Assessing Antiretroviral Inventory Management Data Quality, Through Adopting Potential Digital Solutions: Case Study of ART Clinics in Western Equatoria State, South Sudan

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Abstract

Background: The human immunodeficiency virus response in South Sudan has worsened the country's situation unlike recovering from the devastating civil conflicts. The people living with the human immunodeficiency virus who are on antiretroviral drugs will need access to quality drugs to improve their health and prolong their lives, having sustainable access to drugs depends on effective inventory management and reliable data quality. The study aims: The study aims to examine the quality of inventory management data in antiretroviral clinics in the context of South Sudan with a particular focus on Western Equatoria health facilities.

Method: The study adopted a descriptive cross-sectional research design using a mixed-method research approach (qualitative and quantitative). A total of 20 antiretroviral therapy clinics in Western Equatoria State (WES) were considered the target population of the study comprising ARV dispensers, Data clerks, ART clinicians, and ART facility Directors.

Findings: 75% of study respondents were male, and it was observed that most of the interviewees had good experiences of more than 10 years in providing services to people living with HIV. Data quality was measured using a five-point Likert scale analysis, the respondents reported that the data quality was compliant in terms of accuracy, consistency, relevancy, validity, and genuineness of consumption data at ART clinics in WES. Regarding factors affecting inventory management, the infrastructures took the leading among others like the capacity of Human resources at public facilities and tools for managing data among others.

Conclusion: Based on the findings, respondents who participated in this study reported satisfaction with data quality in Western Equatoria ART clinics. Based on the views of the majority, the antiretroviral therapy clinics used to compile accurate, consistent, relevant, and valid, data of their inventory.

Keywords: HIV; AIDS; Antiretroviral Therapy; Public Health Priority; Public Health Information System

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Abbreviations: HIV: Human Immunodeficiency Virus; AIDS: Acquired Immune Deficiency Syndrome; WES: Western Equatoria State; MOH: Ministry of Health; CD4: Cluster of Differentiation 4 (is a glycoprotein found on the surface of a cell, T cell); ARV: Antiretroviral Drug; ART: Antiretroviral Therapy; UNDP: United Nations Development Program; LMIS: Logistic management Information System; HIS: Health Information System; EDT: Electronic Dispensing Tool; FESC: Facility Electronic Stock Card; mSupply: pharmaceutical supply chain software created by Sustainable Solutions.

Introduction

The presence of effective antiretroviral drugs at the national and subnational warehouses is ultimately necessary, control of the spread of Human immunodeficiency virus and acquired immunodeficiency syndrome is still a public health priority number one in the Republic of South Sudan with a prevalence of 2.7% among adults aged 15- 45 years 5% among the key and vulnerable population [1]. The country has made some achievements with 24% of the estimated 200,000 people living with HIV knowing their status, and from which 67% of those who know their status are initiated on lifesaving antiretroviral therapy [1]. The HIV response in South Sudan has added a burden to the country's situation, which is indicated as recovering from devastating civil conflicts. Access to life-saving antiretroviral drugs has been challenging, especially in hard-to-reach resident groups including highly mobile refugees residing in neighboring countries and internally displaced populations [2]. The first national guideline for use of antiretroviral drugs in South Sudan was launched in 2008, at which the start initiation of CD_4 200cell/mm^3. By December 2016 there were 35 accredited antiretroviral therapy [ART] clinics across the country with a respected number of clients receiving treatment.

The epidemic is geographically concentrated in the Equatoria region which comprises an estimate of 46% (89,891) of People living with HIV of the national estimate for 2020, HIV prevalence in these states is 5.8% in Western Equatoria, 2.3% in Central Equatoria, and 3.1% in Eastern Equatoria [2]. The People living with HIV, who are on antiretroviral do need access to quality drugs to improve their health and prolong their lives, antiretroviral drugs need efficient and effective inventory management, and managing their flow is crucial to ensure uninterrupted supplies, ineffective inventory management was observed in some facilities where it was linked with frequent stock-out, associate with problems with data collection and data reporting tools [3].

Inventory management is the activity that organizes the availability of commodities to the customers or patients; it also coordinates the purchasing, and distribution process to meet the customer's demand. There is a close relationship between data provided by the logistic management information system (LMIS), which is perceived to keep inventory control system data quality, these Data will allow the product manager to know the current stock at the facility and determine whether the stock is above, below, or within the estimated maximum, and minimum stock levels, and predict whether the facility is in a good position or it should place an emergency order [4]. LMIS can also be used to trace consumption and to adjust national procurement as needed because it has made it easy to identify overstock of ARVs and redistribute the product and collect anticipated expiries [5].

In a study conducted in South Africa, it was noted that poor inventory management was due to incorrect stock records or outdated stock records and lack of continuous supportive supervision, while a similar study conducted in Uganda and Kenya, revealed that the suitable intervention was strengthening inventory management at the ART facility level by ensuring availability of adequate stock levels and other medical supplies [3].

This research aims to examine the quality of inventory management data in antiretroviral treatment clinics in Western Equatoria health facilities. this study will use a descriptive cross-sectional study as an approach to assess antiretroviral data quality and data tools for recording data, assess factors facing the inventory management process, identify associated discrepancies between data recorded on the stock cards and the physical count process, as well as identify factors contributing to poor inventory management, and also assess the potential digital solution [6]. This study has looked at the Western Equatoria state taking the lead in the country with a prevalence of 5.6%. People living with HIV, and has investigated the efforts being deployed to provide quality of ARVs to people living with HIV, to suppress their viral load and improve their lives, and looked at ways to reduce reports of frequent stock out [7], which are still being registered across clinics, due to the flow of inaccurate information and lack of data recording tools, like stock cards, and data collection tools and to counteract delayed report submission. This has often resulted in the distribution of less stock to the facility which always leads to a frequent shortage of ARVs.

Supply Chain System in Western Equatoria; The United Nations Development Fund and the Global Fund in South Sudan are the donors and Principal recipients of funds; they are responsible for the purchase and delivery of ARV to ART clinics in the country and Western Equatoria State in particular. The ART clinics determine their needs, submit their orders to the Federal Ministry of Health for validation

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and data verification, and then send them to the warehouse for processing using a software called the "supply".

Methodology

The study Settings

The study was conducted in Western Equatoria State, which covers an area of 79,343 kilometers. It is the state which has the highest HIV prevalence of 5.6%. WES is divided into ten counties, but the research was conducted in five counties: Ezo county, Nzara County, Yambio county and Tambura County and Maridi county. The selected counties were based on rendering HIV services [8].

The Study Design & the Population

This study employed a descriptive cross-sectional design, and the purposive sampling technique was used due to the small size of the study population, the clinician, Data clerk, facility in charge involved in this study, this method used the entire population as sample size, all the 40 employees listed below were used as the study population sample. Kothari [6] mentioned and explained that when this method is used for sampling it provides highest accuracy level of confidence, as it leaves no element chance. The method was preferred for this study due to the small population size. Staffs were visited in their workplace and the relevant data collection tools were used to gather the intended data from those Data Sources and Type: There was one type of data source which were primary data, and the primary data was obtained using semi-structured questionnaires, interview, and checklist [9].

Sample Design

The target population is health professionals who were in close contact with ARVs management, like ARV dispensers, data clerks, Art clinicians, and facility directors. The sample consisted of 20 ARV dispensers, 10 data clerk accounts, 5 ART clinicians, and 5 ART facility directors.

Inclusion Criteria: In this study health workers in Western Equatoria who were dealing or in close contact with ARVs management were included, after signing the consent letter.

Exclusion Criteria: In this study health workers who were not dealing with ARVs management or ARVs data reporting were excluded.

Data Sources and Type: There was one type of data source which were primary data, and the primary data was obtained by administering semi-structured questionnaires to the informant and collect them afterward [9].

Data Collection Procedures

This study employed semi-structured questionnaires, and a semi-structured interview, data collection process was cascaded into two phases using data collecting instruments as follows Questionnaires: was for the collection of primary data, they were administered to the respondents, the investigator used this method because it is reliable, simple and was a quicker way to collect data. This activity was conducted in September 2021, it took one week in Yambio town from 19-24 September 2021. It happened in two phases as below: phase one, the distribution of closed-end questionnaires to the participants using "the drop -and pick later" procedures, the respondents were given enough time to answer the questions. Phase Two, the collection of filled questionnaires from the respondents.

Method of Data Analysis and Presentation

Questionnaires were gathered, edited, coded, and entered the computer software Statistical Package for Social Sciences (SPSS) version 20. Likert scale analyses were employed to get the means and the grand means. Data analysis was done through descriptive and inferential statistics to identify inventory management data quality for ARVs.

Descriptive Analysis, descriptive statistics such as percentage, frequency distribution, charts, and graphs will be used to analyze data obtained via closed-end questionnaires. Inferential Analysis, the inferential statistic will be used to analyze data obtained from the analysis of the relationship between variables, using mean & ST deviation [10].

Ethical Considerations

➢ The study applied standard ethical principles during the assignment. The study investigator will get approval from the Ethics Review Board (ERB) of the South Sudan Ministry of Health at the Directorate Policy, Planning, Budgeting, and Research. In addition, a letter to conduct the study was obtained from University of Rwanda

➢ A formal letter was written by MOH to State MOH, CHDs, and health facilities to introduce the assessment and request their involvement/support. Informed written consent were secured from all participants before any data collection is conducted

Results

Demographic and Human Resources Capacity

From the total forty questionnaires that were distributed to participants, only 33 questionnaires were returned and

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retained for final analysis. Accordingly, male respondents account for 75.8% while, 24.2% were female. Similarly, 78.8% of the respondents were found to be in the age range of 26 to 35 years, while their experience indicates 42.4% of them had 6-10 years of experience followed by 39.4% of them had 1-5 years of experience. On the other hand, the respondents' experience in the clinic shows that 39.4% and 36.4% were found to have 1-5 years, and 6-10 years, respectively. Concerning their educational background majority (72.7%) of them were Diploma holders followed by Degree holders (24.2%) and master's degree holder accounts for only 3% of the respondents. Table 1: below explain the experiences of staff rendering HIV services and the capacity needed to work in the ART clinics in WES.

Particulars	Variables	Frequency	Percent
Gender of Respondents	Male	25	75.8
	Female	8	24.2
Age of respondents	18-25 Years	2	6.1
	26-35 Years	26	78.8
	40 years and above	5	15.1
Experience of respondents	0<1 year	4	12.1
	1-5 years	13	39.4
	6-10 years	14	42.4
	11+ years	2	6
Education level of respondents	Diploma	24	72.7
	University Degree	8	24.2
	Postgraduate	1	3

Table 1: Demographic & Human Resources Capacity.
Source: Own Survey, 2021

Inventory Management Best Practices

Table 2 Below explain the results of inventory best practices at the ART sites in WES, the variable was divided into three dimensions, stock keeping records, stock status reporting, and the advantages of stock tools, and the results revealed that all the ARVs have updated stock which represents 81.8% from the respondents and stock count took the 90,9%, in the second dimension the respondent ensured that consumption data are included in the report with stock on hand which represent 84.8%,69.7% respectively .in the last dimension the advantages of using tools has increased reporting rate by 60.9% and has reduced stock out rate by 75.8%.

Dimension	Variable	Frequency	Percentage
Stock keeping tools	All ARVs have a stock card.	27	81.80%
	All stock cards are updated	23	69.70%
	There is a regular count for ARVs	26	78.80%
	Stock count is divided into grouping	30	90.90%
Reports	ARVs reports are compiled end of the reporting period	26	78.80%
	Consumption data are captured &reported	28	84.80%
	Stock on hand is included in the report	23	69.70%
	Stock expiring & losses are included in the report	26	78.80%
Advantages of stock tools	Has increased report rate	18	60.60%
	Has reduced stock out rate	25	75.80%
	Has reduced the order lead time	22	66.70%

Table 2: Inventory management best practices.
Source: Own Survey, 2021

Factors Affecting Inventory Management

In descriptive data analysis, the average (mean) was calculated for each Likert scale dimension, from strongly disagree = 1 to strongly agree = 5, the scale was calculated to understand the mean values Table 3 Below is the interpretation of the average categories (mean values) with the degree of agreement for each factor based on Alfarra WA, et al. suggestion as a weighted average between the values (please refer to Table 2).

Weighted Average	Result	Result Interpretation
1.00 - 1.79	Strongly disagree	Very un-influential
1.80 - 2.59	disagree	Un influential
2.60 - 3.39	Neutral	Neutral
3.40 - 4.19	Agree	Influential
4.20 – 5.00	Strongly agree	Very influential

Table 3: Weighted Average for 5-point Likert Scales.
Source: Alfarra WA, et al.

Factors Affecting Inventory Management

In Table 4 Factors affecting inventory management were grouped into three categories as, stock infrastructures, which include Lack of proper storage, lack of inventory control system, and lack of tools for management, in the second category, data tools which involved, record keeping, and poor reporting of data in the third category Human resources came as incompetent staffs & unreliable supplies of medicines.

Dimension	Factors Affecting Inventory Management	Mean	SD
Stock infra structure	Lack of proper storage	3.6	1.9
	Lack of inventory control system	3.5	1.9
	Poor inventory infrastructures	3.5	1.9
Data tools	Poor record-keeping	3.2	1.6
	Poor reporting of data	3.1	1.5
HR capacity	Incompetent staffing	3.3	1.7
	Unreliable supplies of medicines	3.5	1.8
	Inadequate training in stock management	3.8	2.1
	Lack of commitment by managers	3.4	1.7
	Inadequate staff	3.8	1.9
Grand mean		3.47	1.8

Table 4: Factors affecting inventory management.
Source: Own Survey, 2021

Inventory Management Data Quality Dimensions

In Table 5 below the data quality was measured using data dimensions, and the difference between St. Dev & Mean for Data accuracy and data genuineness was 0.5, which was close to one, hence the difference between St. Dev and Mean for data completeness, consistency, relevancy, and validity were below 0.5.

Dimension	Items	Mean	St. Dev
Data accuracy	ART data in the clinic is accurate	3.2	2.9
Data completeness	ART data in the clinic is accurate	3.1	2.7
Data consistency	ART data in the clinic is consistent.	3.2	2.7
Data relevancy	ART data in clinic relevant	2.9	2.5
Data genuineness	ART data in the clinic is genuine	2.8	2.3
Data validity	ART data in the clinic is valid.	3.1	2.7
Grand mean for data quality		3.06	2.6

Table 5: Data quality measurement.
Source: Own Survey, 2021

Discussions

The present study aims to examine the quality of inventory management data of antiretroviral therapy clinics in Western Equatoria health facilities, the present study used a descriptive cross-sectional study as an approach to assess antiretroviral data quality and tools being used for recording data, also it has assessed factors facing the inventory management process, identify associated discrepancies between data recorded on the stock cards and the physical count process, as well as identify factors contributing to poor inventory management, and assess the potential digital solution.

Inventory Management Best Practices

The findings in Table 2, explain the outcome observed by the respondents when it comes to the stock cards used in the ART clinics 81.8% have stock cards, and the process of stock-taking is being conduct in 90.9% of ART sites , and this is in consistency with a study conducted in Gondar north west Ethiopia [11] where they said the discrepancies between physical count and stock record were realized by 60% .

The results in the same table have also assured that reports are compiled by the end of the reporting period and these reports must contain data on consumptions, stock on hand, and information about losses and expiries,

which contradicts the study done in Namibia [10] where it says discrepancies between patients and stock records were observed in most facilities. the findings of this study are contrary to the findings of a study [4] carried out in Uganda antiretroviral therapy clinics where the level of underreporting was high compared to good reporting rate in WES art clinics .and in further validation of the study an audit of 100 randomly selected medical records bear an error rate of 67% [9].

The finding of this study is contrary to the findings of a study carried out in Kenya [12]. Where discrepancies in records were 33% of the recorded balance was greater than the physical count which indicates records of supplies were poor and poor stock management was found to be a major issue in ARVs drug inventory management.

Factors Affecting the Inventory Management in Antiretroviral Therapy Clinics

The findings in Table 4 narrate factors affecting inventory management practices at the facilities, after dividing the variables into three dimensions stock infrastructures, data management tools, and Human resources, the respondent's responses [4] the results realized that the informant's opinion did deviate from being goods in term of stock storage facility, and tools being used for data management and this is in line with most chapter of the book of the logistic handbook [13].

In a study in Nigeria poor planning and forecasting, plus insufficient information about drugs consumption and current stock level, capacity constraint, and poor infrastructure are the reason for inappropriate stocks level as stated by Sado from Ethiopia [7], and stock management is done with stock holding cards and followed first in-first out strategy [8]. The findings of this study are inconsistent with the findings of a study conducted in Kenya where the respondent assured that both staff competency & inventory record management can affect inventory management [12]. The findings of this study were inconsistent with the findings of a study conducted in Kenya [3] where they found out the major causes of inaccurate stock records were inadequate training, inadequate staffing oversight, and staff turnover.

Inventory Management Data Quality Dimensions

Data quality from the perspective of data producers and managers focuses on data matching their sources [14], and data quality dimensions serve as a guide for selecting the most suitable data set and will lead to choosing the data set with higher accuracy to ensure trust and confidence in the employees in Table 5.

In regards to the inventory data quality the group means and ST. Dev. were 3.52 and 3.06 respectively, were employed to measure data quality and it was indicating average / moderate opinions which did not deviate from the overall consensus, this is in an agreement when it comes to quality of data at various Antiretroviral therapy clinics , which were found accurate, complete, and consistent with their sources and valid [15,16], these findings concurred with Kumar& corroborate with the study done in both Rwanda & Papua new guinea where the process of mapping data location can high light missing or inefficient practices such as duplication of data collection or poor data sharing practices [17] these findings is contrary to a study conducted in Kampala district, where they term improving data quality by uncovering the data defect through data profiling which is the process of analyzing data for completeness, genuineness, and consistency, etc.

Conclusion

The finding in Table 1 summarizes the demographic data and the human resources capacity of the staff working in ART clinics to high with experiences reaching more than ten years. Findings of this study reveal that inventory management of ARVs was good compared to findings of some studies in the neighboring countries. This study observed that inventory management is the determinant of consumption data quality. And the respondents revealed that there is a consensus amongst the staff working at different Art clinics in WES when it comes to the quality of data that it is reliable and genuine.

Based on the findings above the respondents found that stock infrastructure is still a major challenge facing inventory management, The study emphasizes on the inventory best practices which use of the stock card, conduct regular stock-taking, and reporting stock on hand and stock out rate.

Based on the findings, respondents who participated in this study reported satisfaction with data quality in Western Equatoria ART clinics. Based on the views of the majority, the antiretroviral therapy clinics used to compile accurate, consistent, relevant, and valid, data.

Recommendations

➢ MHO Directorate of pharmaceutical to urge implementing partners to Integrate commodities reporting and use the MOH-DHIS2 reporting forum.
➢ Federal MOH to accelerate the transition to the eLMIS system for improvement of stock management at the health facilities.
➢ Health facilities to conduct regular training on stock management, and consumption data collection.
➢ Factors that might influence organizational effectiveness

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and success

Recommendation for Future Research

➢ Last Delivery of ARVs, challenges, and recommendations.
➢ Assessing factors affecting the order management at Health facilities across the country.
➢ Assessing the impact of the paper-based systems on stock availability and stock out at public health facilities.

Declarations

➢ **Participant consent letter:** obtained
➢ **Competing interest**: not applicable
➢ **Funding**: no funding was obtained.

8.4. Authors contributions

➢ Odol Ocay Amykeui, designed the study and collected data & drafted the manuscript
➢ Prof. Shiferaw Mitiku provided technical support & substantively revised the work & the manuscript.
➢ Dr. Kashi Carasso, substantively revised the work
➢ Jean D'Mour Habagusenga, substantively revised the manuscript
➢ Prof. Marine Mukazayire Jeanne substantively revised the manuscript

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