered them user friendly (93%).

Conclusion and Recommendations: The study showed substantial data completeness challenges for the HIV and ART programme but, showed quite high accuracy levels as measured by concordance of the paper and electronic records. Factors affecting this were lack of skills, inadequate supervision for routine HIS tasks; and inadequate availability of HIV paper records in facilities.

To improve the low level of completeness and further strengthen the already reasonably high levels of accuracy, creative capacity building interventions that addresses the 'know-do' gap at the point of service such as the 'low-dose high-frequency' approach should be implemented. Additionally, data management should form part of the key performance areas for nurses to enhance completeness of the HIV clinical records. Lastly, TIER.Net technical functionalities should be reviewed to ensure that it induces data capturers to capture definitive data only.

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I would also like to express my gratitude to the Eastern Cape Province Department of Health's Epidemiological Research and Surveillance Management Unit, Chris Hani district health management, health care workers and data capturers in Enock Mgijima sub-district for giving me permission and taking time to participate in the study.

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Declaration

I, Timothy Makazha, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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Date: 10 January 2020

List of Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral therapy
ARV	Antiretroviral
CD4	Cluster of differentiation 4
CPT	Cotrimoxazole Preventive Therapy
DES	Data Exchange Standards
DIT	District Implementation Team
DoH	Department of Health
DHIS	District Health Information System
HIS	Health Information System
HIV	Human Immunodeficiency Virus
IPT	Isoniazid Preventive Therapy
IT	Information Technology
LDHF	Low-Dose High-Frequency
NHC	National Health Council
NHLS	National Health Laboratory Service
NIMART	Nurse Initiated and Managed Antiretroviral Therapy
OTEs	Opportunities for Transcribing Errors
PEPFAR	President's Emergency Plan for AIDS Relief
PHC	Primary Health Care
PIT	Provincial Implementation Team
PMTCT	Prevention of Mother-To-Child Transmission

PRISM	Performance of Routine Information Systems Management
RHIS	Routine Health Information System
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
TIER	Three Integrated Electronic Registers
UNAIDS	United Nations Programme on HIV and AIDS
USAID	United States Agency for International development
Web-DHIS	Web-based District Health Information System
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 HIV & ART Programme in South Africa

In South Africa, public health facilities, specifically better capacitated large clinics and hospitals, started providing free antiretroviral treatment (ART) in April 2004 for patients infected with the human immunodeficiency virus (HIV) who had become immunocompromised (National Department of Health, 2006). In 2011, to expand access to HIV care and management, the government of South Africa task shifted the administration of the ART programme from doctors to primary healthcare nurses. All primary healthcare nurses providing ART care had to undergo a training course (called NIMART or Nurse Initiated and Managed Antiretroviral Therapy) on how to initiate and manage HIV positive patients on ART. Professional nurses undergo a five-day didactic training course, coupled with a six-month mentorship program through which they have to complete a workbook with different patient scenarios to be initiated on ART and managed thereafter, before submitting a portfolio of evidence for competence assessment and NIMART certification. The NIMART training however does not include data collection for patients on ART.

The annual HIV prevalence among South Africa's population was estimated to be 12.8% in 2016 (Johnson, 2016). The ART programme has, as a result of this high burden of disease, grown to be the largest in the world and the most expensive public health programme ever implemented in South Africa, with the government spending approximately R23 billion in 2016 with 20% of the funds being contributed by development partners (National Strategic Plan, 2017). It was reported that in 2018 there were 4,100,000 patients receiving ARVs in state-owned health institutions, with these patients constituting slightly more than half of the estimated 7.9 million South Africans living with the human immunodeficiency virus (Massyn, Pillay & Padarath, 2019)

1.1.2 Overview of the HIV Routine Health Information Systems in South Africa

Rapid growth of the ART population coupled with the huge amounts of money spent on funding the programme, necessitated the implementation of a robust monitoring and evaluation system, in order to monitor the outputs and outcomes of the ART programme (Osler et al., 2014).

Monitoring & Evaluation of the ART programme in South Africa

The South African National Health Council (NHC) in December 2010 approved and introduced a 3-tiered approach to ART monitoring, aimed at standardising monitoring of ART, improving clinical management of patients on ART and optimising routine data collection (Osler et al., 2014). This followed an October 2010 nation-wide audit aimed at determining the number of antiretroviral monitoring systems, which indicated that there were more than forty systems in use (Pillay, White & McCormick, 2012). The results of the audit implied an unavailability of a standardized system to effectively monitor antiretroviral services. This was a cause for concern given its magnitude and the huge investments made in funding the programme (Schneider, Coetzee, Van Rensburg & Gilson, 2010).

The 3-tiered ART monitoring suite consists of paper ART registers (Tier 1), a stand-alone single computer-based HIV electronic data collection system (Tier 2), also known as three integrated electronic registers (TIER.Net) and a web-based full electronic medical record (Tier 3). The 3-tiered approach enables each public health facility offering ART services to implement one of the systems based on context and resources at its disposal. The HIV clinical record guides clinicians on information required by any of the three systems and in the clinical management of patients. Each of the three tiers offers increased management support and sophistication.

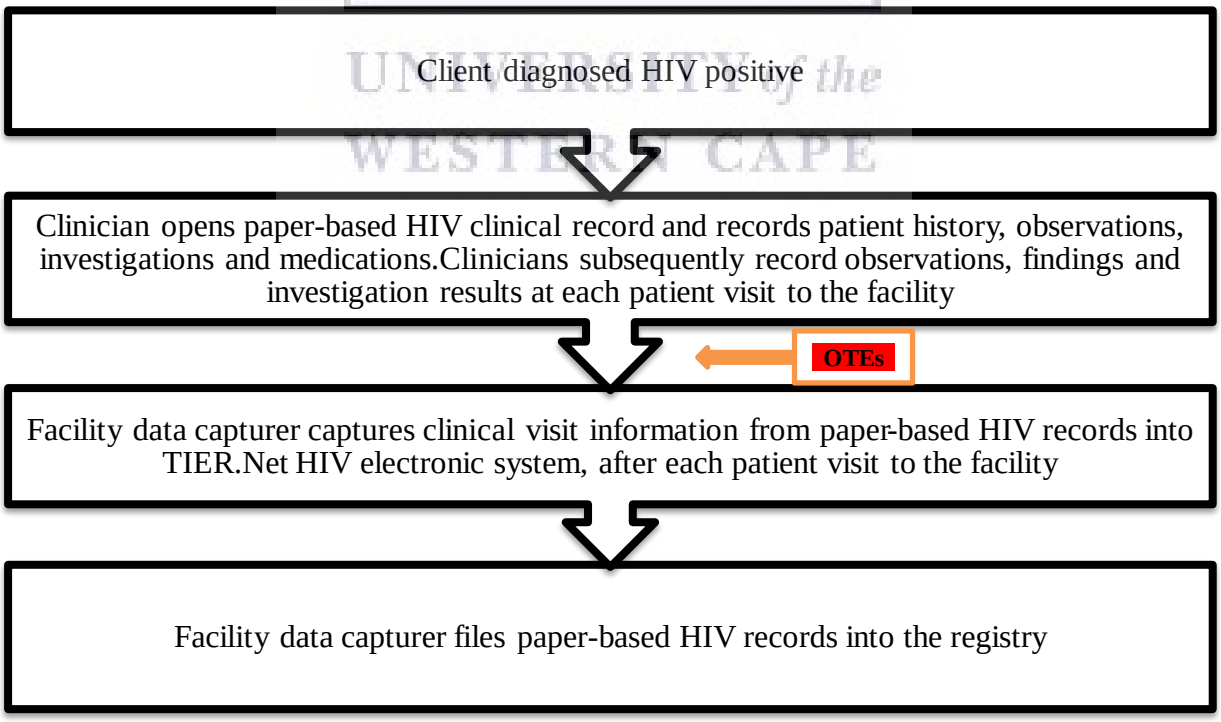
Out of the three tiers, emphasis was placed on rolling-out TIER.Net (Tier 2) which facilitates future migration to the networked electronic medical record (Tier 3) (Osler, et al, 2014) .This was because the bulk of health facilities in South Africa through support from various international non-governmental organizations and donors such as the United States Agency for International Development (USAID), through local implementing partners, had the required infrastructure and electronic information of ART patients that could easily be migrated to TIER.Net, through data exchange standards (DES) thereby automating generation of facility reports (Porter et al., 2012).

The structure of the TIER.Net HIV electronic system

The TIER.Net HIV electronic system (also known as Tier 2) is a stand-alone single computer-based HIV electronic data collection system that captures patient level HIV and ART data and generates immunological, clinical and virological indicators for monitoring HIV and ART services through a push of a button (Osler et al., 2014). Data capturers undergo a mandatory pre-implementation training on the electronic TIER.Net system (see appendix 5).

Data captured into the HIV electronic system is first collected on laboratory forms and structured paper-based HIV clinical records. The data collection process starts when clinicians upon diagnosing a client with HIV, open an HIV clinical record wherein they record the entire patient's history, observations, investigations and medications. They subsequently record observations, findings, investigation results and medications at each visit of the patient to the facility. Before the end of each day, a dedicated facility-based data capturer collects all HIV clinical records from all consulting rooms, for patients seen on each particular day, and captures the clinical visit information of each patient into the stand-alone TIER.Net HIV electronic system, on the designated computer for the facility, before filing back the HIV clinical records into the registry.

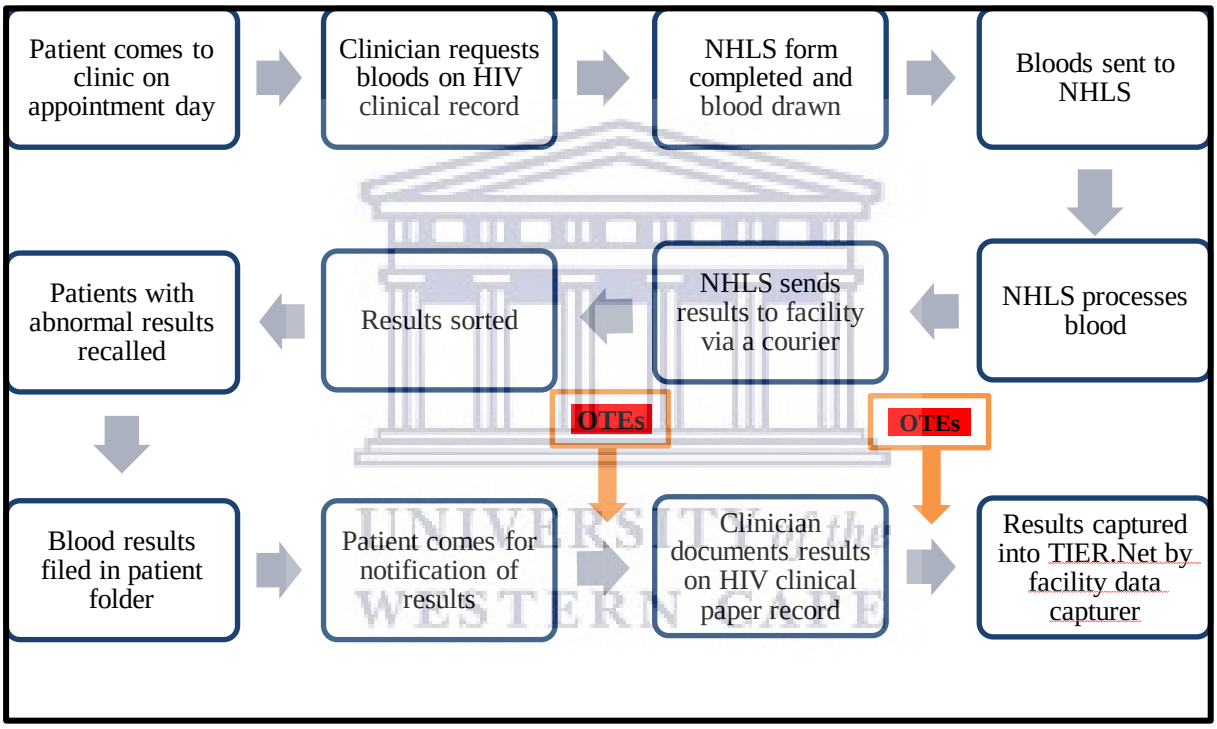
Figure 1:General flow of HIV & ART data into the HIV Electronic System (TIER.Net)



OTEs: Opportunities for transcribing errors

For laboratory data, clinicians must complete a laboratory request form and send it together with the specimen to the National Health Laboratory Services (NHLS) via a courier. After investigation of the specimen, the NHLS laboratory technician prints the laboratory test results and sends them back to the facility via a courier. At the facility, laboratory results are received by a clinician who reviews them and then transcribes the results into the patient's HIV clinical record, after which a data capturer enters the clinical record result (rather than the original printed laboratory test result) into the TIER.Net HIV electronic system, on the designated computer.

Figure 2: Flow of HIV laboratory data into the HIV Electronic System (TIER.Net)

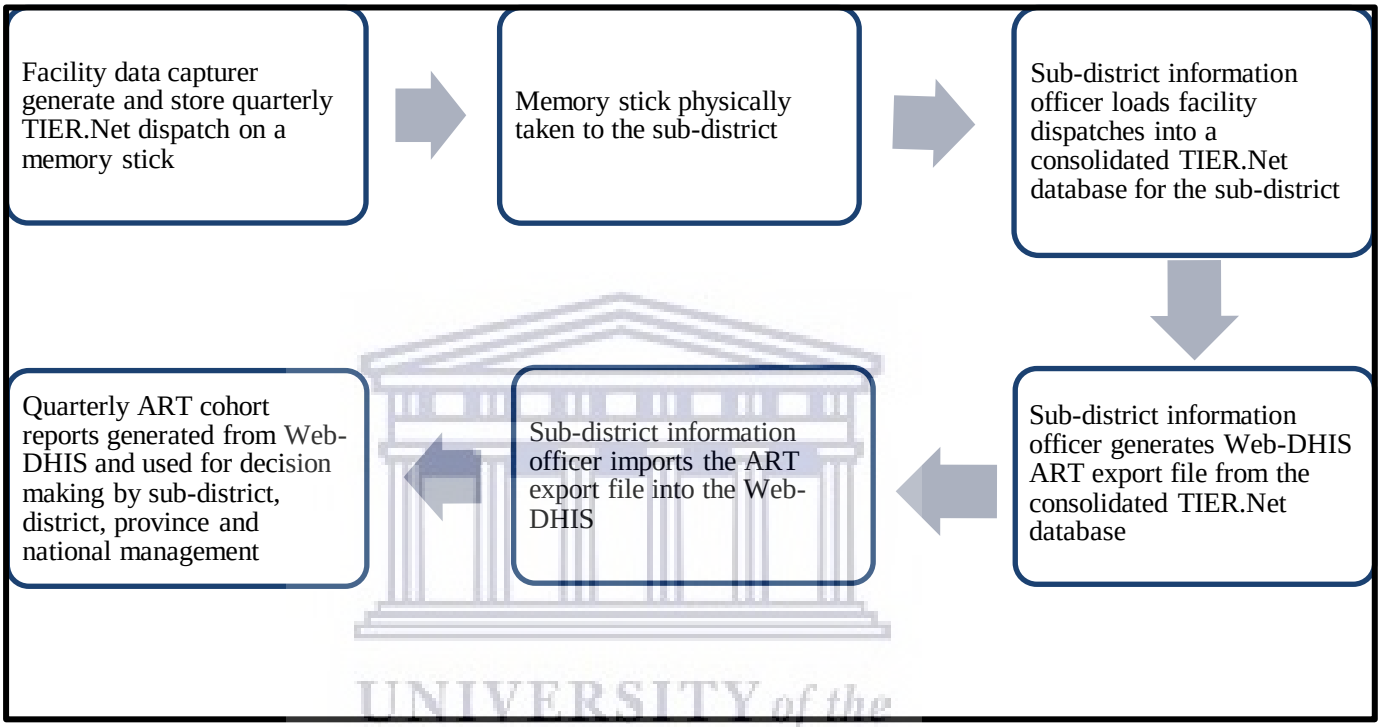


__OTEs__: Opportunities for transcribing errors

At quarterly intervals, facility-based data capturers generate TIER.Net dispatches (electronic data files) for transferring patient-level data to the sub-district. These are stored on a memory stick and physically taken to the sub-district where the sub-district information officer loads them into a consolidated TIER.Net database for the sub-district. Thereafter the sub-district information officer exports the data into a broader health information database, which acts as a repository for a wide variety of health information and is called the Web-based District Health Information System (Web-DHIS). Sub-district management use the quarterly ART data from Web-DHIS to routinely monitor cohort treatment outcomes for ART patients and to make decisions pertaining to the HIV and ART programme (National Department of Health, 2011).

This data also automatically becomes accessible at district, provincial and national level for decision making at those levels as well. This implies that any errors detected in the individual HIV paper records would cascade through to the facility, sub-district, district, provincial and national level via the above-mentioned process.

Figure 3: Quarterly HIV data flow from TIER.Net into the Web-based District Health Information System (Web-DHIS)



TIER.Net HIV electronic system implementation process

In South Africa by March 2019, there were 3,830 health facilities reporting ART data through Web-DHIS (National Department of Health, 2019). Of these, 94% (3,600) of the health facilities were implementing the TIER.Net HIV electronic system and all of them had fully completed implementation (National Department of Health, 2019). A facility is considered to have fully implemented the HIV electronic system (TIER.Net) once it reaches a stage called Phase 6. These implementation phases (Phase 0 to 6) are based on the National Department of Health's TIER.Net implementation steps developed to ensure uniformity in implementation practices across the entire country (National Department of Health, 2014).

The first phase involves introducing the HIV electronic system to facility staff including the HIV paper record. Requirements for rolling-out the system are also discussed and planned for in detail. Stock-taking is then conducted to identify resources at the facility's disposal such as

computers, space for data capturing, current number of patients receiving antiretroviral treatment in the facility, staffing, previous ART data management system and the current data flow process. Based on this assessment, a report is compiled detailing all the gaps noted in the facility and the recommended implementation plan for that facility (Myburgh et al., 2015).

Additional resources required are then procured including the appointment of data capturers. Phase two is marked by training on the functionalities of the HIV electronic system for all staff who will be involved in implementation, reporting, and maintenance of the system. Phase three involves the back capturing of active and non-active patients previously recorded in the paper-based ART registers onto the HIV electronic system. Once all patients have been transferred onto the HIV electronic system, data clean-up is commenced (Myburgh et al., 2015). Data clean-up involves data capturers checking, identifying and correcting errors in the data.

Phase four in the implementation process involves direct capturing of patients' data from HIV paper records rather than from the paper-based ART registers, a process called live capturing. Phase five involves signing-off of data by the district or provincial TIER.Net implementation teams (DIT/PIT). Once the facility has been signed-off, it is declared to be on phase six. Clinicians are responsible for ensuring that HIV paper records are completed and kept in paper folders and for returning the patient folders to the data capturers, who then capture the data from the paper records into the HIV electronic system, before filing the folders. Generating routine facility reports is the responsibility of the data capturers.

1.1.3 Data quality

Chen, Hailey, Wang & Yu (2014) define quality data as data that fits the purpose for which it was collected. This definition is highly consistent with that of the Canadian Institute of Health Information (2009), which defines high quality data as data that meets the intended objectives of the users. In as much as multiple definitions based on varying perspectives have been put forward in public health to define data quality, there seems to be a general consensus that data quality is a multidimensional concept (Karr, Sanil & Banks, 2006; Wang & Strong, 1996; Canadian Institute of Health Information, 2009). To this end, researchers lately put forward dimensions that determine data quality. However, in as much as there is no consensus on the dimensions of data quality; timeliness, accuracy and completeness are the most common attributes in reviewed literature (Chen et al., 2014; Ndabarora et al., 2013; Wand & Wang, 1996; Ahanhanzo et al., 2014).

Several studies conducted in low and middle-income countries reported that data from routine health information systems (RHIS) was of poor quality (Mavimbe, Braa & Bjune, 2005; Onta, Sabroe & Hansen, 1998; AbouZahr & Boerma, 2005; Makombe et al., 2008; Kabakama et al, 2016; Gloyd et al, 2016; Nicol, Dudley & Bradshaw, 2016). Various methodologies premised on one or more of the previously highlighted data quality dimensions have been used to measure the levels of data quality in routine health information systems (Chen et al., 2014). The most frequently used method for assessing the accuracy and completeness of source data highlighted in the literature is via logical consistency (Alipour & Ahmadi, 2017). This involves assessing the level of agreement between sources of data.

1.2. Study setting

Enock Mgijima sub-district is one of the six geographical areas within Chris Hani district, located in the central part of the Eastern Cape Province of South Africa. The estimated population in Enock Mgijima is 267 000, representing 32% of the total district's population (Chris Hani district, 2017). HIV prevalence among the population in Enock Mgijima stood at 12.6% in 2016 (Eastern Cape Socio-economic Consultative Council, 2017). As at the end of February 2018, there were 17 534 patients receiving antiretroviral treatment in public health facilities in the sub-district, representing 52% of those infected with HIV (Department of Health, 2018). Major drivers of HIV infection are high levels of unemployment (38%), poverty (27%) and illiteracy (23%) (Eastern Cape Socio Economic Consultative Council, 2017). The public healthcare system in Enock Mgijima consists of 37 fixed primary health care facilities (PHCs), 10 mobile clinics and 4 district hospitals. Of these, forty (the 37 fixed PHCs and 3 district hospitals) have fully completed implementation of the electronic HIV information system. However only 21 of the 37 fixed PHCs have registered 30 or more HIV positive patients on ART.

The researcher works for an international non-governmental organization named Africare which provides technical assistance to Chris Hani district in implementing HIV care and treatment services. As part of technical support to the district, clinical staff from Africare trained as experts in HIV management, sample folders of HIV positive patients in health facilities and conduct clinical audits aimed at assessing the quality of clinical care, and tailor make interventions aimed at addressing any deficiencies. During these clinical audits, gaps in recording crucial patient management information were noted in the HIV patient records.

Since HIV clinical records are the primary source of data captured into the electronic HIV information system (TIER.Net), it is probable that any inaccuracies and incompleteness of information in them will also lead to inaccurate and incomplete information in the electronic HIV information system. Also, since data capturers transfer information manually recorded by clinicians on HIV clinical records onto the TIER.Net system, this also presents possibilities for transcription errors. Such erroneous information will result in the generation of monthly and quarterly ART cohort reports that do not reflect reality, thereby misinforming health system managers.

In as much as both the partners (Africare and the Department of Health – Enock Mgijima sub-district) acknowledge the problem in the quality (completeness & accuracy) of HIV and ART related information, the magnitude of the problem is not known. Factors that might potentially affect data quality in Enock Mgijima include, but are not limited to, high staff attrition due to the rural nature of the sub-district (Department of Health, 2018; Eastern Cape Socio Economic Consultative Council, 2017; Cristofari et al., 2014); data processing errors (Nicol, Dudley & Bradshaw, 2016; Department of Health, 2018; Aqil, Lippeveld, & Hozumi, 2009) poor data capturing and reporting emanating from inadequate resources (Nicol, Dudley & Bradshaw, 2016; Aqil, Lippeveld, & Hozumi, 2009; Health Metrics Network, 2008) too many primary health care data elements collected resulting in overload and thereby leading to overworked data collectors not prioritizing data collection (Ahanhanzo et al., 2014; Williamson, Stoops & Heywood, 2001), poor recording as a result of inadequate skills (Garrib et al., 2008; MEASURE Evaluation, 2010; Harrison, 2010; Nicol, Dudley & Bradshaw, 2016) and lack of managerial and staff use of the information generated from the data with consequent minimal pressure from those who constitute the primary information users group for improved data quality (Kumalo, 2006; Rohde et al., 2008; Nicol, Dudley & Bradshaw, 2016)

1.3. Research problem

The main objective for implementing the electronic HIV information system (TIER.Net) is to generate data that facilitates informed decision making and planning. For this objective to be realized many processes including generation, transmission, analysis and use of data, are involved. Problems with any of these may result in erroneous data unsuitable for informing the decision-making process and planning cycles, being generated. Anecdotal evidence suggested that the data in the patient folders was of low quality, with in many instances inaccurate as well as incomplete data, but the degree of inaccuracy as well as incompleteness was unknown, with the causes of this assumed poor quality data being speculative.

Enock Mgijima sub-district may potentially have poor staffing levels, inadequate resources, inadequate data collection procedures, inadequate skills and lack of information use. All these summed-up, and if proven true, might explain why there was perceived poor quality HIV and ART related data being collected through patient folders into the electronic HIV information system from health facilities, and subsequently being reported via Web-DHIS to sub-district managers. However, literature is spare on the current state of HIV and ART data quality in Enock Mgijima sub-district, nor on the factors that potentially influence data quality in the routine health information systems. It was therefore important to assess the quality of HIV and ART data, as well as to investigate the factors that affect data quality in the setting.

1.4. Study purpose

The study sought to investigate the levels of accuracy and completeness of HIV and ART data in the paper and electronic systems and to determine factors influencing the degree of accuracy and completeness. The results of the study, if they indicate low data quality (accuracy & completeness), could be used by Africare as well as the Department of Health to improve the quality of the data. On the contrary, if the results of the study indicate high data quality, Africare as well as the Department of Health will use it to maintain the high data quality levels. With low data quality the causes of low data quality could be pro-actively addressed, while with high data quality best practices identified can be encouraged and duplicated in other settings, and the knowledge of high-quality data will instill confidence in the use of the data for decision making.

CHAPTER 2: LITERATURE REVIEW

2.1. HIV routine health information systems

Since 2002, many low-income countries in sub-Saharan Africa have scaled up HIV care and treatment rapidly (Hochgesang et al, 2017). Access to antiretroviral therapy has improved life expectancy in many resource constrained countries including South Africa (Hotchkiss et al, 2012). To this end, HIV is now classified as a chronic disease that needs long-term monitoring. Sound information systems that allow longitudinal tracking of patients' treatment outcomes are considered the backbone of effective chronic disease management (World Health Organization, 2006). Several authors have defined routine health information systems as an organized scheme for generating and collecting data for services provided at health facilities (Lippeveld, Sauerborn & Bodart, 2000; Matshidze & Hanmer, 2007; Health Metrics Network, 2014). Accordingly, these can either be paper-based or electronic systems (UNAIDS, 2012).

In many low-income countries, health information systems are paper-based at facility level and computer based at district level (Heywood & Rhode, 2001; Haux, Knaup & Leiner, 2007). Monitoring of treatment outcomes for ART patients in many resource constrained countries was at first through manual collation of data from the treatment cards of patients (Harries et al, 2004). Due to the rapid increase of ART patients as a result of treatment expansion efforts in resource limited countries, monitoring systems were forced to adapt accordingly in order to track treatment outcomes of a growing ART population (United Nations Programme on HIV and AIDS, 2008). Due to weak health systems in many resource limited countries, international donors such as the President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund provided technical and financial support to governments to expand ART coverage, including the development and implementation of longitudinal paper-based, and in some instances electronic, monitoring systems (United Nations Programme on HIV and AIDS, 2012).

The need for patient level antiretroviral treatment data in resource limited countries surpassed the development of national patient level monitoring system guidelines. This compelled development partners to develop and implement different monitoring systems at local site level. However, the decision as to whether to implement a paper-based or an electronic ART patient monitoring system was based purely on the technical capacity and resources at the disposal of each development partner (Hochgesang et al, 2017). South Africa is among the countries that

once implemented such disparate systems. The main objective of implementing such health information systems, whether electronic or paper-based, according to Health Metrics Network (2008) is to generate information fit for purpose (quality data). However, this is contrary to global research findings which have shown that data being generated from health information systems is of poor quality (Calle et al.,2000; Goeree et al., 2009).

2.2. Importance of high-quality data in HIV management

The importance of high-quality data in healthcare cannot be overemphasized. Data from HIV and ART patient monitoring systems is used by clinicians in monitoring immunological responses to antiretroviral treatment. This therefore implies that if the data is erroneous, clinicians are bound to make treatment errors which could impact on patient safety (Leape et al, 1995). HIV programme managers are responsible for monitoring standards of care compliance as well as monitoring enrolments and retention in HIV care. This implies that based on poor data quality, they may underestimate healthcare workers compliance to national HIV guidelines as well as projections for future service needs and staffing (Wilton & Pennisi, 1994). At population level, researchers use HIV data in estimating disease prevalence. To this end, if the quality of such data is grossly poor, there's a possibility of under or overestimating prevalence of disease (Johnson et al, 1991).

It is therefore logical to argue that generating poor quality data is a waste of resources such as time, money and effort. To this end, Reagon (2015) convincingly argues that having no data at all is cheaper and better than having grossly poor-quality data.

Although good quality data is critical for decision making, several studies conducted in middle-income and low-income countries reported that data from routine health information systems was of poor quality (Mavimbe, Braa & Bjune, 2005; Onta, Sabroe & Hansen, 1998; AbouZahr & Boerma, 2005; Makombe et al., 2008; Kabakama et al, 2016; Gloyd et al, 2016; Nicol, Dudley & Bradshaw, 2016).

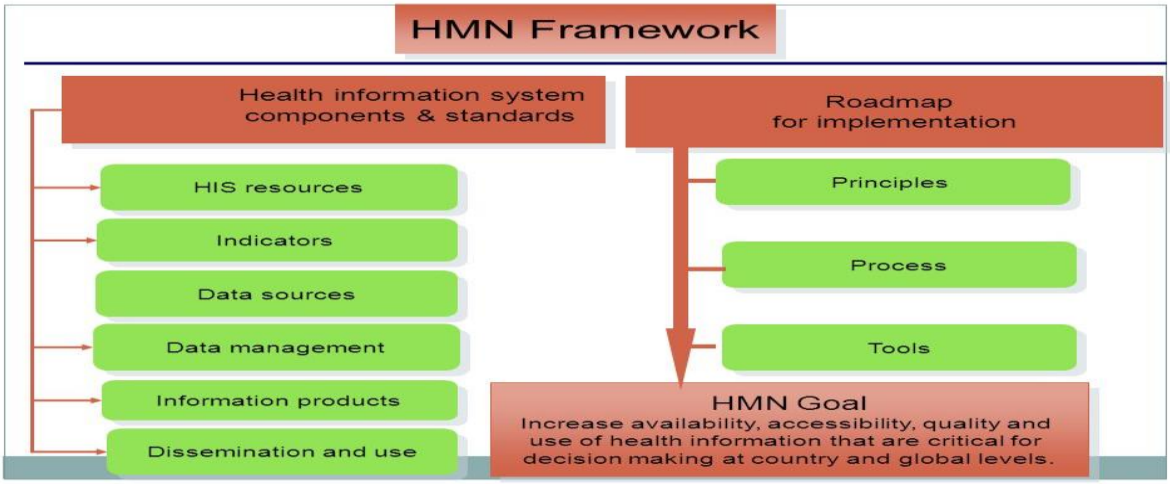
2.3. Routine health information systems data quality assessment frameworks

Various methodologies premised on one or more of the data quality dimensions have been used to measure the levels of data quality in routine health information systems (Chen et al., 2014). The Performance of Routine Information System Management (PRISM) and the Health Metrics Network are the most common frameworks used to assess the performance of routine health information systems.

The Health Metrics Network Framework

The Health Metrics Network framework *(figure 4)* developed by Health Metrics Network is divided into two parts, namely the six prerequisite standards and components required for a health information system as well as the requirements for building and or strengthening a health information system (Health Metrics Network, 2008). The standards and components for a health information system are sub-divided into inputs, processes and outputs. Inputs include health information system resources such as IT infrastructure, human resources, finance and legislative frameworks; processes include sources of data and indicators; and outputs include transformation of data into information, as well as accessibility and use of information by end users (Health Metrics Network, 2008). Part two of the framework highlights the principles, processes and tools required to build and or strengthen a health information system. Above all, the Health Metrics Network also designed tools for evaluating the overall national health information system performance based on the above standards and components for a health information system (Health Metrics Network, 2008). However, such an evaluation is highly superficial as it seeks to assess the information system in its entirety (National Department of Health, 2009).

Figure 4: The Health Metrics Network Framework *(Health Metrics Network, 2008)*

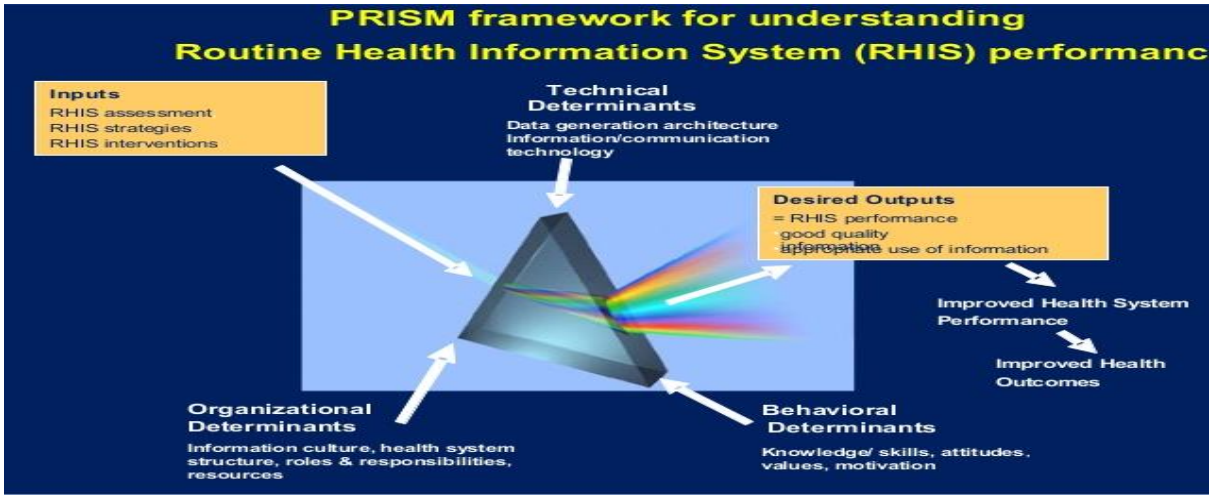


The Performance of Routine Information Systems Management (PRISM) Framework

The PRISM framework and its associated tools developed by John Snow Inc. in collaboration with MEASURE Evaluation Project (Aqil, Lippeveld & Hozumi, 2009) have been applied in many low-income countries to measure the quality of data in routine health information systems (Aqil, Lubaale & Orobaton, 2004; MEASURE Evaluation, 2006; Boone and Aqil, 2008; Gnassou et al., 2008). The framework postulates that routine health information system processes such as data generation, transmission, analysis, data quality checking and use of data affect the performance of routine health information systems, with these processes in turn affected by technical, organizational and behavioural factors. Technical factors include complexity of technology, reporting tools, standard operating procedure manuals and health information systems design while organizational factors include facility level management functions such as training, supervision, planning, finance availability, information systems governance and utilization of quality performance standards (Aqil, Lippeveld & Hozumi, 2009). Behavioural factors include human related factors such as the degree to which staff understand the reasons for collecting data, staff competence in checking quality of data, staff competence and confidence levels in performing health information systems duties, as well as incentives and determination to fulfil such tasks (Aqil, Lippeveld & Hozumi, 2009).

Based on a systematic review of seven conceptual frameworks for routine health information system performance, Hotchkiss, Diana, and Foreit (2012) concluded that the PRISM framework *(figure 5)* is the only framework that classifies health information systems according to inputs, processes, outputs, outcomes and impact.

Figure 5: Performance of Routine Information System Management (PRISM) Framework *(Aqil, Lippeveld & Hozumi, 2009)*



The PRISM tools consist of the performance diagnostic tool, the facility checklist, the organizational and behavioural questionnaire and the management assessment tool (Aqil, Lippeveld & Hozumi, 2009). The performance diagnostic tool assesses data quality whilst the other three determine technical, organizational and behavioural factors that affect data quality (Aqil, Lippeveld & Hozumi, 2009). The PRISM tools can either be adapted or utilized in their original form.

2.4. Data completeness in HIV routine health information systems

The World Health Organization (2003) framework on data quality defines data completeness as the presence of all the data required. Several studies conducted in many resource constrained countries assessing levels of completeness of data in routine health information systems highlight myriads of challenges. A retrospective chart review via logical consistency in a large HIV clinic in Mozambique noted that overall data elements completeness for enrolment and follow-up visits were 72% and 65% respectively. However, gaps in the recording of important quality care data elements such as the World Health Organisation (WHO) clinical staging of disease, ART medication regimen type, cluster of differentiation 4 (CD4) white cell counts and body weight were noted (Young et al, 2010). A similar study conducted in Malawi identified deficiencies in the recording of WHO staging, drug toxicities and opportunistic infections (Lowrance et al, 2007). Lowrance et al. (2009) in a national retrospective cohort study in Rwanda found that six and twelve-month CD4 cell counts in medical records were only complete for 49% and 35% of patients respectively. However, it is unclear from the literature whether the problem was with the clinical recording of data or with the laboratory data documentation.

A cross-sectional descriptive study conducted in central Mozambique to evaluate availability of data in a HIV electronic system noted high levels of completeness for most variables (Lambdin et al., 2012). These results are consistent with those of an analytical observational study evaluating the quality of PMTCT outcome indicators in two districts (Amajuba-KwaZulu Natal Province & Cape Metro-Western Cape Province) in South Africa, that noted 91% completeness in facility-level data and 96% at district level (Nicol, Dudley & Bradshaw, 2016). However, data for some variables were missing in both studies. In as much as results of both studies are valid, however, both studies are limited in exploring factors that contributed to such high levels of completeness of data so that they can be used as best practices in similar settings.

In sharp contrast to the results of the two studies above, Mate et al. (2009) in a retrospective evaluation of the quality of PMTCT routine data reported in DHIS in KwaZulu Natal Province, South Africa, noted that data at facility-level was only complete 50.3% of the time. This implies that such information is insufficient to monitor performance of the programme or to use in decision making.

2.5. Data accuracy in HIV routine health information systems

Accurate data is data that is a true reflection of an incident the exact way it happened (WHO, 2003). Studies conducted in resource limited settings evaluating the degree of accuracy of data in routine health information systems reported major concerns. In the first study alluded to in section 2.4 above, overall data elements accuracy for enrolment and follow-up visits were 95% and 84% respectively. In spite of this, critical elements for tracking quality of care (WHO stage, ART regimen, CD4 cell counts and weight) were not accurately recorded (Young et al, 2010). Similarly, deficiencies were noted in the recording accuracy of WHO staging, drug toxicities and opportunistic infections in the second study referred to in section 2.4 above conducted in Malawi (Lowrance et al, 2007).

A study evaluating the accuracy of the reported number of adult patients on ART data in thirty-two facilities from three Eastern Cape sub-districts, found that DHIS figures were over-reported by 36.6% (Kaposhi, Mqoqi & Schopflocher, 2014). Results of this study are consistent with a similar study conducted by Makombe et al. (2008) in Malawi assessing the accuracy of data aggregated by clinics providing ART. The study revealed a 12% under-reporting of total patients receiving first line ART.

While implementation of the TIER.Net HIV electronic information system in South Africa enabled automation of reporting ART monthly and quarterly indicators, the system still depends on accurate recording of individual paper-based HIV clinical records, diligent data transcription and suitable inference of the resulting information. However, to date, there are no reported studies in the literature that have been conducted in South Africa to evaluate the quality of data in this system. To ensure appropriate, planned and targeted HIV epidemic interventions, it's therefore crucial to determine the levels of accuracy and completeness of HIV and ART routine monitoring data through the transmission chain from initial paper-based patient records to the TIER.Net HIV electronic system and to assess factors potentially influencing the degree of accuracy and completeness.

2.6. Factors affecting data quality (accuracy & completeness)

Although complete and accurate data is critical, information systems in middle-income and low-income countries are continuously failing to generate complete and accurate data. In situations where information systems can generate data, the resulting information is insufficiently utilized for management and planning purposes (Nicol, Dudley & Bradshaw, 2016). Several studies conducted to appraise the performance of routine health information systems focused on clinical processes, as well as organizational and technical issues, and rarely on human factors that contribute to the failure or success of health information systems (Kumalo, 2006; Loveday, Smith & Monticelli, 2006; Rohde et al., 2008; Kaplan & Shaw, 2004 & Lau et al, 2010). In studies that assessed factors associated with failure or success of routine health information systems, few focused-on people factor such as motivation, competence, data use for decision making and service improvement (Nicol, Dudley & Bradshaw, 2016).

Technical factors

Technical factors refer to the skills and technology utilized in designing, managing and improving the processes of data collection, collation and analysis. These include complexity of technology, reporting tools, standard operating procedure manuals and health information systems design (Aqil, Lippeveld & Hozumi, 2009). Kumalo (2006) in a case study evaluating health information system capacity in one province in South Africa, reported inadequate availability of health information system IT infrastructure such as internet, printers and computers in health facilities; poor competence of information officers on DHIS computer software and data analysis, as well as unavailability of standardized guidelines and policies to guide the processes of data management. Findings of this study are consistent with results of a review conducted by Rohde et al (2008), evaluating the extent to which information is used in primary healthcare decision making in South Africa. They also reported lack of skills and inadequate availability of health information system staff.

Kumalo (2006) and Rohde et al's (2008) findings to a large extent confirm some of the findings highlighted by Loveday, Smith & Monticelli (2006), in a South African nationwide health information system audit. The audit reported that 35% of the sampled 677 national health information system personnel were not trained on DHIS computer software and an additional 20% were insufficiently trained for less than a week. Despite ninety-five percent of interviewed health information system staff reporting having access to computers, the audit noted that many of the computers were unusable due to outdated hardware and software.

Organizational factors

Organizational factors have been identified in the literature as significant factors that impact on the success or failure of health information systems (Aqil, Lippeveld & Hozumi, 2009). Organizational factors include facility level management functions such as training, supervision, planning, finance availability, information systems governance and utilization of quality performance standards (Aqil, Lippeveld & Hozumi, 2009). Other factors such as data quality emphasis, sense of responsibility, community and staff feedback, information use, accountability and empowerment, as well as reward, are also considered organizational factors (Nicol, Dudley & Bradshaw, 2016).

A cross-sectional descriptive study evaluating data quality levels and the factors associated with it in 267 heath facilities in Ethiopia, noted lack of data feedback, inadequate staff training and inadequate supervision as factors contributing to poor data quality (Teklegiorgis, Tadesse, Mirutse & Terefe, 2016). Results of this study are consistent with those of a similar study conducted in Kenya, which showed a strong relationship between data quality and supportive supervision (Cheburet & Odhiambo-Otieno, 2016). However, the study did not assess the effect of training and staffing on the quality of data in health information systems. A descriptive cross-sectional study conducted in Tharaka Nithi County in Kenya evaluating factors affecting information use also reported unavailability of a culture that supports information use, inadequate supportive supervision and lack of staff training as organizational factors influencing use of information (Mucee, Kaburi, Odhiambo-Otieno & Kinyamu, 2016). Even though organizational factors are considered critical in determining the success and failure of health information systems, Lorenzi et al. (1997) convincingly argue that these have not been given much attention during implementation of health information systems.

Behavioural factors

Human related factors (behavioural) have been highlighted in the literature as part of the reasons for inadequate utilization of information in decision making as well as for poor data quality. Aqil (2008:1) defines behavioural factors as "knowledge, skills, attitudes, values, and motivation of the people who collect and use data".

In many resource limited settings, a typical challenge faced by nurses is the need to find a balance between providing care for patients versus ensuring that clinical records, which are the initial source of routine data, are properly completed. Because of these competing responsibilities, Kumalo (2006) argues that this may affect the amount of time nurses dedicate for collecting data. Indeed, several authors have highlighted that in most cases; clinicians will

overlook data collection and concentrate on attending to patients, thereby affecting the quality of data collected (Ledikwe et al., 2014; Aqil, 2008; Harrison & Bakari, 2008; Harrison, 2010).

Numeracy skills have been reported in several studies as lacking among staff involved in collecting data both at district and facility levels (Belay & Lippeveld, 2013; Hotchkiss et al., 2010; Nicol, Dudley & Bradshaw, 2016). This has partly been ascribed to insufficient numeracy skills training of nurses (Nutley & Reynold, 2013; Arkell & Rutter, 2012). To this end, Rohde et al. (2008) recommends the inclusion of data collection and use, as critical components in the undergraduate curriculum of nurses and other medical staff. Nicol, Dudley & Bradshaw (2016) on the other hand advocate for inclusion of basic mathematics literacy as a pre-requisite for enrolling potential nursing students.

Staff attrition has been highlighted in the literature as a contributor to poor data quality (Doherty et al., 2009; Matshidze & Hanmer, 2007; English et al., 2011). Cristofari et al. (2009) in a study aimed at assessing adequacy of health information system human resources in two African countries, noted staff shortages as a huge factor contributing to substandard data quality and inadequate use of information. The same study reported on the dual effect interventions such as on-site training has on health information systems. The authors observed that in as much as training increases the capacity of staff to better undertake their duties, it increases demand for such staff leading to a high turn-over. Cristofari et al. (2009) convincingly argue that such problems can be solved by ensuring that staff get adequate incentives and are always motivated.

CHAPTER 3: AIMS AND OBJECTIVES OF THE STUDY

3.1. Aim of the study

To assess the level of accuracy and completeness of HIV and ART data through the transmission chain, from initial paper-based patient records to TIER.Net, and to determine which factors influence the degree of accuracy and completeness of data collection.

3.2. Objectives of the study

The study has three major objectives namely to:

(i). assess accuracy and completeness of source data via logical consistency

(ii). assess accuracy and completeness of source data translation through the transmission chain

(iii). determine the factors affecting the degree of accuracy and completeness of the data at facility level.

CHAPTER 4: METHODOLOGY

4.1. Study design

The study used combination of a cross-sectional descriptive study design to assess the prevalence of data completeness and accuracy and an ecological study design to assess the factors affecting data completeness and accuracy. The cross-sectional descriptive study design was used because it is relatively economical, easy to conduct, and appropriate to the aim and objectives. Using this study design, one can assess the prevalence of data accuracy and completeness and can theoretically identify factors affecting/associated with it. Unfortunately, data records per patient in the folders and in the electronic datasets could not be traced back to the individual staff member who entered them. Therefore, factors affecting accuracy and completeness could not be assessed at the individual patient and staff member level via the cross-sectional descriptive study design, and hence their elucidation required the use of an additional study design.

Given that the level of data completeness and accuracy was assessed for each facility, an ecological study design was used to determine the effect of facility level factors on data completeness and accuracy, such as staff training, staff ability and staff motivation. In summary, the cross-sectional descriptive study was used to assess the prevalence of data completeness and accuracy, while the ecological study was used to assess the facility level factors affecting data completeness and accuracy.

4.2. Study population

Inclusions: The study population was comprised of:

- Data sources for HIV and ART data at the 21 PHC facilities which had more than 30 patients registered with HIV (adults & children) who have been on ART for 12 months or more (see appendix 1). The data sources were laboratory reports, paper-based HIV clinical records and the TIER.Net electronic HIV information system.
- All 48 Professional Nurses in the 21 primary health care facilities who were NIMART trained and were involved in recording on the paper-based HIV clinical records (see appendix 2).
- All 21 facility-based data capturers capturing HIV and ART information on the TIER.Net electronic HIV information system and generating reports at the 21 facilities.

Exclusion criteria: The following special cases were excluded from the study population:

- Individual HIV clinical records (adults & children 12 months on ART) for patients that were transferred from other facilities, as they might contain insufficient information for evaluation since the patients would have been initiated on ART in other facilities.
- Individual HIV clinical records (adults & children 12 months on ART) for TB/HIV co-infected patients, as the amount of data recording required for such patients will be more than those who are only HIV infected, leading to higher chances of them being incomplete and inaccurate.
- Staff (all types) newly appointed for less than six months during the time of the study.

4.3. Sample size

Epi Info Version 7.2.2.6 StatCalc function was used to calculate a random sample of 1054 HIV patient records required to be assessed, based on a design effect of 1; acceptable error margin of 2%; expected frequency of data quality errors of 30%; level of confidence of 80% and estimated population size of 2000 ART patients. The further stratification of the sample per facility is shown in appendix 1. Those facilities with less than 55 (but more than 30) patients on ART had the entire eligible number of patients in the facility included in the sample. Those facilities with 55 or more patients on ART each had 55 patients randomly selected. Since the sample was then disproportionately spread across the population, to over-represent the smaller facilities, the records were proportionately weighted when creating summary values for the sub-district.

4.4. Sampling

Sampling of patient folders: To select a representative sample of patient files from the facilities with more than 55 eligible patients, a random sample of all eligible patients from the participating PHC facilities were identified from the aggregated sub-district HIV electronic dataset of all the patients. All the patients in the HIV electronic system who initiated treatment between September 2016 and August 2017 per facility were allocated numbers chronologically. Random sampling via computer-generated random numbers was then used to select the sample for each facility. Folder numbers of selected patients was then used to access their files at their respective facilities.

Sampling of staff: All previously mentioned staff members (48 Professional Nurses & 21 data capturers) from the 21 PHCs were included and hence the sample was the same as the study population.

4.5. Data collection

Data collection on the prevalence of accuracy and completeness was done via a retrospective record review, while data collection on potential factors affecting the degree of accuracy and completeness with which the data is collected was done via interviewer-administered questionnaires.

4.5.1. Data collection on the prevalence of accuracy and completeness

To measure ***accuracy*** of the recording of laboratory tests results, the original paper records, the original laboratory reported results (viral load and CD4) taken during the period under review, the results of the same date recorded on the HIV clinical record and the results of the same date captured on the TIER.Net system were compared. Data was considered accurate if results of the three sources match. Data was considered relatively accurate (accurate for transcription only) if results of the paper record and those of the TIER.Net system match, as this was considered accurate transcription, even though the paper record itself might be inaccurate. For assessing accuracy of clinical data recorded in TIER.Net, an excel sheet with corresponding variables in the TIER.Net HIV electronic system and those in the HIV clinical record (such as gender, ART start date, WHO stage at ART start date, etc., see appendix 3) was created. Like the above described, the TIER.Net records (of clinical data) was considered accurate if clinical data of the two sources match.

To measure ***completeness*** of the recording of laboratory tests results, the original laboratory reported results (viral load and CD4) taken during the period under review, the original paper records (HIV clinical records), and the TIER.Net HIV electronic system were compared. Data was considered complete if results were present in all the three sources. Data was considered relatively complete (complete for transcription only) if results were present in the TIER.NET system but not recorded in the paper record, as this was considered complete transcription, even though the paper record itself might be incomplete. For assessing completeness of clinical data recorded in TIER.Net, an excel sheet with corresponding variables in the TIER.Net HIV electronic system and those in the HIV clinical record (such as age, gender, ART start date, WHO stage at ART start date, etc., see appendix 4) was created. Similar to the above described, the TIER.NET records (of clinical data) was considered complete if clinical data was recorded in both sources.

4.5.2. Data collection on the factors affecting accuracy & completeness

To assess factors affecting the degree of accuracy and completeness of HIV data, after ethical approval and permission was obtained, the researcher set meeting appointments with each of the 21 facilities to explain the objectives of the study and seek their consent to participate in the study. After getting informed consent, the researcher and two research assistants administered the questionnaires to the staff with a plea to honestly express their opinions and assurance that their responses shall remain confidential to the researchers.

To measure factors affecting data quality, the questionnaire was sub-divided into behavioral, organizational and technical factors. Behavioral factors were classified into two groups; namely skills and perceptions. Actual skills were measured by assessing proficiency in fulfilling tasks related to routine health information systems i.e. plotting data, interpreting and using data for management. Perceptions on the other hand were measured through assessing confidence levels in performing tasks related to routine health information systems, knowledge of checking data quality, perceived motivation and in terms of the level of appreciation of the rationale behind implementing routine health information systems.

To assess organizational factors, trained interviewers asked respondents to rate their perceptions on various questions relating to organizational processes. Questions asked included the decision-making process in the department of health, perceptions about superiors in the department of health, perceptions about fellow staff and the respondents themselves. A 4-point Likert scale ranging from 'strongly agree' to 'strongly disagree' was then used to calculate composite scores for various indicators related to organizational factors. These include 'evidence-based decision making, information use, promotion of problem solving, sense of responsibility, data quality emphasis, empowerment and accountability'.

Technical factors were measured through trained interviewers asking respondents to rate their perceptions on various questions relating to availability and complexity of using HIV and ART data collection and reporting tools including TIER.Net, availability of standard operating procedure manuals. A 4-point Likert scale ranging from 'strongly agree' to 'strongly disagree' was then used to calculate composite scores for various indicators related to technical factors. These include 'availability of HIV and ART recording tools, availability of instruction guides for HIS, complexity of using HIV and ART recording tools'.

4.6. Data analysis

Data quality: The study used data completeness and data accuracy as the two dimensions for data quality. Descriptive statistics with percentages and frequencies were used to summarize and describe the prevalence of data accuracy and completeness at facility and sub-district levels. Using selected variables in the HIV clinical record and in the electronic TIER.Net system and setting 75% as a cut-off point based on experts' opinion, completeness and accuracy of individual variables in the HIV clinical records and in the TIER.Net were classified as being adequate and inadequate. An aggregate sub-district weighted composite score for completeness and accuracy was then calculated with each of the individual variables having equal weight.

Behavioral, organizational and technical determinants: Univariate analyses was used to describe demographic and biographical characteristics of the participants. Bivariate and Spearman's correlation analyses were done on each of the demographic and biographical characteristics to determine the existence of any statistical associations between the variables and the outcomes of data completeness and accuracy. However, since it was done comparing facilities the small effective sample size of 21 facilities would only allow one to detect very strong associations. All the analysis was done using the Statistical Package for Social Sciences (SPSS version 25).

4.7. Validity and reliability

To minimize selection error due to chance a sufficient sample size was calculated for the sub-district, however obtaining a sufficient sample size for each facility was more difficult due to logistical (there were insufficient patients at the facility) and data collection (it was too onerous to collect data on large samples for every facility) constraints. Measurement errors due to random error were minimized by having clear definitions for completeness and accuracy i.e. for data to be considered accurate, data values in the paper-based HIV clinical record must be the same as those in the TIER.Net HIV electronic system. For data variables to be considered complete, they must reflect on both the paper-based HIV clinical record and in the TIER.Net HIV electronic system as required by the data collection protocol.

Selection bias was reduced by random sampling of HIV clinical records from the facilities with more than 55 eligible patients. Measurement bias was minimized by the researcher and the two research assistants assessing all records in the same way. The sample size for the ecological study was unfortunately structurally limited in the setting, as there were only 21 primary care facilities that met the study inclusion criteria. Similarly, due to the low number of facilities

included, the effect of potential confounding variables was difficult to determine, and the usual ecological paradox therefore unfortunately prevailed, and should be cautioned against.

To ensure high reliability, the research instruments were piloted in two health facilities to check their capacity to consistently measure the variables, as well as to identify if adjustments were needed before final implementation. Two recruited research assistants were also trained for a week on the research instruments and the approach used in the data collection process, so that it was always done in the same way. This was complemented by a data collection guideline that was developed to standardize the data collection process.

4.8. Generalisability

Results and recommendations of the study are generalizable to all health facilities in Chris Hani district implementing the TIER.Net HIV electronic system and possibly to primary health care facilities in the country at large, provided the facilities have the same or similar data collection and analysis methods, as well as similar staffing levels and training.

4.9. Ethics

Ethical clearance was obtained from the University of the Western Cape Research Committee and permission to conduct the research in the health facilities was sought from the Department of Health's Epidemiological Research and Surveillance Management Unit, Eastern Cape Province. Authority to access patients' HIV records and TIER.Net records was additionally sought from individual health facility managers. Participation of staff was voluntary with informed written consent obtained from each respondent after the study was explained to them. Their responses to questions posed were kept strictly confidential as only the researcher and the two research assistants saw their replies and no names or indirect identifying characteristics which would allow individuals or small groups to be identified, appear in the report or in any ancillary documents. The study did not pose any psychological harm to participants as they were neither asked sensitive nor personal questions. This final study report will be shared with the Eastern Cape Provincial Department of Health HIV/AIDS Directorate, Chris Hani District health management, as well as Enock Mgijima Sub-district management, for easy access and use by the respondents.

CHAPTER 5: RESULTS

The study findings described and presented below include: HIV and ART data quality (completeness and accuracy) and the factors affecting the degree of accuracy and completeness of the data at facility level.

5.1. HIV and ART data quality

Both the level of completeness of the paper and electronic datasets, as well as the level of accuracy, as determined by the degree of concordance between the paper and electronic dataset and the laboratory and electronic dataset, are shown below.

5.1.1 HIV clinical records and TIER.Net system completeness

Table 1 below shows the prevalence of completeness (%) of selected variables in the HIV paper clinical records and the electronic TIER.Net system. All variables except CD4 counts, viral load and next appointment were 100% complete in TIER.Net, but much lower percentages were noted in the paper HIV clinical records. This reflects poor paper record keeping by clinicians. The percentage of completeness for CD4 count and viral load were exactly the same in the paper records and in TIER.Net suggesting that there might be complete capturing of available paper records into the TIER.NET system. The divergence from 100% in TIER.Net emanates from there being a lack of CD4 and viral load tests being done and or a lack of documentation by clinicians of the results of tests done, in the HIV paper clinical records. This results in data capturers being unable to capture that data into the electronic TIER.Net system. Whereas next appointment date completion rates varied between TIER.Net and the paper records suggesting a straightforward lack of data capture in both the paper records and the TIER.Net system. Although the percentage of missing data was small (7% and 3% respectively).

Table 1: Prevalence of completeness (%) of selected variables in the HIV paper clinical record and the TIER.Net system

	Variable	HIV paper clinical record	TIER.Net system
Patient details	Patient name	100	100
	Patient surname	100	100
	Date of birth	100	100
	Gender	100	100
ART baseline information	ART start date	100	100
	Prior ART history	57	100
	Method into ART	66	100
	WHO stage at ART start	69	100
	TB treatment status at ART start	64	100
	IPT status at ART start	54	100
	CPT status at ART start	56	100
	Baseline CD4 count	44	44
Treatment visit information	Visit date	100	100
	Health provider	86	100
	TB screening status	86	100
	IPT status	48	100
	6 months viral load result	57	57
	12 months viral load result	49	49
	12 months CD4 count result	44	44
	ARVs prescribed	100	100
	Months ART prescribed	58	100
	Next clinical appointment date	97	93

5.1.2 HIV clinical records and TIER.Net system concordance

Table 2 below shows the prevalence of data accuracy (%) of selected variables in the HIV paper-based clinical records and the electronic TIER.Net system. Accuracy was determined by concordance between the listed paired data systems in the table (NHLS laboratory and paper clinical record) and (paper record and TIER.Net). Patient detail variables, for data recorded in more than one dataset, had the highest level of agreement; patient name, surname, date of birth and gender had more than 93% concordance across both the HIV clinical records and the TIER.Net system. Relatively low levels of concordance were noted between HIV clinical records and the TIER.Net system. This reflects inaccurate data abstraction from the clinical records into the TIER.Net data base by facility data capturers. The percentage of concordance for CD4 count and viral load were high (100%) suggesting that there might be accurate capturing of available records from the HIV clinical records into the electronic TIER.Net system.

Table 2: Prevalence of data accuracy (%) of selected variables in the HIV clinical record and TIER.Net system based on concordance between the paired data systems

	Variable	NHLS lab form + HIV clinical record	HIV clinical record + TIER.Net system
Patient details	Patient name	100	94
	Patient surname	100	100
	Date of birth	100	99
	Gender	100	99
ART baseline information	ART start date	-	96
	Prior ART history	-	57
	Method into ART	-	44
	WHO stage at ART start	-	50
	TB treatment status at ART start	-	44
	IPT status at ART start	-	57
	CPT status at ART start	-	78
	Baseline CD4 count	66	100
Treatment visit information	Visit date	-	93
	Health provider	-	98
	TB screening status	-	85
	IPT status	-	48
	6 months viral load result	62	100
	12 months viral load result	60	100
	12 months CD4 count result	47	100
	ARVs prescribed	-	88
	Months ART prescribed	-	50
	Next clinical appointment date	-	92

Table three below shows composite scores of the adequacy of data completeness and accuracy of selected variables in the HIV clinical record and in the TIER.Net system in Enock Mgijima Sub-district. Using the selected variables in the HIV clinical record and in the TIER.Net highlighted below and setting 75% as a cut-off point, completeness and accuracy of individual

variables in the HIV clinical records and in the TIER.Net were classified as being adequate and inadequate. An aggregate composite score for completeness and accuracy was then calculated with each of the individual variables having equal weight.

Overall HIV data quality in Enock Mgijima sub-district seems inadequate for evidence-based decision making, given the low completeness score for the paper-based records (45%). Major gaps were noted in the availability of critical ART baseline information (Prior ART history, Method into ART, WHO stage at ART start, TB treatment status at ART start, IPT status at ART start, CPT status at ART start, Baseline CD4 count) and subsequent treatment visit information (TB screening status, IPT status, 6 months viral load result, 12 months viral load result and 12 months CD4 count result) in the HIV clinical records.

Table 3: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net in Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	0
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	10/22(45%) Inadequate	18/22 (82%) Adequate	9/10 (90%) Adequate

The rest of the tables showing composite scores on the adequacy of data completeness and accuracy of selected variables in the HIV clinical record and in the TIER.Net system, per each of the 21 facilities in Enock Mgijima Sub-district, are shown in appendix 7 (Tables A – U).

5.2. Factors affecting data quality (accuracy & completeness)

The findings of this objective, which is to assess the behavioural, organisational and technical factors affecting the degree of accuracy and completeness of the HIV and ART data at facility level are described and presented in several sections below. Univariate analyses in frequency tables are shown first, followed by bivariate comparison and then correlation analyses.

5.2.1. Socio-demographic characteristics of participants

The background characteristics of respondents are shown in table 4 below. Results of the study shows that most respondents were females (94.2%) with no difference between nurses and data capturers. Study results shows that all (100%) data capturers were within the same age group (31-40 years) while nurses were unevenly distributed among age groups, with a preponderance (83.3%) in the age group 51-60 years and most importantly almost one third (31.2%) being close to retirement age at ≥61 years. In terms of work experience, study results show that data capturers were less experienced (2-9 years) as compared to nurses. This was expected as this a relatively new cadre of staff in the Eastern Cape province. Most nurses (83.3%) and data capturers (90.5%) claimed to have attended HIV and ART HIS trainings targeted mostly at their respective categories of staff. Education level, as expected was higher amongst nurses than data capturers.

Table 4: Socio-demographic characteristics of participants

Variables	All participants (n=69)		Professional nurses (n=48)		Data capturers (n=21)	
	No.	**%**	**No.**	**%**	**No.**	**%**
Sex:						
Male	4	5.8	3	6.2	1	4.8
Female	65	94.2	45	93.8	20	95.2
Age group (years):						
21 – 30	2	2.9	2	4.2	0	0
31 – 40	24	34.8	3	6.2	21	100
41 – 50	3	4.3	3	6.2	0	0
51 – 60	25	36.2	25	52.1	0	0
61+	15	21.7	15	31.2	0	0
Highest level of education:						
Matric	14	20.3	0	0	14	66.7
Diploma	39	56.5	32	66.7	7	33.3
Bachelor's Degree	11	15.9	11	22.9	0	0
Postgraduate Degree	5	7.2	5	10.4	0	0
Work experience (years):						
2 - 9	51	73.9	31	64.6	20	95.2
9 – 16	11	15.9	10	20.8	1	4.8
16 – 23	5	7.2	5	10.4	0	0
23 – 30	2	2.9	2	4.2	0	0
HIV and ART HIS trainings attended						
5-day Basic HIV & AIDS Data Management Course	42	60.9	40	83.3	2	9.5
TIER.Net (including data abstraction from HIV clinical records)	22	31.9	3	6.2	19	90.5
HIV clinical records completion	5	7.2	5	10.4	0	0

5.2.2. Behavioural factors

As highlighted in section 2.6 above, behavioural factors have been defined as human related factors such as values, attitudes, motivation, knowledge and skills (Aqil,2008). These have been highlighted in the literature as some of the factors contributing to poor data quality.

5.2.2.1. Competence of and confidence in health information system skills

Competence and confidence level scores for health information tasks are shown in Figure 6 below. Respondents were given a self-administered basic competence test based on viral load suppression data for adult patients on ART for 12 months over a period of five years and requested to plot the data on a bar graph, interpret it, suggest at least one way in which the resultant information could be used and explain at least three ways of checking data quality at facility level. The resulting information was used to calculate the indicators below on 'Competence'. Respondents' confidence levels in interpreting, using, plotting and checking data quality was obtained through using a 10-point Likert scale ranging from 0 to 10, with 0 indicating that they feel unable to perform the task and 10 indicating that they are extremely confident to perform the task. This was used to calculate the below indicators on 'Confidence'. Figure 3 below shows that despite eighty-six percent of participants claiming that they can check data quality, the actual skills assessment indicated that only 36% could do so. Similarly, 87% of the respondents claimed that they could use information to make appropriate actionable decisions, however the actual skills proficiency assessment indicates that only 13% could do so.

Figure 6: Competence in and reported confidence skills for various health information system tasks evaluated

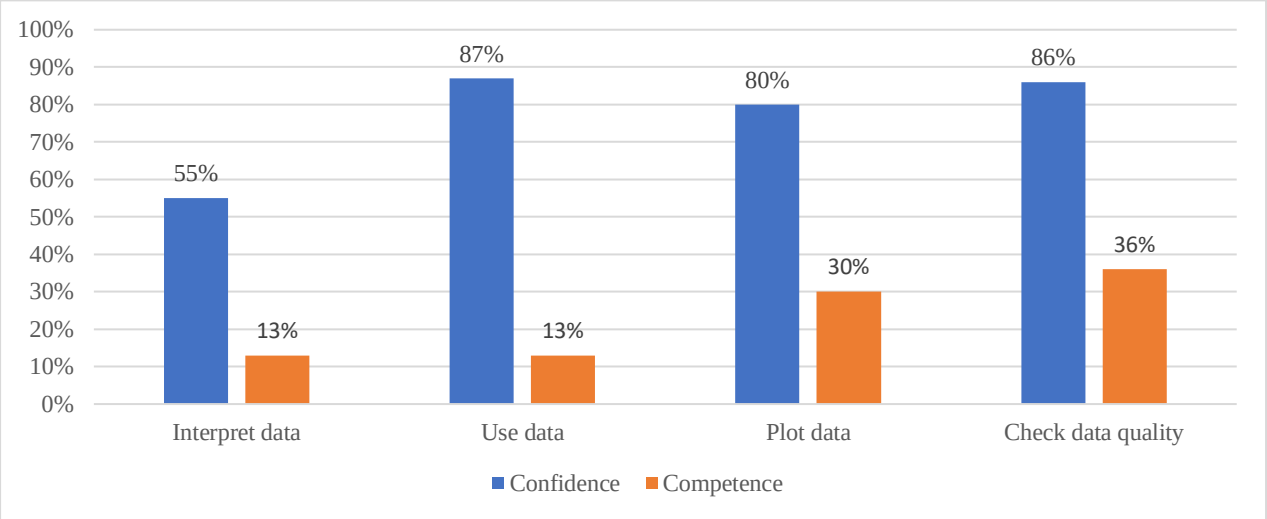
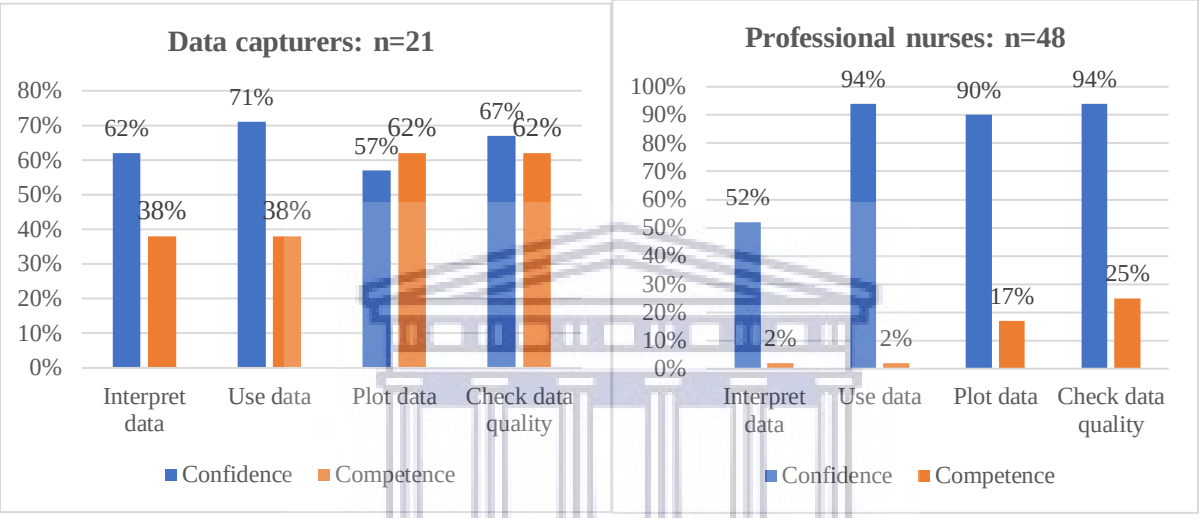


Figure 7 below contains the same analysis as figure 6 above, but it is stratified by staff category (Data capturers and Professional nurses). It shows that nurses had higher confidence levels compared to data capturers across all elements assessed. However, nurses demonstrated less objective competence in comparison to data capturers across all elements. Competencies for data interpretation and data use were low among both nurses and data capturers.

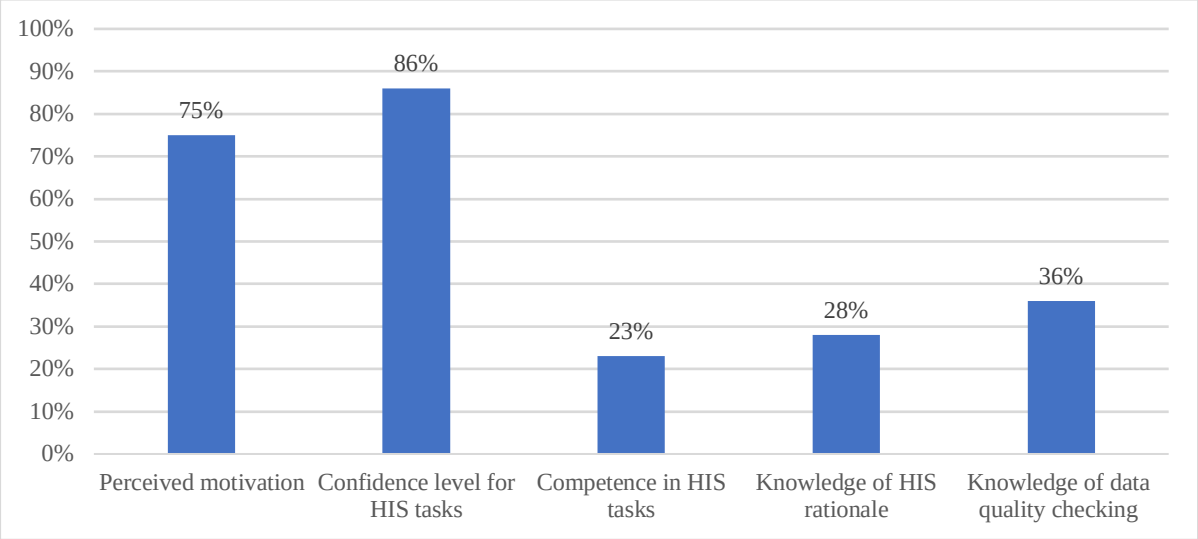
Figure 7: Competence in and reported confidence skills for various health information system tasks, stratified by staff category (Data capturers & Professional nurses)



5.2.2.2. Behavioural factor profile

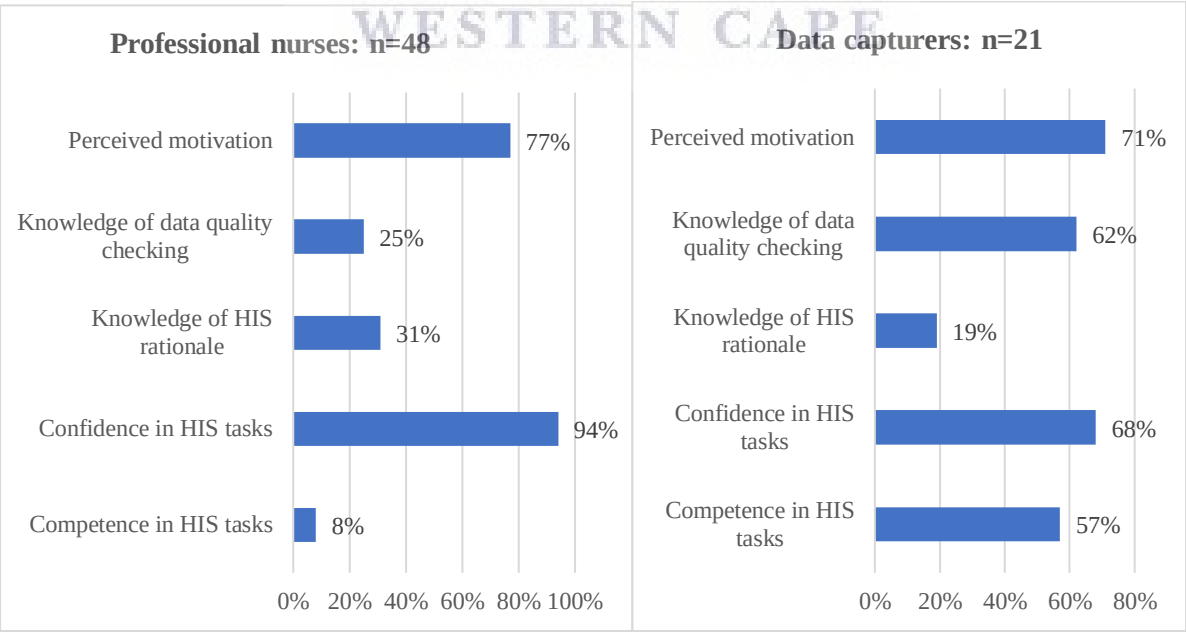
The average scores for each of the behavioural factors shown in figure 8 below are based on composite scores from variables of equal weighting. These scores were calculated based on various selected variables related to each of the behavioural factors (Appendix 6). Figure 8 shows that respondents' levels of confidence in health information system tasks (86%) were not proportionate to the overall levels of competence (23%). Similarly, respondents' levels of knowledge of data quality checking and knowledge of health information system rationale were low at 36% and 28% respectively. Respondents showed high levels of motivation (76%) in performing health information system tasks, despite their relatively low levels of knowledge and competence.

Figure 8: Behavioural factor scores (n=69)



Computing average scores by professional designation for each behavioural factor (*Figure 9 below*) indicates that professional nurses were more confident in performing health information system tasks (94%), compared with data capturers (68%). However, in as much as professional nurses were more confident in performing health information system tasks, data capturers were more competent (57%) in performing health information system tasks and more knowledgeable in checking data quality (62%) as compared to professional nurses, at 8% and 25% respectively.

Figure 9:Behavioural factors by professional designation



5.2.2.3. Association between socio-demographic characteristics and behavioural factors

A χ^2 test (Table 5) was used to evaluate the association between participants' socio-demographic characteristics and analogous behavioural determinants of health information system performance. Table 5 below shows that knowledge of checking data quality was positively associated with age (p=0.001), level of education (p=0.015), professional designation (p=0.003) and health information system (HIS) trainings attended (p=0.017). Confidence in HIS tasks was found to be positively associated with age (p<0.001), professional designation (p=0.007) and HIS trainings attended (p=0.033). On the other hand, competence in HIS tasks was positively associated with age (p=0.001), level of education (p=0.041), professional designation (P<0.001) and HIS trainings attended (p<0.001). In contrast, motivation and knowledge of HIS rationale were not associated with any socio-demographic characteristics.

Table 5:Percentage distribution of participants' socio-demographic characteristics by behavioural factors

			Behavioural factors				
Socio-demographic characteristics	N=69	%	Motivation (%)	Knowledge of data quality checking (%)	Knowledge of HIS rationale (%)	Confidence in HIS tasks (%)	Competence in HIS tasks (%)
Sex:							
Male	4	5.8	50.0	75.0	25.0	100.0	25.0
Female	65	94.2	76.9	33.8	27.7	15.4	23.1
P-value			*0.252*	*0.132*	*1.000*	*1.000*	*1.000*
Age group (years):							
21 – 30	2	2.9	50.0	100.0	50.0	50.0	50.0
31 – 40	24	34.8	75.0	54.2	16.7	70.8	50.4
41 – 50	3	4.3	100.0	33.0	0.0	33.3	0.0
51 – 60	25	36.2	72.0	36.0	36.0	100.0	12.0
61+	15	21.7	80.0	0.0	33.3	100.0	0.0
P-value			*0.768*	***0.001***	*0.334*	***< 0.001***	***0.001***
Highest level of education:							
Matric	14	20.3	71.4	57.1	14.3	71.4	50.0
Diploma	39	56.5	82.1	20.5	28.2	87.2	15.4
Bachelor's Degree	11	15.9	72.7	54.5	27.3	90.9	27.3
Postgraduate Degree	5	7.2	40.0	60.0	60.0	100.0	0.0
P-value			*0.190*	***0.015***	*0.274*	*0.464*	***0.041***
Designation:							
Professional nurse	48	69.6	77.1	25.0	31.2	93.8	8.3
Data capturers	21	30.4	71.4	61.9	19.0	66.7	57.1
P-value			*0.616*	***0.003***	*0.386*	***0.007***	***< 0.001***

Socio-demographic characteristics	N=69	%	Motivation (%)	Knowledge of data quality checking (%)	Knowledge of HIS rationale (%)	Confidence in HIS tasks (%)	Competence in HIS tasks (%)
Work experience (years):							
2 - 9	51	73.9	74.5	33.3	23.5	80.4	23.5
9 - 16	11	15.9	81.8	63.6	36.4	100.0	27.3
16 - 23	5	7.2	100.0	0.0	20.0	100.0	0.0
23 - 30	2	2.9	50.0	50.0	100.0	100.0	50.0
P-value			*0.875*	*0.051*	*0.128*	*0.416*	*0.533*
HIV and ART HIS trainings attended							
5-day Basic HIV & AIDS Data Management Course	42	60.9	76.2	23.8	38.1	92.9	7.1
TIER.Net	22	31.9	72.7	59.1	13.6	68.2	54.5
HIV clinical records completion	5	7.2	80.0	40.0	0.0	100.0	20.0
P-value			*0.906*	***0.017***	*0.052*	***0.033***	***< 0.001***

The association between socio-demographic characteristics and behavioural factors were analysed using Spearman's rank correlation and the findings are shown in table 6 below. The table shows that highest level of qualification had a weak but significant negative relationship with competence in health information system tasks. However, competence in health information system tasks had a significant moderate positive correlation with knowledge of checking data quality. Findings of the study further shows a weak but significant positive relationship between work experience and confidence in health information system. Attending HIV and ART health information system training had a weak but significant positive relationship with knowledge of health information system rationale but negatively correlated with knowledge of checking data quality. Additionally, findings of the study show that age had significant moderate positive relationships with knowledge of checking data quality, confidence and competence in health information system tasks.

Table 6: Association between socio-demographic and behavioural factors shown in a pairwise correlation matrix (p=0.05)

	Motivation	Knowledge of checking data quality	Knowledge of routine HIS rationale	Confidence in HIS tasks	Competence in HIS tasks	Gender	Current Age	Highest Qualifications	Job tittle	Work Experience	HIV and ART HIS trainings attended
Motivation	1										
Knowledge of checking data quality	**-0.409**** (0.000)	1									
Knowledge of routine HIS rationale	-0.024 (0.845)	0.008 (0.949)	1								
Confidence in HIS tasks	0.044 (0.718)	0.032 (0.792)	-0.069 (0.571)	1							
Competence in HIS tasks	-0.164 (0.178)	**0.515**** (0.000)	-0.031 (0.799)	0.164 (0.178)	1						
Gender	-0.146 (0.231)	0.200 (0.099)	-0.014 (0.909)	-0.102 (0.404)	0.011 (0.931)	1					
Current Age	-0.047 (0.700)	**0.443**** (0.000)	-0.142 (0.246)	**0.416**** (0.000)	**0.470**** (0.000)	0.177 (0.145)	1				
Highest Qualifications	0.096 (0.433)	-0.020 (0.869)	-0.185 (0.128)	0.209 (0.084)	**-0.243*** (0.044)	-0.068 (0.581)	**0.356**** (0.003)	1			
Job tittle	0.060 (0.622)	**-0.353**** (0.003)	0.126 (0.303)	**0.354**** (0.003)	**-0.532**** (0.000)	0.029 (0.811)	**-0.718**** (0.000)	**0.690**** (0.000)	1		
Work Experience	-0.021 (0.865)	-0.068 (0.579)	-0.163 (0.181)	**0.242*** (0.045)	0.019 (0.877)	-0.105 0.389	0.153 (0.209)	**0.308**** (0.010)	**-0.325**** (0.006)	1	
HIV and ART HIS trainings attended	0.016 (0.898)	**-0.298*** (0.013)	**0.304*** (0.011)	-0.214 (0.078)	**-0.427**** (0.000)	**-0.249*** (0.039)	**-0.685**** (0.000)	**-0.417**** (0.000)	**0.596**** (0.000)	**-0.330**** (0.006)	1

*. Correlation is significant at the 0.05 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

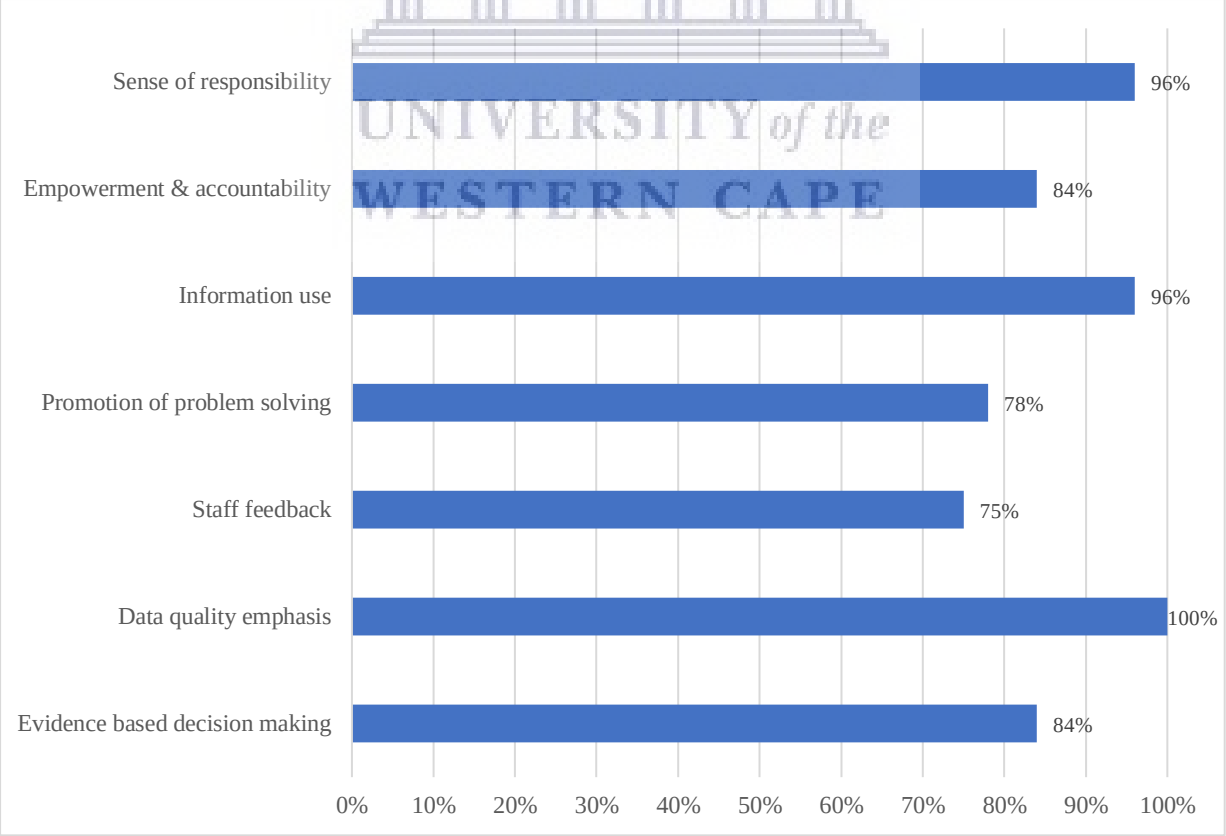
5.2.3. Organizational factors

The importance of organizational factors in routine health information systems performance has been highlighted in various literature (Aqil, Lippeveld & Hozumi, 2009). Organizational processes based on the PRISM framework were used to measure organizational factors affecting data quality. These include promotion of information use, evidence-based decision making, data quality emphasis, staff accountability and empowerment, promotion of problem solving, sense of responsibility, consideration of community and staff feedback.

5.2.3.1. Organizational factor profile

The average composite scores for each of the organizational factors recorded as 'agree' or 'strongly agree', which were measured as detailed in the data collection section above, are shown in Figure 10 below. All (100%) of the staff agreed that data quality is emphasised in the Department of Health and all the other organisational factors received an 'agree' or 'strongly agree' score from a high percentage of staff.

Figure 10: Composite scores for each of the organizational factors showing the percentage of staff who reported that they either 'agree' or 'strongly agree' with the issue described (n=69)



5.2.3.2. Association between socio-demographic characteristics and organizational factors

A chi square test (Table 7) with a significance level of p=0.05 (Table 8) was used to evaluate the association between participants' socio-demographic characteristics and corresponding organizational determinants of health information system performance. Table 7 below shows that work experience was positively associated with all organizational factors except empowerment & accountability. In contrast, gender was not associated with any of the organizational factors. All the other socio-demographic characteristics were positively associated with at most 50% of the organizational factors.

Table 7: Percentage distribution of participants' socio-demographic characteristics by organizational factors

			Organizational factors					
Socio-demographic Characteristics	N=69	%	Sense of responsibility	Information use	Evidence based decision making (%)	Staff feedback (%)	Promotion of problem solving (%)	Empowerment & Accountability (%)
Sex:								
Male	4	5.8	100.0	100.0	100.0	100.0	75.0	100.0
Female	65	94.2	95.4	98.5	83.1	73.8	78.4	83.1
P-value			*0.096*	*0.427*	*0.156*	*0.663*	*1.000*	*1.000*
Age group (years):								
21 – 30	2	2.9	100.0	100.0	100.0	100.0	50.0	50.0
31 – 40	24	34.8	95.9	95.8	91.7	75.0	62.5	79.2
41 – 50	3	4.3	100.0	100.0	100.0	100.0	100.0	100.0
51 – 60	25	36.2	92.0	92.0	100.0	92.0	80.0	96.0
61+	15	21.7	100.0	100.0	40.0	40.0	100.0	73.3
P-value			*0.667*	*0.395*	***<0.001***	***<0.001***	***<0.001***	*0.103*

Socio-demographic characteristics	N=69	%	Sense of responsibility	Information use	Evidence based decision making (%)	Staff feedback (%)	Promotion of problem solving (%)	Empowerment & accountability (%)
Highest level of education:								
Matric	14	20.3	100.0	100.0	100.0	85.7	57.2	100.0
Diploma	39	56.5	97.5	97.4	71.8	66.7	84.6	74.4
Bachelor's Degree	11	15.9	81.8	81.9	100.0	81.9	72.8	90.9
Postgraduate Degree	5	7.2	100.0	100.0	100.0	100.0	100.0	100.0
P-value			*0.347*	***0.008***	***0.007***	*0.227*	***0.002***	*0.099*
Designation:								
Professional nurse	48	69.6	95.8	95.9	81.3	77.1	87.4	85.4
Data capturers	21	30.4	95.2	95.2	90.4	71.5	57.1	81.0
P-value			*0.645*	*0.452*	*0.103*	***<0.001***	***0.004***	*0.725*
Work experience (years):								
2 - 9	51	73.9	98.0	98.0	78.4	70.6	74.5	78.4
9 - 16	11	15.9	100.0	100.0	100.0	100.0	100.0	100.0
16 - 23	5	7.2	100.0	100.0	100.0	100.0	100.0	100.0
23 - 30	2	2.9	0.0	0.0	100.0	0.0	0.0	100.0
P-value			***<0.001***	***<0.001***	***0.043***	***<0.001***	***0.001***	*0.277*
HIV and ART HIS trainings attended								
5-day Basic HIV & AIDS Data Management Course	42	60.9	95.2	95.3	78.6	69.0	90.5	88.1
TIER.Net	22	31.9	95.5	95.5	90.9	81.8	68.2	77.3
HIV clinical records completion	5	7.2	100.0	100.0	100.0	100.0	20.0	80.0
P-value			*0.104*	*0.135*	***0.002***	***0.001***	***<0.001***	*0.423*

**. Data quality emphasis was excluded due to 100% positivity rate.*

The correlation between socio-demographic characteristics and selected organizational factors as measured via Spearman's rank correlation, are shown in the correlation matrix in table 8, below. The table shows significantly moderate to strong positive relationship between perceived sense of responsibility, use of information, evidence-based decision making, data quality emphasis, staff feedback and promotion of problem solving. Attending HIV and ART HIS trainings showed extremely weak but significant positive relationship with perceived sense of responsibility, use of information and promotion of problem solving. Work experience on the other hand had significantly weak negative correlation with all organizational factors. Age, highest level of qualification and professional designation were shown in the study not to have significant correlation with any of the organizational factors.

Table 8: Association between socio-demographic and organizational factors shown using a correlation matrix (p=0.05)

	Sense of responsibility	Use of information	Evidence based decision making	Emphasis on data quality	Staff feedback f	Promoting problem solving	Empowerment & Accountability	Gender	Current Age	Highest Qualifications	Job tittle	Work Experience	HIV/ART HIS trainings attended
Sense of responsibility	1												
Use of information	**0.767**** (0.000)	1											
Evidence based decision making	**0.559**** (0.000)	**0.701**** (0.000)	1										
Emphasis on data quality	**0.408**** (0.001)	**0.614**** (0.000)	**0.603**** (0.000)	1									
Staff feedback	**0.571**** (0.000)	**0.631**** (0.000)	**0.734**** (0.000)	**0.609**** (0.000)	1								
Promotion of problem solving	**0.675**** (0.000)	**0.677**** (0.000)	**0.442**** (0.000)	**0.509**** (0.000)	**0.651**** (0.000)	1							
Empowerment & Accountability	**0.276*** (0.022)	**0.371**** (0.002)	**0.262*** (0.030)	0.124 (0.311)	**0.242*** (0.046)	**0.310**** (0.010)	1						
Gender	**0.256*** (0.034)	0.167 0.171	**0.251*** (0.038)	0.205 0.091	0.192 0.115	-0.119 (0.330)	0.108 (0.377)	1					
Current Age	-0.209 (0.085)	-0.136 (0.266)	0.039 (0.752)	0.071 (0.562)	0.036 (0.769)	-0.208 (0.086)	-0.044 (0.720)	0.177 (0.145)	1				
Highest Qualifications	0.115 (0.348)	0.006 (0.963)	-0.170 (0.162)	-0.185 (0.129)	-0.036 (0.768)	0.039 (0.750)	0.031 (0.800)	-0.068 (0.581)	**0.356**** (0.003)	1			
Job tittle	0.118 (0.332)	0.054 (0.659)	0.094 (0.443)	-0.033 (0.785)	0.070 (0.565)	0.122 (0.318)	0.056 (0.647)	0.029 (0.811)	**-0.718**** 0.000	**-0.690**** (0.000)	1		
Work Experience	**-0.260*** (0.031)	**-0.264*** (0.028)	**-0.281*** (0.019)	**-0.485**** (0.000)	**-0.443**** (0.000)	**-0.401**** (0.001)	**-0.256*** (0.034)	-0.105 (0.389)	0.153 (0.209)	**0.308**** (0.010)	**-0.325**** 0.006	1	
HIV/ART HIS trainings attended	**0.242*** (0.045)	**0.239*** (0.048)	-0.013 (0.918)	0.190 (0.118)	0.021 (0.864)	**0.451**** (0.000)	0.132 (0.281)	**-0.249*** (0.039)	**-0.685**** 0.000	**-0.417**** (0.000)	**0.596**** (0.000)	**-0.330**** 0.006	1

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

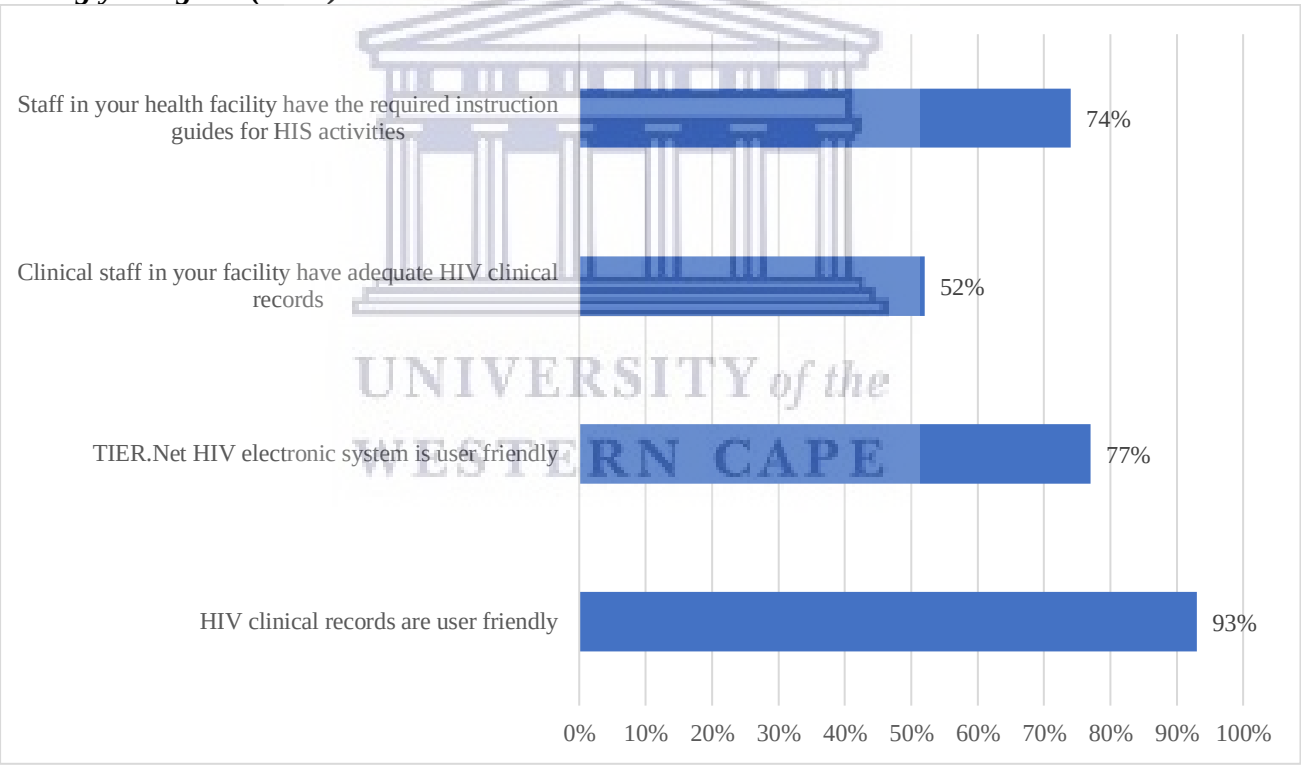
5.2.4. Technical factors

Skills and technology utilized in designing, managing and improving the processes of data collection, collation and analysis are referred to as technical determinants of health information systems. As highlighted in section 2.6 above, these include complexity of technology, reporting tools, standard operating procedure manuals and health information systems design.

5.2.4.1 Technical factor profile

The average scores for each of the technical factors previously described under data collection, are shown in figure 11 below. Most of the staff (93%) agreed that HIV clinical records are user friendly and all the other technical factors received an 'agree' or 'strongly agree' score from more than half of the staff.

Figure 11:Composite scores for each of the technical factors recorded as 'agree' or 'strongly disagree' (n=69)



5.2.4.2. Association between socio-demographic characteristics and technical factors

A chi square test (Table 9) with a significance level of p=0.05 (Table 10) was used to evaluate the association between participants' socio-demographic characteristics and corresponding technical determinants of health information system performance. Table 9 below shows that highest level of education was positively associated with all technical factors except. All the

other socio-demographic characteristics except for gender were positively associated with at least one but not more than three of the four technical factors.

Table 9: Percentage distribution of participants' socio-demographic characteristics by technical factors

			Technical factors			
Socio-demographic characteristics	N=69	%	HIV clinical records availability %	HIS instruction guides availability %	HIV clinical records user friendliness (%)	TIER.Net User friendliness (%)
Sex:						
Male	4	5.8	75.0	100.0	75.0	100.0
Female	65	94.2	50.8	72.3	93.9	75.4
P-value			*0.731*	*0.655*	*0.064*	*0.490*
Age group (years):						
21 – 30	2	2.9	100.0	50.0	50.0	100.0
31 – 40	24	34.8	54.2	83.4	83.3	91.6
41 – 50	3	4.3	100.0	33.3	100.0	33.3
51 – 60	25	36.2	60.0	92.0	100.0	88.0
61+	15	21.7	20.0	40.0	100.0	40.0
P-value			***<0.001***	***<0.001***	*0.206*	***<0.001***
Highest level of education:						
Matric	14	20.3	64.3	100.0	92.8	100.0
Diploma	39	56.5	35.9	61.5	92.3	59.0
Bachelor's Degree	11	15.9	72.7	72.7	90.9	100.0
Postgraduate Degree	5	7.2	100.0	100.0	100.0	100.0
P-value			***<0.001***	***0.002***	***0.001***	***<0.001***
Designation:						
Professional nurse	48	69.6	54.2	70.8	91.6	70.8
Data capturers	21	30.4	47.6	80.9	95.2	90.5
P-value			***0.041***	*0.616*	*0.429*	*0.330*

Socio-demographic Characteristics	N=69	%	HIV clinical records availability %	HIS instruction guides availability %	HIV clinical records user friendliness (%)	TIER.Net User friendliness (%)
Work experience (years):						
2 - 9	51	73.9	49.1	68.6	92.2	68.7
9 - 16	11	15.9	36.4	100.0	90.9	100.0
16 - 23	5	7.2	100.0	100.0	100.0	100.0
23 - 30	2	2.9	100.0	0.0	100.0	100.0
P-value			***0.012***	***<0.001***	*0.100*	***0.015***
HIV and ART HIS trainings attended						
5-day Basic HIV & AIDS Data Management Course	42	60.9	50.0	66.7	100.0	73.9
TIER.Net	22	31.9	59.1	81.8	81.8	90.9
HIV clinical records completion	5	7.2	40.0	100.0	80.0	40.0
P-value			***0.021***	***0.012***	***0.007***	*0.114*

The association between socio-demographic characteristics and technical factors were analysed using Spearman's rank correlation and the findings are shown in table 10 below. The analysis shows a significant strong positive correlation between perceived TIER.Net user friendliness and availability of health information systems instruction guides. On the other hand, perceived user friendliness of HIV clinical records had weak positive but significant relationships with highest levels of qualification and age.

Table 10: Association between socio-demographic and technical factors shown using a correlation matrix (p=0.05)

	HIV clinical records availability	HIS instruction guides availability	HIV clinical records user friendliness	TIER.Net user friendliness	Gender	Current age	Highest qualifications	Job tittle	Work experience	HIV and ART HIS trainings attended
HIV clinical records availability	1									
HIS instruction guides availability	0.172 (0.158)	1								
HIV clinical records user friendliness	-0.009 (0.943)	**-0.273*** (0.023)	1							
TIER.Net user friendliness	**0.368**** (0.002)	**0.777**** (0.000)	**-0.438**** (0.000)	1						
Gender	0.087 (0.478)	0.108 (0.379)	-0.018 (0.883)	0.015 (0.903)	1					
Current Age	0.145 (0.235)	0.022 (0.860)	**0.297*** (0.013)	0.160 (0.189)	0.177 (0.145)	1				
Highest qualifications	-0.206 (0.089)	0.206 (0.089)	**0.250*** (0.038)	0.131 (0.282)	-0.068 (0.581)	**0.356**** (0.003)	1			
Job tittle	0.048 (0.694)	-0.044 (0.718)	-0.080 (0.514)	-0.229 (0.058)	0.029 (0.811)	**-0.718**** (0.000)	**-0.690**** (0.000)	1		
Work experience	-0.035 (0.772)	-0.229 (0.058)	0.144 (0.237)	-0.214 (0.078)	-0.105 (0.389)	0.153 (0.209)	**0.308**** (0.010)	**-0.325**** (0.006)	1	
HIV and ART HIS trainings attended	0.073 (0.550)	0.020 (0.871)	**-0.369**** (0.002)	0.068 (0.579)	**-0.249*** (0.039)	**-.0685**** (0.000)	**-0.417**** (0.000)	**0.596**** (0.000)	**-0.330**** (0.006)	1

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

CHAPTER 6: DISCUSSION

6.1. Chapter overview

This chapter provides a discussion of the level of accuracy and completeness of HIV and ART data through the transmission chain, from initial paper-based patient records to the TIER.Net electronic system, and comments on the factors influencing the degree of accuracy and completeness of that data.

6.2. HIV clinical records and TIER.Net system completeness

This study suggests that the level of completeness of data in the HIV paper clinical records and in the electronic TIER.Net system in Enock Mgjima sub-district requires attention. The average completeness of HIV paper records was found to be 45%, which is lower than data completeness of a similar study conducted in a large HIV clinic in Mozambique, that noted 72% and 65% overall data elements completeness for enrolment and follow-up visits respectively (Young et al, 2010). The low level of completeness means that the paper-based records are inadequate for evidence-based decision making. Major gaps were noted in the recording of critical ART baseline information and subsequent treatment visit information in the HIV clinical paper records. These results are consistent with similar studies conducted by Lowrance et al (2007), Lowrance et al (2009) and Young et al (2010) in Malawi, Rwanda and Mozambique respectively, where gross deficiencies were noted in the recording of important quality of care data elements. In contrast the electronic TIER.Net system was much better than that found in Mozambique with a completeness level of 82%. The low levels of completeness in the paper records can perhaps be attributed to the duplicate capturing in TIER.Net and hence less enthusiasm for complete recording in the paper records by clinicians.

Unlike the Lowrance et al. (2009) study in Rwanda, which found that completeness of six and twelve-months CD4 cell counts in medical records was 49% and 35% respectively but did not specify whether the problem was with the clinical recording of data or with the laboratory data documentation; in this study six and twelve-months CD4 cell counts were 57% and 44% complete respectively, and directly attributed to poor paper record keeping by clinicians, as these results were available on the NHLS laboratory forms. Program managers in Enock Mgijima sub-district can use this information to further enhance recording by clinicians through regular data feedback at facility level.

This study noted that all variables in the electronic TIER.Net system with the exception of CD4 counts, viral load and next appointment were 100% complete in TIER.Net. These findings confirm those of a similar study conducted by Lambdin et al. (2012) evaluating availability of data in a HIV electronic system in central Mozambique, which noted high levels of completeness for most variables. Even though variables in our study with 100% completeness in the electronic TIER.Net system have much lower completeness levels in the primary source of data (HIV paper records), the high completeness levels noted in the electronic TIER.Net system is superficial. This is because the electronic TIER.Net system allows data capturers to capture '*Unknown or Not Sure'* for most of the variables, with the exception of demographics and laboratory investigations, when there is incomplete data in the HIV paper records. The effective completeness with definitive data is therefore far lower that the nominal 82% completeness and hence this calls for a review of the electronic TIER.Net system functionalities, to ensure that it compels data capturers to capture definitive data only. This means that data capturers would then have to return incomplete HIV paper clinical records to the clinicians and request them to update the paper records to allow for electronic data capturing. Completeness of both paper and electronic records would be further enhanced if program managers conducted routine paper file audits, in order to identify and address challenges with clinical recording, to ensure availability of complete data for data capturers to transcribe into the electronic TIER.Net system.

6.3. HIV clinical records and TIER.Net system accuracy

The study findings indicate adequate data concordance (90%) for variables completed in both the HIV clinical records and the electronic TIER.Net system, indicating accurate abstraction of available data from the HIV paper records into the electronic TIER.Net system by data capturers. These findings are consistent with those of a similar study alluded to in 5.1.1 above done by Lambdin et al. (2012) in Mozambique, which noted above 92% levels of concordance for all variables between HIV patient charts and an electronic HIV patient tracking system. However, since data was missing for 55% of variables on the paper forms, accuracy as measured by concordance could only be assessed for 45% of the variables. Therefore, the importance of complete data collection for a patient encounter through the entire transcription process, should be emphasized by program managers during site support visits, in order to resolve these issues.

6.4. Factors influencing data quality (accuracy & completeness)

Chapter 2 describes potential factors that affect data quality. These have been divided into organizational, behavioral and technical factors based on the PRISM framework.

6.4.1 Socio-demographic characteristics of participants

The study shows that demographic features for professional nurses and data capturers were homogenous within each group (i.e. the professional nurse group and the data capturer group) but were quite different between the two groups. Data capturers were all young (31- 40 years) matriculants, one third of whom also had a diploma. Professional nurses on the other hand were older (83.3% aged between 51 and 60 years) and more highly educated, with all having a post-matric diploma or higher tertiary education, as this is a requirement for them to register and work as a professional nurse. This massive and stark difference between the two groups means that the ability to assess associations was negatively impacted, as several of the variables would be severely confounded by "job title", as data capturers were younger, less educated, and received a different type of HIS training from that of the nurses. On the other hand, nurses were more confident as a group probably because of their professional status, and additionally they have been working for longer and hence have more work experience.

6.4.2. Behavioral factors

This study has revealed that even though nursing staff displayed high levels of confidence (94%) in health information system tasks, they lack the actual competence in performing HIS related tasks with only 8% demonstrating competence. Conversely, data capturers although reporting less confidence in their ability to perform HIS related tasks (68% confident), they demonstrated much greater competence (57% competent) than the nurses. Worryingly competence was only assessed on the most basic of HIS functions such as how to plot, interpret and use data in decision making, which should easily be within the capability of nurses and yet the performance of nurses was extremely poor. The results are illustrative of nurses being quite unaware of their inabilities and hence would probably be reluctant to undergo training on activities which they 'already know how to do'. These findings are consistent with that of a similar study conducted by Nicol, Dudley & Bradshaw (2016) evaluating the quality of PMTCT outcome indicators and factors affecting data quality in two districts (Amajuba-KwaZulu Natal Province & Cape Metro-Western Cape Province) in South Africa, which noted that only 30% of respondents could perform the previously alluded to tasks, even though they

showed high levels of confidence and motivation. This calls for the implementation of creative capacity building interventions such as mentoring and coaching which ensure engagement of service providers and allows opportunity for continuous constructive feedback and simulated learning practices. These should be planned and delivered on a low-dose, high-frequency (LDHF) basis to address the 'know-do' gap at the point of service and generate sustained performance improvement, rather than formal training sessions, aimed at improving primarily nurses, but also data capturers skills and knowledge in routine health information system tasks.

Knowledge of data quality checking was found to be positively correlated with competence and age but negatively correlated with job title and health information system training. However, since age is confounded by job title (nurses were much older) and training is also confounded by job title (nurses were much more likely to attend the 5-day basic HIV & AIDS data management training), this implies that true significant correlation only exists between job title and competence. The difference in outcome correlation between the two job categories (nurses less competent than data capturers) can be explained by the fact that management of health information system is a daily routine for data capturers, but is a minor tangential activity for nurses, who are as expected more focused on patient care, and hence they are not as competent at data quality checking than the data capturers.

The study also shows that knowledge of health information system rationale was positively correlated with training, implying that attending health information system trainings positively influences data quality. These results are contrary to those of a similar study conducted by Nicol, Dudley & Bradshaw (2016) highlighted above which showed no correlation between attending health information system trainings and knowledge of health information system rationale. To this end, the above noted positive correlation in this study can probably be due to confounding effect as nurses (who mainly attended the training) were better versed in the theoretical use-value of health information systems, while data capturers were better technically at operating health information systems. This is not an unexpected result as nurses would be more interested in the outputs from the health information system since the outputs might assist them with overall patient care. Whereas data capturers are likely to be more focused on the mechanics of performing functions required within the health information system rather than the outputs from it, as they would not directly use those outputs.

Confidence in health information tasks was found to be positively correlated with age but negatively correlated with job title. This result is contrary to those of a similar study conducted by Nicol, Dudley & Bradshaw (2016) alluded to, which showed no correlation between these variables. This implies that the above noted correlations in this study might probably again be due to a confounding effect. This is because nurses were much older and more confident, despite having a lower competence than data capturers. As noted above confidence amongst the nurses is likely to have been boosted by their professional status while data capturers were less confident, perhaps due to a natural reticence related to being lower rung employees.

Additionally, this study found that competence in health information system tasks was negatively correlated with the highest level of qualification, suggesting that the higher the level of education an individual has, the lower the competence levels in performing tasks related to health information systems. These results are inconsistent with those of a similar study conducted by Nicol, Dudley & Bradshaw (2016) highlighted above, which showed a positive correlation between education and health information system competence. Furthermore, Nicol, Dudley & Bradshaw (2016) in their study noted a positive relationship between education and professional designation. This is consistent with results of this study which showed a positive relationship between levels of education and professional designation. Attending HIV and ART HIS trainings were found to be positively correlated with knowledge of routine health information systems rationale and with job title. The training aspect is consistent with results of an intervention study conducted by Mphatswe et al (2012) which showed a positive relationship between training staff on how to collect routine data and increased awareness on the importance of data quality in decision making. The job title correlation is purely because a particular training course was provided to nurses only, as noted previously. Similarly, the noted strong correlation between job title and age was because nurses were much older than data capturers.

Even though the study noted high levels of motivation (76%) among personnel in performing health information system tasks, this didn't translate into improved data quality. In fact, it was the complete opposite, with high motivation being negatively correlated with 'knowledge of checking data quality'. These results contradict findings of studies conducted by Lorenzi et al. (1997) and Hotchkiss et al. (2010) which highlighted motivation as an important determinant of data quality. To this end, it is very logical to conclude that other factors besides motivation are influencing the quality of data in Enock Mgijima sub-district, and/or that the measurement used for motivation in this study only measures this variable at a superficial face-value level,

and/or that there is a social desirability bias with staff feeling obliged to report that they feel motivated, even if they don't, as it is expected that staff would use health information to assist in improving the health services.

6.4.3. Organizational factors

Study findings show above average levels for perceptions that the health service organisation positively reinforces high data quality (100%), encourages empowerment & accountability (84%), promotes problem solving (78%), values staff feedback (78%), engenders a sense of responsibility and applauds use of information (96% respectively). These scores are slightly higher compared to those of a similar study conducted by Nicol, Dudley & Bradshaw (2016) in South Africa, wherein the scores for the same organizational elements ranged between 71% and 78%. Despite these high scores noted in this study, this has not translated into adequate data quality in Enock Mgijima sub-district. This might be explained by the fact that even though most nurses (83%) and data capturers (91%) claimed to have attended targeted HIV and ART HIS didactic trainings, they still lack adequate skills to carry out routine health information tasks such as data quality checking, data interpretation and use, as only 23% could do so. Insufficient HIS skills among healthcare workers have been highlighted by Burn and Shongwe (2004), Garrib et al. (2008) and MEASURE Evaluation (2010) as a major factor affecting data quality in healthcare settings. This calls into questioning the focus and adequacy of the training as well as post training support and perhaps calls for program managers to review the HIV and ART HIS course content, the aptitude of facilitators, the way the training is delivered to participants and the post-training mentoring, with a view to ensuring practical retention and use of skills learnt to improve data quality.

This study also found that perceived empowerment & accountability was positively associated with a sense of responsibility, implying that empowering staff in decision making and holding them accountable for poor performance has the potential to improve staff awareness of their obligations. However, this has not translated into improved data quality. This calls into questioning the quality of supervision provided by facility and programme managers. Doherty et.al (2009) and Ferguson et. al. (2012) in studies evaluating the accuracy of routinely collected PMTCT data in South Africa and Kenya respectively, noted lapses in supervision of clinic staff as a contributor to inaccurate data quality at facility level. To this end, implementation of performance indicators aimed at tracking supervision effectiveness becomes paramount.

A perception by staff that they received sufficient feedback, on the other hand, was found to be significantly correlated with promotion of problem solving and use of information. This finding is consistent with results of similar studies conducted by Garrib et al. (2008), Hotchkiss et al. (2010) and English et al. (2011) which noted lack of feedback at various levels of the health system as a determinant of non-use of information and poor data quality. To this end, in order to improve data quality, it is imperative that program managers give staff autonomy to make decisions in their daily work, at the same time providing timely high-quality supervisory feedback.

Work experience was noted in the study as negatively correlated with all organizational factors, implying that the greater the number of years an individual has worked, the less they perceive that the health service organisation positively reinforces high data quality, encourages empowerment & accountability, promotes problem solving, values staff feedback, engenders a sense of responsibility and applauds use of information. This can probably be attributed to confounding effect as nurses as a group have been working for longer, hence they have more work experience compared to data capturers.

6.4.4. Technical factors

The study showed that most respondents (93%) perceive HIV paper clinical records as being user friendly, even though this didn't translate into improved completeness of the HIV paper records. This can be attributed to our study finding that very few nurses (10%) were trained on how to complete HIV clinical records. On the other hand, the electronic TIER.Net was perceived as user friendly by most (77%) respondents and by 90.5% of data capturers and this translated into adequate completeness and accuracy of data captured into the electronic system. This can be attributed to our study finding that most data capturers were trained on the electronic TIER.Net system, including how to abstract data from the HIV paper clinical records. Our study results highlight the importance of adequate training of facility staff on data collection processes. To this end, program managers should ensure that completion of HIV paper records forms part of the nurse initiated and managed antiretroviral therapy (NIMART) training for nurses, followed by continuous onsite mentorship and supportive supervision.

Availability of reporting tools is a critical factor in effectively implementing routine health information systems. HIV paper records are the primary source of data for the electronic TIER.Net system. To this end it is critical to ensure seamless availability of these to ensure timeous and complete recording of patients' clinical visit assessments. The study findings have

revealed that many nurses and data capturers (48%) perceive availability of HIV paper records in their facilities as inadequate, even though they perceive them as user friendly (93%). These perceived stock-outs, even though our study did not focus on verifying the assertions, might also be contributing to the observed incompleteness of HIV paper records, as nurses will be forced to recall and update patient information when stock becomes available. This probably shows that facility managers as the accounting officers of their respective health facilities are not adhering to the prescripts of the 'Department of Health Integrated TB/HIV Data Management Standard Operating Procedure' (2019), which requires them to maintain at least three months buffer stock of HIV paper clinical records. To this end, program managers must always monitor availability of adequate HIV paper records during their routine supportive supervision and emphasize the importance of adhering to the above alluded to SOP.

The study found a significant strong positive correlation between perceived TIER.Net user friendliness and availability of health information systems instruction guides, confirming findings of a study conducted by Mishra et al.(2012) and Teklegiorgis et al. (2016) alluded to above, which showed that data quality is influenced by the user friendliness of the health information system and availability of health information systems instruction guides. Since the one seems to also reinforce the other (user-friendly forms tend to be more available since staff clearly want them) there is positive reinforcement, which then impacts on improved data quality.

Perceived user friendliness of HIV clinical records was noted in the study as positively correlated with education levels, implying that the more educated an individual is, the more user friendly they perceive the HIV clinical records. Since nurses were highly educated with all having a diploma or higher tertiary education, one would have expected them not to struggle completing the HIV clinical records. However, judging from the incompleteness of the HIV clinical records, nurses seem reluctant to complete them for some other unspecified reasons other than them being user unfriendly. To this end, programme managers should include data management as part of the key performance areas for nurses, in order to improve data quality. The study also noted that perceived user friendliness of HIV clinical records was negatively correlated with HIV and ART health information system trainings. These results are contrary to those of studies conducted by Cristofari et al. (2009) and Mphatswe et al. (2012), which showed a positive relationship between training staff on health information systems and improved data quality.

6.5. Limitations of the study

The study had both weaknesses and strengths. The first strength was that all sample size records (100%) were found and reviewed in the clinics. Secondly, all sampled study participants (nurses & data capturers) were interviewed. This 100% success rate is attributed to repeated visits to facilities as some of the participants were either not on duty or busy during the interview visits. Possible conflict regarding role of the researcher, and his employment in relation to the research subjects was addressed through employment of two research assistants with no power relationships with the study participants to conduct the interviews.

The first limitation of the study is that we used semi-structured questionnaires which included closed-ended questions which have the potential to limit the possibility of in-depth understanding of the factors affecting data quality through probing questions. Secondly, in as much as the ecological study design used enables determination of the levels of relationships between dependent and independent variables, it does not allow establishment of causality. Thirdly, linking individual clinicians to data captured by those individuals was tenuous due to a lack of a data trail and was also likely to be intimidating to the staff, thereby limiting the ability to compare the factors affecting data quality directly from individual staff.

Also, even though the study sought to forecast determinants of data accuracy through multivariate logistic regression analysis, the number of eligible facilities (n=21) limited the ability to conduct a high-level analysis. The study focused only on primary care facilities, with the three hospitals in the sub-district excluded, as they are no longer keeping ART patients beyond the admission period, due to the decentralization of the ART programme to PHC facilities. This implies that results of the study are not generalizable for hospitals.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

Completeness and accuracy levels of HIV and ART data: Results of the study show that HIV and ART data generated and reported by Enock Mgijima sub-district is inadequate for evidence-based decision making. This is due to the low levels of completeness noted in the HIV paper records characterized by unavailability of crucial patient management information and the low levels of completeness for definitive data noted in the electronic TIER.Net system. High levels of concordance were however noted for variables completed in both the HIV clinical records and the electronic TIER.Net system. There is a need to include data management as part of the key performance areas for nurses to enhance completeness of the HIV paper records.

Behavioral factors influencing the degree of accuracy and completeness: Results of the study reveal that even though nursing staff showed high levels of confidence in performing health information systems tasks, they lacked actual skills and competence in performing basic health information system tasks as compared to data capturers even though they had received formal didactic training. This calls for a different approach to capacity building aimed at addressing the 'know-do' gap at the point of service, such as the low-dose high-frequency approach.

Organizational factors influencing the degree of accuracy and completeness: The study results suggest that there is limited supportive supervision being provided to health facilities. This is because although the DoH emphasizes data quality, facility staff, primarily nursing staff, seem not to prioritize health information systems tasks, which is an indication that they are not being held accountable for poor data quality. The importance of empowering staff and holding them accountable for poor performance was further emphasized by the positive association between sense of responsibility and perceived empowerment & accountability. To this end, Department of Health programme managers should provide adequate supportive supervision to health facilities to enhance prioritization of health information systems tasks.

Technical factors influencing the degree of accuracy and completeness: The study shows challenges in the availability of HIV paper records in health facilities. Even though the study did not focus on verifying the extent and the reasons for stock-outs, this might also be contributing to the noted incompleteness of paper records. The stock-outs also imply that

facility managers are not keeping buffer stocks of at least three months as prescribed in the Department of Health Integrated TB/HIV Data Management Standard Operating Procedure. For this reason, Department of Health programme managers should develop strategies aimed at enhancing availability of HIV paper records in health facilities and re-orient facility managers on their roles and responsibilities as espoused in the Integrated TB/HIV Data Management Standard Operating Procedure.

7.2 Recommendations

7.2.1 Practical and Policy Recommendations

Based on the study results, the researcher recommends the following:

1. The Department of Health should develop and implement creative capacity building interventions such as the low-dose high-frequency approaches aimed at addressing the 'know-do' gap, rather than the traditional formal didactic training sessions which have shown to be less effective in improving skills in routine health information system tasks.
2. To enhance supportive supervision, the Department of Health should develop and implement performance indicators aimed at tracking the effectiveness of supervision, rather than just counting the number of supervisory visits conducted, as they currently do.
3. To enhance completeness of the HIV clinical records, programme managers should include data management as part of the key performance areas for nurses.
4. The electronic TIER.Net system technical functionalities should be reviewed to ensure that it induces data capturers to capture definitive data only.

7.2.2 Future Research Recommendations

1. The small study sample limited the ability of the study to conduct a high-level analysis in order to predict determinants of data accuracy. To this end, the researcher recommends conducting a similar study with a bigger sample size in order to explore potential factors influencing data accuracy.
2. In order to enhance the ability to compare factors affecting data quality directly from individual staff, future research on this topic should focus on linking individual clinicians to data captured by those individuals where data trail is available.

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APPENDICES

Appendix 1: Patient folder sampling frame

Health facilities included in the study		Population	Sample size
1	A	332	55
2	B	203	55
3	C	167	55
4	D	147	55
5	E	144	55
6	F	132	55
7	G	107	55
8	H	91	55
9	I	76	55
10	J	70	55
11	K	69	55
12	L	67	55
13	M	56	55
14	N	55	55
15	O	52	52
16	P	52	52
17	Q	44	44
18	R	40	40
19	S	33	33
20	T	33	33
21	U	30	30
Total		**2000**	**1054**

	Health facilities excluded from the study due to small population sizes	Population	
22	AA	17	N/A; not sampled
23	BB	15	N/A; not sampled
24	CC	14	N/A; not sampled
25	DD	13	N/A; not sampled
26	EE	13	N/A; not sampled
27	FF	12	N/A; not sampled
28	GG	11	N/A; not sampled
29	HH	11	N/A; not sampled
30	JJ	11	N/A; not sampled
31	KK	10	N/A; not sampled
32	LL	10	N/A; not sampled
33	MM	10	N/A; not sampled
34	NN	8	N/A; not sampled
35	PP	8	N/A; not sampled
36	QQ	7	N/A; not sampled
37	RR	3	N/A; not sampled
Total		**173**	N/A; not sampled

Appendix 2: Nurses sampling frame

Health facilities included in the study		Study population	Sample size
1	A	3	3
2	B	3	3
3	C	3	3
4	D	3	3
5	E	3	3
6	F	3	3
7	G	2	2
8	H	2	2
9	I	2	2
10	J	2	2
11	K	2	2
12	L	2	2
13	M	2	2
14	N	2	2
15	O	2	2
16	P	2	2
17	Q	2	2
18	R	2	2
19	S	2	2
20	T	2	2
21	U	2	2
Total		**48**	**48**

	Health facilities excluded from the study due to small population sizes	Population	
22	AA	2	N/A; not sampled
23	BB	2	N/A; not sampled
24	CC	2	N/A; not sampled
25	DD	2	N/A; not sampled
26	EE	2	N/A; not sampled
27	FF	1	N/A; not sampled
28	GG	2	N/A; not sampled
29	HH	2	N/A; not sampled
30	JJ	1	N/A; not sampled
31	KK	1	N/A; not sampled
32	LL	2	N/A; not sampled
33	MM	1	N/A; not sampled
34	NN	2	N/A; not sampled
35	PP	1	N/A; not sampled
36	QQ	1	N/A; not sampled
37	RR	1	N/A; not sampled
Total		**25**	N/A; not sampled

Appendix 3: Data elements for accuracy review in the HIV clinical record and TIER.Net

	Data Element	Definition	HIV clinical record	TIER.Net
Patient details	Patient name	Name of patient captured in the TIER.Net system is consistent with the HIV clinical record		x
	Patient Surname	Surname of patient captured in the TIER.Net system is consistent with the HIV clinical record		x
	Date of birth	Date of birth captured in the TIER.Net system is consistent with the HIV clinical record		x
	Gender	Gender captured in the TIER.Net system is consistent with the HIV clinical record		x
ART baseline information	ART start date	ART start date captured in the TIER.Net system is consistent with the HIV clinical record		x
	Method into ART	Method into ART captured in the TIER.Net system is consistent with the HIV clinical record		x
	Pregnancy status at ART start	Pregnancy status at ART start captured in the TIER.Net system is consistent with the HIV clinical record		x
	WHO stage at ART start	WHO stage at ART start captured in the TIER.Net system is consistent with the HIV clinical record		x
	TB treatment status at ART start	TB treatment status at ART start captured in the TIER.Net system is consistent with the HIV clinical record		x
	IPT status at ART start	IPT status at ART start captured in the TIER.Net system is consistent with the HIV clinical record		x

	CPT status at ART start	CPT status at ART start captured in the TIER.Net system is consistent with the HIV clinical record		x
	Baseline CD4 count	Baseline CD4 count results recorded in both the TIER.Net and the HIV clinical record (if bloods were taken) are consistent with the original laboratory test report	x	x
Treatment visit information	Visit date	Date of visit captured in the TIER.Net system is consistent with the HIV clinical record		x
	Health Provider	Health provider captured in the TIER.Net system is consistent with the HIV clinical record		x
	Pregnancy status	Pregnancy status captured for females in the TIER.Net system is consistent with the HIV clinical record		x
	TB screening status	TB screening status captured in the TIER.Net system is consistent with the HIV clinical record		x
	IPT status	IPT status captured in the TIER.Net system is consistent with the HIV clinical record		x
	6 months viral load result	6 months viral load results recorded in both the TIER.Net system and the HIV clinical record (if bloods were taken) are consistent with the original laboratory test report	x	x
	12 months viral load result	12 months viral load results recorded in both the TIER.Net system and the HIV clinical record (if bloods were taken) are consistent with the laboratory test report	x	x
	12 months CD4 count result	12 months CD4 count result recorded in both the TIER.Net system and the HIV clinical record (if	x	x

		bloods were taken) are consistent with the laboratory test report		
	ARVs prescribed	ARVs prescribed captured in the TIER.Net system is consistent with the HIV clinical record		x
	Months ART prescribed	Months ART prescribed captured in the TIER.Net system is consistent with the HIV clinical record		x
	Next clinical appointment date	Next clinical appointment date captured in the TIER.Net system is consistent with the HIV clinical record		x

Appendix 4: Data elements reviewed for completeness in the HIV clinical record and TIER.Net

	Data element	Definition	HIV clinical record	TIER.Net
Patient details	Patient name	Name of patient recorded	x	x
	Patient Surname	Surname of patient recorded	x	x
	Date of birth	Date of birth recorded	x	x
	Gender	Gender recorded	x	x
ART baseline information	ART start date	ART start date recorded	x	x
	Method into ART	Method into ART recorded	x	x
	Pregnancy status at ART start	Pregnancy status at ART start recorded	x	x
	WHO stage at ART start	WHO stage at ART start recorded	x	x
	TB treatment status at ART start	TB treatment status at ART start recorded	x	x
	IPT status at ART start	IPT status at ART start recorded	x	x
	CPT status at ART start	CPT status at ART start recorded	x	x
	Baseline CD4 count (if bloods were taken)	Baseline CD4 count recorded (if bloods were taken)	x	x
Treatment visit information	Visit date	Date of visit recorded	x	x
	Health Provider	Health provider recorded	x	x
	Pregnancy status	Pregnancy status recorded in female	x	x
	TB screening status	Tb screening status recorded	x	x
	IPT status	IPT status recorded	x	x
	6 months viral load result	6 months viral load result recorded (if bloods were taken)	x	x
	12 months viral load result	12 months viral load result recorded (if bloods were taken)	x	x

	12 months CD4 count result	12 months CD4 count result recorded (if bloods were taken)	x	x
	ARVs prescribed	ARVs prescribed recorded	x	x
	Months ART prescribed	Months ART prescribed recorded	x	x
	Next clinical appointment date	Next clinical appointment date recorded	x	x

Appendix 5: TIER.Net HIV electronic system training curriculum

Training modules	Topics covered
1. What is HIV?	• Introduction to HIV • Stages of HIV • HIV and the human body • Treating HIV
2. HIV and TB	• TB transmission • HIV and TB • Diagnosing TB
3. Using TIER.Net	• How to use TIER.Net system and its controls • How to navigate TIER.Net - how to search for a patient - how to enter a new patient - how to view and edit patient details • HCT - how to navigate the HCT sub-module - how to enter a HIV test result • PRE-ART - how to enter baseline enrolment data - how to enter work-up data - how to read the pre-treatment visits calendar - how to enter pre-treatment visit data - how to make changes to a pre-treatment visit - how to enter a CD4 blood result - how to enter outcome data • ART - how to enter ART baseline data - how to read the treatment visits calendar - how to enter treatment visit data - how to make changes to a treatment visit - how to enter a CD4 or viral load blood result - how to enter an outstanding blood result - how to enter ART outcome data - how to capture patient details in backlog mode - how to create back-ups and dispatches - how to run reports

Appendix 6. Data collection forms

1. Data quality assessment tool

SECTION A: Assessment of the completeness of HIV clinical records & TIER.Net HIV electronic system

	HIV clinical record: Available (1=Yes; 0=No)			**HIV electronic system (TIER.Net):** Available (1=Yes; 0=No)		
	Patient details	**ART baseline information**	**Treatment visit information: (**Consider all the last 12 patient visits documented before selecting *"1"or "0"* for each of the variables)	**Patient details**	**ART baseline information**	**Treatment visit information: (**Consider all the last 12 patient visits documented before selectiong *"1"or "0"* for each of the variables)
Table No.	Patient name Patient surname Date of birth Gender	ART start date Prior ART history Method into ART Pregnancy status at ART start WHO stage at ART start TB treatment status at ART start IPT status at ART start CPT status at ART start Baseline CD4 count (if bloods were taken)	Visit dates Health Provider Pregnancy status TB screening status IPT status 6 months viral load result (if bloods were taken) 12 months viral load result (if bloods were taken) 12 months CD4 count result (if bloods were taken) ARVs prescribed Months ART prescribed Next clinical appointment date	Patient name Patient surname Date of birth Gender	ART start date Prior ART history Method into ART Pregnancy status at ART start WHO stage at ART start TB treatment status at ART start IPT status at ART start CPT status at ART start Baseline CD4 count (if bloods were taken)	Visit dates Health Provider Pregnancy status TB screening status IPT status 6 months viral load result (if bloods were taken) 12 months viral load result (if bloods were taken) 12 months CD4 count result (if bloods were taken) ARVs prescribed Months ART prescribed Next clinical appointment date

SECTION B: Assessment of the accuracy of TIER.Net HIV electronic system entries

	HIV clinical record: Available (1=Yes; 0=No)																								**HIV electronic system (TIER.Net):** Entry consistent with HIV clinical record? (1=Yes; 0=No)																							
	Patient details				**ART baseline information**									**Treatment visit information:** (Consider all the last 12 patient visits documented before selecting *“1”or “0”* for each of the variables)											**Patient details**				**ART baseline information**									**Treatment visit information:** (Consider all the last 12 patient visits documented before selectiong *“1”or “0"* for each of the variables)										
Folder Number	Patient name	Patient surname	Date of birth	Gender	ART start date	Prior ART history	Method into ART	Pregnancy status at ART start	WHO stage at ART start	TB treatment status at ART start	IPT status at ART start	CPT status at ART start	Baseline CD4 count (if bloods were taken)	Visit dates	Health Provider	Pregnancy status	TB screening status	IPT status	6 months viral load result (if bloods were taken)	12 months viral load result (if bloods were taken)	12 months CD4 count result (if bloods were taken)	ARVs prescribed	Months ART prescribed	Next clinical appointment date	Patient name	Patient surname	Date of birth	Gender	ART start date	Prior ART history	Method into ART	Pregnancy status at ART start	WHO stage at ART start	TB treatment status at ART start	IPT status at ART start	CPT status at ART start	Baseline CD4 count (if bloods were taken)	Visit dates	Health Provider	Pregnancy status	TB screening status	IPT status	6 months viral load result (if bloods were taken)	12 months viral load result (if bloods were taken)	12 months CD4 count result (if bloods were taken)	ARVs prescribed	Months ART prescribed	Next clinical appointment date

2. Questionnaire on factors influencing data quality in HIV and ART health information system in Enock Mgijima Sub-district

Kindly fill in the facility code and circle the location of the facility before interviewing the participant:

Code of health facility: _____

Location of Health facility: **1.** Urban or **2.** Rural

SECTION A: RESPONDENT SOCIAL DEMOGRAPHIC DATA

Kindly circle responses for the following questions:

1. Gender **1**. Male **2**. Female

2. What is your specific job title?: **1**. Professional Nurse **2**.Data Capturer

3. How long have you been in this post? Years_____ Months_____

4. What is your current age? _____

5. What is the highest degree or level of school you have completed? **1**. Did not complete Matric **2**. Matric **3**. Diploma **4.** Bachelors degree **5**. Postgraduate Degree **6.** Other (specify)_____

6. Which of the following HIV and ART related Health Information Systems training(s) have you attended? *(Circle all that apply)* **1**. 5 day Basic HIV & AIDS Data Management Course **2**. TIER.Net (including data abstraction from HIV clinical records) **3**. HIV clinical records completion **4**. DHIS

7. Have you received any other general Health Information Systems training course? **1**. No **2**. Yes

8. If ***Yes*** to **Q7**, which subjects were covered in the training? *(Circle all that apply)* **1.** Data collection **2.** Data analysis **3.** Data quality checking **4**. Use of information **5**.Other *(specify)* _____

SECTION B: BEHAVIORAL FACTORS

8a. Do you think the HIV and ART data you collect is sufficiently accurate for your purposes? 1. Yes **2**. No

8b. Please explain why:

_____

_____

_____
_____
_____
_____
_____

9a. Do you think the HIV and ART data you collect is sufficiently complete for your purposes?
1. Yes **2**. No

9b. Please explain why:

_____
_____
_____
_____
_____
_____
_____

10. Why do you think there is a need for the collection of accurate and complete HIV and ART data?

_____
_____
_____
_____
_____

11. Describe at least three ways of checking data quality.

1._____
2._____
3._____

12. Please rate your confidence in performing the following activities related to health information systems in the table below *(Cross (X) only one choice per statement)*.
On the scale 0 indicates that you feel unable to perform the activity at all, while 10 indicates that you are extremely confident that you can perform the activity.

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
12a. I feel comfortable checking data accuracy											
12b. I feel comfortable plotting data by months or years											
12c. I feel comfortable calculating percentages/rates correctly											
12d. I feel comfortable interpreting numerical analyses in tables and graphs											

12e. I feel comfortable computing trends from tables											
12f. I feel comfortable using data for setting targets											
12g. I feel comfortable using data for identifying gaps in service provision and outcomes											
12h. I feel comfortable using data for making various types of decisions and providing feedback											

13. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
13a. Collecting information makes me feel bored	1	2	3	4
13b. Collecting information which is not used for decision making discourages me	1	2	3	4
13c.Collecting information is meaningful for me	1	2	3	4
13d. Collecting information gives me the feeling that data is needed for monitoring performance	1	2	3	4
13e. Collecting information gives me the feeling that it was forced on me	1	2	3	4
13f. Collecting information is appreciated by co-workers and superiors	1	2	3	4

SECTION C: ORGANIZATIONAL FACTORS

14. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, DECISIONS are based on:				
14a. Superiors' directives	1	2	3	4
14b. Personal liking	1	2	3	4
14c. Evidence/facts	1	2	3	4

14d. Political interference	1	2	3	4
14e. Considering costs	1	2	3	4
14f. Community health needs	1	2	3	4
14g.Health management information systems data	1	2	3	4
15. To what extent, do you agree with the following statements on a scale of 1-4*(Circle only one choice per statement):*				
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, SUPERIORS:				
15a. Emphasize data quality in monthly reports	1	2	3	4
15b. Seek feedback from staff	1	2	3	4
15c. Discuss conflicts openly to resolve them	1	2	3	4
15d. Promote team work	1	2	3	4
15e. Seek feedback from concerned community members	1	2	3	4
15f. Are open to alternative views	1	2	3	4
15g. Listen to employees' ideas and concerns	1	2	3	4
15h. Allow disagreements before reaching a decision	1	2	3	4
15i. Are concerned about serving target community/clients' needs	1	2	3	4
15j. Check data quality at the facility level and higher level regularly	1	2	3	4
15k. Use health management information system data for setting targets and monitoring	1	2	3	4
15l. Report on data accuracy regularly	1	2	3	4
15m. Provide regular feedback to their staff through regular reports based on routine information	1	2	3	4

16. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, STAFF:				
16a. Document their activities and keep records	1	2	3	4
16b. Are punctual	1	2	3	4
16c. Are given appropriate training for health management information systems activities	1	2	3	4
16d. Receive timely monthly feedback on their submitted reports	1	2	3	4
16e. Are told about their annual performance criteria	1	2	3	4
16f. Set appropriate and doable targets for their performance	1	2	3	4
16g. Feel committed in improving the health status of the target population	1	2	3	4
16h. Are rewarded for good work	1	2	3	4
16i. Feel guilty for not accomplishing the set target/performance	1	2	3	4
16j. Display data for monitoring their set target	1	2	3	4
16k.Use health management information system data for day to day management of the facility and sub-district	1	2	3	4
16l. Can develop appropriate criteria for selecting interventions for a given problem	1	2	3	4
16m.Can gather data to find the root cause(s) of the problem	1	2	3	4
16n.Can develop appropriate outcomes for a particular intervention	1	2	3	4
16o. Can evaluate whether the targets or outcomes have been achieved	1	2	3	4
16p. Are empowered to make decisions	1	2	3	4
16q. Are able to say no to superiors and colleagues for demands/decisions not supported by evidence	1	2	3	4
16r. Are made accountable for poor performance	1	2	3	4

16s. Use health management information system data for community education and mobilization	1	2	3	4
16t. Admit to mistakes	1	2	3	4

SECTION D: TECHNICAL FACTORS

16. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
16a. HIV clinical records are complicated to use	1	2	3	4
16b. Monthly data reporting forms are complicated to use	1	2	3	4
16c. Clinical staff in your facility have adequate HIV clinical records	1	2	3	4
16d. TIER.Net HIV electronic system is user friendly	1	2	3	4
16e. Staff in your health facility have the required instruction guides for health management information system activities	1	2	3	4

SECTION E: INFORMATION SKILLS

17. The viral load suppression rate[1] for adult ART patients at 12 months were found to be 50%, 50%, 60%, 70%, 80% for years 2012, 2013, 2014, 2015 and 2016 respectively.

17a.Develop a bar graph for viral load suppression percentages by years

[1] *Proportion of adult ART clients with viral load suppressed (under 400 cps/mL) at 12 months of being on ART*

17b.Explain the findings of the bar chart

_____
_____
_____
_____
_____

17c.Did you find any trend in the data? If no or yes, explain reason for your answer

_____
_____
_____
_____

17d. Suggest at least one way in which this information could be used at facility level.

_____
_____
_____
_____

18. What should be recorded on the "**ART start date"** field in the HIV clinical record or TIER.Net system? *(Circle only one answer)* 1. Date patient tested HIV positive **2.** Date ART patient started receiving ART at this clinic after transferring-in from another clinic **3**. Date HIV positive patient started ART at this or transferring clinic **4**. Date ART patient transferred-in to this clinic.

19. What should be recorded on the **"Health Provider"** field in the HIV clinical record or TIER.Net system? *(Circle only one answer)* **1.** Name of healthcare provider **2**. Designation of healthcare provider (Nurse/Doctor) **3**. Department of Health **4.** Name of treatment supporter

20. What should be recorded on the **"Method into ART"** field in the HIV clinical record or TIER.Net system? *(Circle only one answer)* **1.** Whether ART client is a child or an adult **2.** Whether ART client tested HIV positive in a fixed health facility setting or during community testing **3.** Whether ART client is a new patient or a transfer-in patient

Questionnaire items used for developing behavioural factor scores

Perceived motivation for Health Information Systems tasks

Q. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1. Collecting information makes me feel bored	1	2	3	4
2. Collecting information which is not used for decision making discourages me	1	2	3	4
3.Collecting information is meaningful for me	1	2	3	4
4. Collecting information gives me the feeling that data is needed for monitoring performance	1	2	3	4
5. Collecting information gives me the feeling that it was forced on me	1	2	3	4
6. Collecting information is appreciated by co-workers and superiors	1	2	3	4

Confidence levels for Health Information Systems (HIS) tasks

Q. Please rate your confidence in performing the following activities related to health information systems in the table below *(Cross (X) only one choice per statement)*.
On the scale 0 indicates that you feel unable to perform the activity at all, while 10 indicates that you are extremely confident that you can perform the activity.

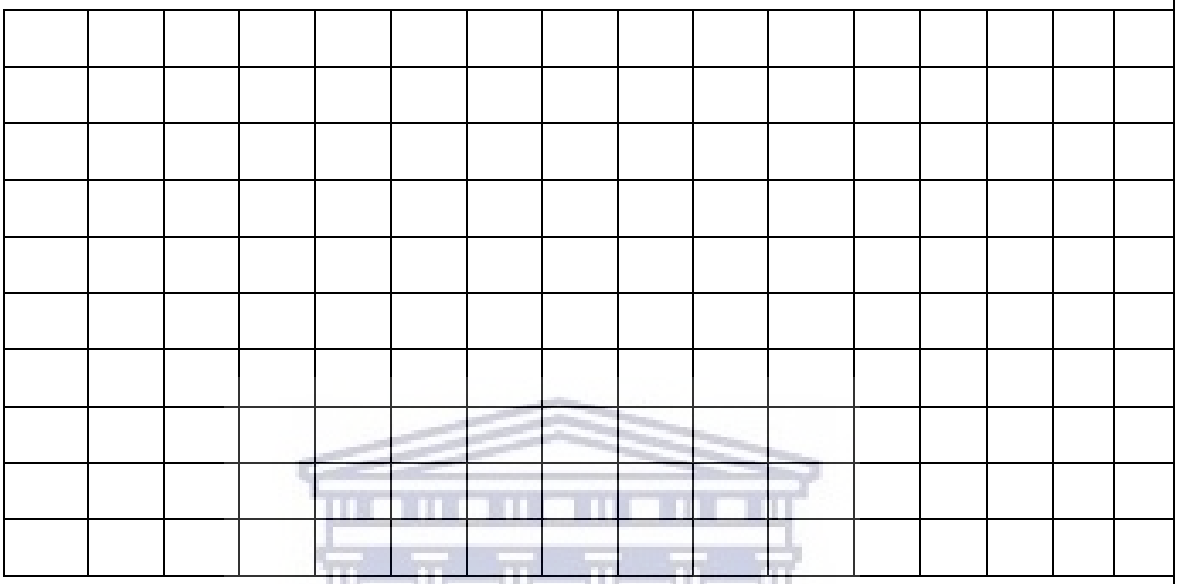
(Score "1" if >= 5; score "0" if < 5)

	0	1	2	3	4	5	6	7	8	9	10
1. I feel comfortable interpreting numerical analyses in tables and graphs											
2.I feel comfortable using data for making various types of decisions and providing feedback											
3.I feel comfortable plotting data by months or years											
4. I feel comfortable checking data accuracy											

Competence in Health Information Systems (HIS) tasks

Q. The viral load suppression rate[2] for adult ART patients at 12 months were found to be 50%, 50%, 60%, 70%, 80% for years 2012, 2013, 2014, 2015 and 2016 respectively.

1.Develop a bar graph for viral load suppression percentages by years *(Score "1" if plotted correctly, else score "0")*



2.Explain the findings of the bar chart. *(Score "1" if correct interpretation, else score "0")*

3. Suggest at least one way in which this information could be used at facility level. *(Score "1" if at least 1 correct suggestion, else score "0")*

Knowledge of Health Information Systems Rationale

Q. Why do you think there is a need for the collection of accurate and complete HIV and ART data? *(Score "1" for correct explanation, else score "0")*

Knowledge of Data Quality Checking

Q. Describe at least three ways of checking data quality *(Score "1" if at least 3 correct descriptions, else score "0")*

[2] *Proportion of adult ART clients with viral load suppressed (under 400 cps/mL) at 12 months of being on ART*

Questionnaire items used for developing organizational factor scores

Sense of Responsibility

Q. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	Agree	Disagree	Strongly Disagree
In the department of health, STAFF:				
1. Feel committed in improving the health status of the target population	1	2	3	4
2. Feel guilty for not accomplishing the set target/performance	1	2	3	4
3. Set appropriate and doable targets for their performance	1	2	3	4
4. Can develop appropriate criteria for selecting interventions for a given problem	1	2	3	4
5. Are punctual	1	2	3	4
6. Can gather data to find the root cause(s) of the problem	1	2	3	4
7. Use health management information system data for day to day management of the facility and sub-district. Receive timely monthly feedback on their submitted reports	1	2	3	4

Empowerment & Accountability

Q. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	Agree	Disagree	Strongly Disagree
In the department of health, STAFF:				
1. Are given appropriate training for health management information systems activities	1	2	3	4
2. Are made accountable for poor performance	1	2	3	4
3. Are empowered to make decisions				
4.Admit to mistakes	1	2	3	4

Information Use

Q. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, STAFF:				
1.Use health management information system data for day to day management of the facility and sub-district	1	2	3	4
2. Use health management information system data for community education and mobilization	1	2	3	4

Promotion of problem solving

15. To what extent, do you agree with the following statements on a scale of 1-4 *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, SUPERIORS:				
1. Discuss conflicts openly to resolve them	1	2	3	4
2. Allow disagreements before reaching a decision	1	2	3	4
3. Listen to employees' ideas and concerns	1	2	3	4
4.Are open to alternative views	1	2	3	4

Staff feedback

Q. To what extent, do you agree with the following statements on a scale of 1-4 *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, SUPERIORS:				
1.Seek feedback from staff	1	2	3	4

2.Provide regular feedback to their staff through regular reports based on routine information	1	2	3	4
3.Seek feedback from concerned community members	1	2	3	4

Data quality emphasis

Q. To what extent, do you agree with the following statements on a scale of 1-4 *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, SUPERIORS:				
1. Emphasize data quality in monthly reports	1	2	3	4
2. Check data quality at the facility level and higher level regularly	1	2	3	4

Evidence based decision making

14. To what extent, do you agree with the following statements on a scale of 1-4? *(Circle only one choice per statement):*

(Score "1" if agree or strongly agree; score "0" if disagree or strongly disagree)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
In the department of health, DECISIONS are based on:				
1.Evidence/facts	1	2	3	4
2. Community health needs	1	2	3	4
3.Health management information systems data	1	2	3	4

Appendix 7: Facility level composite scores on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system

Table A: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility A, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	0	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	1	N/A
	12 months viral load result	0	1	N/A
	12 months CD4 count result	0	1	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	0	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	19/22 (86%) Adequate	9/9 (100%) Adequate

Table B: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility B, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	0	1	N/A
	Health provider	1	1	N/A
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	1	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	18/22 (82%) Adequate	8/8 (100%) Adequate

Table C: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility C, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	0	1	N/A
	Health provider	1	1	1
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	8/8 (100%) Adequate

Table D: Composite score on adequacy of data completeness and ccuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility D, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient Details	Patient name	1	1	0
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART Baseline Information	ART start date	1	1	0
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	0	1	N/A
	Health Provider	0	1	N/A
	TB screening status	1	1	0
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	5/8 (63%) Inadequate

Table E: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility E, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV Clinical Record	TIER.Net System	HIV Clinical Record +TIER.Net System
Patient Details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART Baseline Information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	0	1	N/A
	Health Provider	0	1	N/A
	TB screening status	1	1	0
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	0
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	0	1	N/A
	Composite score (adequate >=75%; inadequate <75%)	7/22 (32%) Inadequate	18/22 (82%) Adequate	5/7 (71%) Inadequate

Table F: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility F, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	1	1	1
	Health provider	0	1	N/A
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	8/8 (100%) Adequate

Table G: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility G, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	1	1	1
	Health provider	0	1	N/A
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	8/8 (100%) Adequate

Table H: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility H, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	0	0	N/A
	Health provider	1	1	1
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%>=%; inadequate <75%)	7/22 (32%) Inadequate	17/22 (77%) Adequate	8/8 (100%) Adequate

Table I: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility I, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	0
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	18/22 (82%) Adequate	9/10 (90%) Adequate

Table J: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility J, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	1	1	1
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	11/22 (50%) Inadequate	19/22 (86%) Adequate	11/11 (100%) Adequate

Table K: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility K, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	1	1	0
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	0
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	1	1	1
	ARVs prescribed	1	1	0
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	11/22 (50%) Inadequate	20/22 (91%) Adequate	8/11 (73%) Inadequate

Table L: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility L, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	0
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	0
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	0	1	N/A
	Health provider	1	1	1
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	6/8 (75%) Adequate

Table M: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility M, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	0
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment Visit Information	Visit date	1	1	0
	Health provider	0	1	N/A
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	0	0	N/A
	Composite score (adequate >=75%; inadequate <75%)	7/22 (32%) Inadequate	17/22 (77%) Adequate	5/7 (71%) Inadequate

Table N: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility N, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	0	1	N/A
	Health provider	0	1	N/A
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	8/22 (36%) Inadequate	18/22 (82%) Adequate	8/8 (100%) Adequate

Table O: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility O, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	0	1	N/A
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	9/22 (41%) Inadequate	18/22 (82%) Adequate	9/9 (100%) Adequate

Table P: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility P, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	0
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	18/22 (82%) Adequate	9/10 (90%) Adequate

Table Q: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility Q, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net System	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	0
	Health provider	1	1	1
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	1	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	0	N/A
	Composite score (adequate >=75%; inadequate<75%)	10/22 (45%) Inadequate	17/22 (77%) Adequate	7/8 (88%) Adequate

Table R: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility R, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	0
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	0	N/A
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	17/22 (77%) Adequate	8/9 (89%) Adequate

Table S: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility S, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	0
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	0
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	18/22 (82%) Adequate	8/10 (80%) Adequate

Table T: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility T, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	1	1	1
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	0
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	0	1	N/A
	Composite score (adequate >=75%; inadequate <75%)	10/22 (45%) Inadequate	18/22 (82%) Adequate	8/9(89%) Adequate

Table U: Composite score on adequacy of data completeness and accuracy of selected variables in the HIV clinical record and TIER.Net system in Health Facility U, Enock Mgijima Sub-district

		*Enter **"1"** if the variable is adequate or **"0"** if not*		
		Completeness		**Accuracy (Concordance)**
	Variable	HIV clinical record	TIER.Net system	HIV clinical record +TIER.Net system
Patient details	Patient name	1	1	1
	Patient surname	1	1	1
	Date of birth	1	1	1
	Gender	1	1	1
ART baseline information	ART start date	1	1	1
	Prior ART history	0	1	N/A
	Method into ART	0	1	N/A
	WHO stage at ART start	0	1	N/A
	TB treatment status at ART start	0	1	N/A
	IPT status at ART start	0	1	N/A
	CPT status at ART start	0	1	N/A
	Baseline CD4 count	0	0	N/A
Treatment visit information	Visit date	1	1	1
	Health provider	1	1	1
	TB screening status	0	1	N/A
	IPT status	0	1	N/A
	6 months viral load result	0	0	N/A
	12 months viral load result	0	0	N/A
	12 months CD4 count result	0	0	N/A
	ARVs prescribed	1	1	1
	Months ART prescribed	0	1	N/A
	Next clinical appointment date	1	1	1
	Composite score (adequate >=75%; inadequate <75%)	9/22 (41%) Inadequate	18/22 (82%) Adequate	9/9 (100%) Adequate