Original Article

Inventory Management Practices and Supply Chain Performance of Antiretroviral Medicines in Public Hospitals in Nyamira County, Kenya

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Abstract

Background

Unreliable supply systems have plagued the provision of an uninterrupted supply of life-saving medicines in many developing countries, with antiretroviral (ARV) medicines having the worst repercussions.

Objective

To identify the inventory management practices used, evaluate the supply chain performance, and determine the challenges affecting inventory management of ARV medicines in public hospitals.

Methods

The study used a descriptive cross-sectional design, gathering snapshot data on inventory management practices happening in all the 8 public hospitals across Nyamira County. Data collection was done using structured questionnaires, key informant interviews, checklists and data from the national health information system.

Results

The response rate was 97.3% for the questionnaires and 100% for the key informant interviews. The prevailing inventory management practices were: use of scheduled inventory control model (80.95%), forecasting demand using previous consumption data (100%), keeping accurate and updated stock records for each commodity (92.31%), having essential logistical data in reports (100%), including safety stock (61.54%) when ordering and keeping ARV medicines in dedicated stores (75%). With the exception of order lead time (17.98 days), the other supply chain performance metrics namely stock out rate (52.12%), stock wastage rate (43.2%), and reporting rates (70.84%) were found to be deficient. The challenges mostly affecting inventory management included inadequate staff and training, lack of proper storage, and unreliable supply of medicines.

Conclusion

Inventory management practices were according to the recommended best approaches despite various challenges. The supply chain performance metrics evaluated, with the exception of order lead time, were all found to be unsatisfactory owing to the high stock out rates, below par reporting rates and high stock wastage rate due to expiries discovered. Adoption of an electronic inventory system, use of data for decision making, dedicated storage of ARV medicines, and inclusion of buffer stock, are some strategies to improve inventory management.

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Keywords: Inventory Management Practices, Supply chain performance, stock availability, order lead time, safety stock

Background

A key objective in WHO's essential medicines strategy is "to expand access to essential medicines by improving financial and supply systems".[1] However, unreliable supply systems have been identified as a major hindrance to sustainable provision of essential medicines across many developing countries.

While HIV/AIDS prevention, care and treatment programs have made great strides in reducing the HIV pandemic in Kenya, former Nyanza province has consistently maintained a high prevalence of the infection.[2] Though the root cause of this sustained high prevalence could be multifactorial, ensuring availability and uninterrupted access to ARV medication is a key intervention being used to contain the spread of the disease. The main consequence of stock outs of ARV medicines is poor adherence to treatment. Schaecher associates poor adherence to treatment with ineffective viral suppression, resistance to medication, increased morbidity and low survival rates. [3]

In a bid to establish whether the supply system of ARV medicines is effective, this research attempted to investigate the inventory management practices being done in public hospitals in one of the counties of Nyanza region called Nyamira County. According to the County HIV and AIDS strategic plan 2014/15-2018/19, erratic and inadequate supply of HIV/STI-related commodities" was listed as a capacity gap that was hindering the availability and access to ARV medicines.[4]

The main aim of this study was to assess the inventory management practices and the supply chain performance of antiretroviral medicines in order to optimize a best practice model for antiretroviral medicines supply chain at sub-national level.

Methods

Study setting

The study was conducted in Nyamira County, Kenya in all of its 8 public hospitals namely: Nyamira county referral hospital, Ekerenyo sub-county hospital, Nyamusi sub-county hospital, Kijauri sub-county hospital, Masaba sub-county hospital, Esani sub-county hospital, Manga sub-county hospital and Nyangena sub-county hospital.

Study design

This study adopted mixed research methods namely: a descriptive cross-sectional survey, qualitative key informant interviews, checklists as well as secondary data from the national health information system. The research was cross-sectional since it gathered snapshot data of the inventory management practices happening in public hospitals across Nyamira County.

Study population and sampling

The target population of the study were health workers involved in ARV medicine management in the 8 public hospitals of Nyamira County, namely: pharmacists in charge, sub county pharmacists, county pharmacist, facility in-charges, hospital administrators and ART nurses. Due to the small target population, census method of sampling was used such that this entire target population made up the sample population, that is, 8 pharmacists in charge, 8 facility in charges, 8 hospital administrators, 8 ART nurses, 5 sub-county pharmacists and 1 county pharmacist.

Data collection instruments

The primary data collection instruments that were used for this study were structured questionnaire, key informant

interview guide, and checklists. Secondary data was also collected from the Kenya Health Information System (KHIS). The KHIS is Kenya's National health information system for data management that provides a platform for reporting, analysis and dissemination of data for all health programs.

Measurement

The independent variable of the study was inventory management practices of which the parameters were: inventory control model, determination of order quantities, stock keeping records and reporting and safety stock policy. The dependent variable was supply chain performance which was measured with the following indicators: stock out rates, order lead times, stock wastage rates and reporting rates.

Data collection procedure

The first phase of data collection involved questionnaires being distributed by the principal investigator to the respondents using the "drop and pick later" technique. This method involved the principal researcher hand delivering the questionnaires to the respondents at the health facilities and retrieving them after a couple of days.

The second phase involved going to collect the questionnaires as well as serving as a site visit to collect additional data on medicine availability and stock wastage rate using the checklist.

The third phase involved conducting key informant interviews with the county and sub county pharmacists of Nyamira County to provide in-depth information.

Finally, secondary data on reporting rates and order lead time was retrieved from the KHIS. This was done by the principal investigator with the permission of the County Health Records and Information Officer.

Data analysis

Quantitative data generated from the questionnaires was validated to check for completeness, coded and fed into the Statistical Package for Social Sciences (SPSS) version 25. The entered data was then analyzed using descriptive statistics to generate frequency distribution, percentages, averages and standard deviations.

Qualitative data collected from the key informant interviews was recorded and transcribed and organized into themes as per the study objectives. They were then used to provide a narrative alongside the quantitative data.

Ethical consideration

Ethical clearance to conduct the research was sought from Kenyatta National Hospital/University of Nairobi Ethical Review Committee (KNH/UON ERC) in Nairobi, Kenya. Written approvals to conduct the study were also sought for all the 8 facilities from their respective in charges. Informed consent form was used to tell eligible participants about the study. Eligible staff who were voluntarily ready and willing to participate in the study were each required to sign the informed consent form.

Results

Sociodemographic characteristics Out of 37 questionnaires distributed, 36 were filled and retrieved representing a response rate of 97.3%. The participants comprised of 13 (36.1%) pharmacists, 8 (22.2%) ART nurses and 15 (41.7%) administrators (Table 1). Majority were male (28, 77.8%) and a substantial number (24, 66.7%) were 25-35 years old. Nineteen (52.8%) participants had worked for between 1-5 years.

Table1. Sociodemographic characteristics of participants

Variable	Category	Frequency n (%)
Cadre	Pharmacist	13 (36.1%)
	ART nurse	8 (22.2%)
	Administrators and In-charges	15 (41.7%)
Sex	Male	28 (77.8%)
	Female	8 (22.2%)
Age (years)	Below 25	1 (2.8%)
	25 – 35	24 (66.7%)
	36 – 45	7 (19.4%)
	Above 45	4 (11.1%)
Work experience (years)	Below 1	3 (8.3%)
	1– 5	19 (52.8%)
	5 – 10	12 (33.3%)
	Above 10	2 (5.6%)

Inventory Management Practices

The most predominantly used inventory control model was the forced order system (81. %) while the continuous review system was the least preferred (23.1%). In the determination of order quantities, all respondents used the projective method. The morbidity method was also largely used (17, 81.%). Use of stock keeping records for each ARV medicine, conducting regular stock counts by using the full inventory counting method and using stock records as the source data for procurement and distribution decisions was being practiced by all the Pharmacist participants. The majority (12, 92.3%) had stock records which were accurate and updated.

Consumption, stock on hand and loses as well as adjustments were the most essential logistical data that were reported (100%). Majority (8, 61.5%) of the Pharmacists when asked about their safety stock policy indicated that they included a buffer stock which was determined using a formula (76.9%).

Table 2. Inventory Management practices (n=13)

Variable	Category	Frequency n (%)
Inventory control model	Forced order system	9 (69.2%)
	Continuous review system	3 (23.1%)
	Standard system	9 (69.2%)
Determination of order quantities	Projective method	13(100%)
	Causal method	7(53.7%)
	Judgmental method	5(38.5%)
	Morbidity method	9(69.2%)
Stock keeping	Present for all ARV medicines	13 (100%)
	Accurate and up to date	12 (92.3%)
	Regular stock counts done	13 (100%)
	Full inventory counting method	13 (100%)
	Cyclical inventory counting method	1 (7.7%)
	Source data for procurement and distribution decisions	13(100%)
Logistical data included in reports	Consumption	13(100%)
	Stock on hand	13(100%)
	Loses and adjustments	13(100%)
	Commodities near expiry	11(84.6%)
Safety stock policy	Buffer stock factored	8(61.5%)
	Calculated using standard formula	10(76.9%)
	Calculated using rough estimate	3(23.1%)

As custodians of non-pharmaceutical supplies, a large majority of ART nurses (6, 75%) affirmed that their facilities had stores dedicated for ARV medicines. Meanwhile, the facility in charges and administrators all (15, 100%) unanimously confirmed that the requisition method was in use for the selection and ordering of ARV medicines and they had adequate personnel responsible for managing ARV inventory in their respective facilities.

As per the key informants, standard treatment guidelines were the preferred reference in selection of ARV medicines. Ordering frequency for ARV medicines was monthly. None of the territories that the respondents were managing had all facilities with dedicated stores for keeping ARV medicines.

Recommendations were made by the respondents on ways in which inventory management could be improved. Facilitating more training was universally recommended by all the respondents. Other common recommendations were: recruiting more pharmaceutical staff (5, 83.3%) and continuous mentorship and supervision (4, 66.7%).

Effect of Inventory Management practices on supply chain performance

The most effective approaches in reducing stock out rates and order lead

time were accurate use of stock keeping records and use of a formula in determination of order quantities at 92.3% and 76.9% respectively. Reduction in stock wastage was better achieved by stock keeping and use of a formula in determining re-order quantities (13, 100%) followed by reports (12, 12.3%).

Table 3. Effect of Inventory Management on Supply Chain Performance (n=13)

Inventory management Practice	Effect on Supply Chain performance	Frequency n (%)
Inventory control model	Reduction in stock out rates	10(76.9%)
	Reduction in order lead time	10 (76.9%)
	Reduction in stock wastage rate	9 (69.2%)
	Increase in reporting rates	12(92.3%)
Use of formula in determination of order quantities	Reduction in stock out rates	12(92.3%)
	Reduction in order lead time	10(76.9%)
	Reduction in stock wastage	13(100%)
	Increase in reporting rates	11(84.6%)
Stock keeping	Reduction in stock out rates	12 (92.3%)
	Reduction in order lead time	8 (61.5%)
	Reduction in stock wastage	13 (100.0%)
	Increase in reporting rates	11 (84.6%)
Reports	Reduction in stock out rates	11(84.6%)
	Reduction in order lead time	8(61.5%)
	Reduction in stock wastage	12(92.3%)
	Increase in reporting rates	13(100%)
Safety stock policy	Reduction in stock out rates	11(84.6%)
	Reduction in order lead time	6(46.2%)
	Reduction in stock wastage	10(76.9%)
	Increase in reporting rates	9(69.2%)

Challenges affecting Inventory Management

A number of challenges were identified by the participants (Figure 1). The most common ones were inadequate staff (26, 72.2%), inadequate training (16, 44.5%) unreliable supply of medicines (16, 44.4%) and lack of proper storage (16, 44.4%).The least significant challenges were: incompetent staff (29, 80.6%), poor record keeping (26, 72.2%) and poor reporting (25, 69.4%).

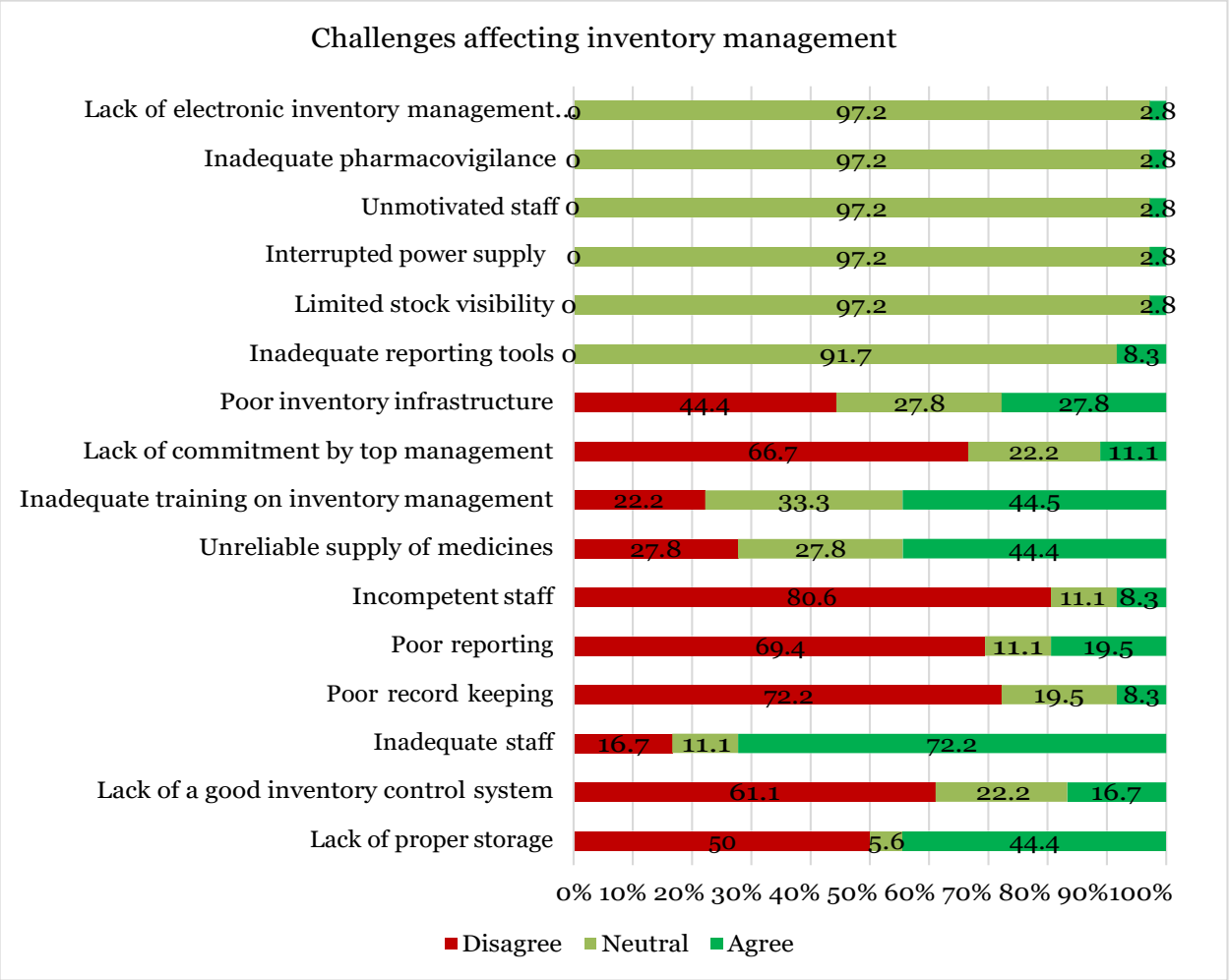

Figure1. Challenges affecting Inventory management

Supply chain performance according to respondents

Slightly more than half (13, 56.52%) of the respondents had experienced stock outs in their respective facilities within the last quarter. Majority (15, 65.2%) had not had expiries within the last quarter. Order lead time was perceived to be short by many (82.61%) respondents while reporting rates were predominantly (86.96%) believed to be meeting the set targets as illustrated in figure 2.

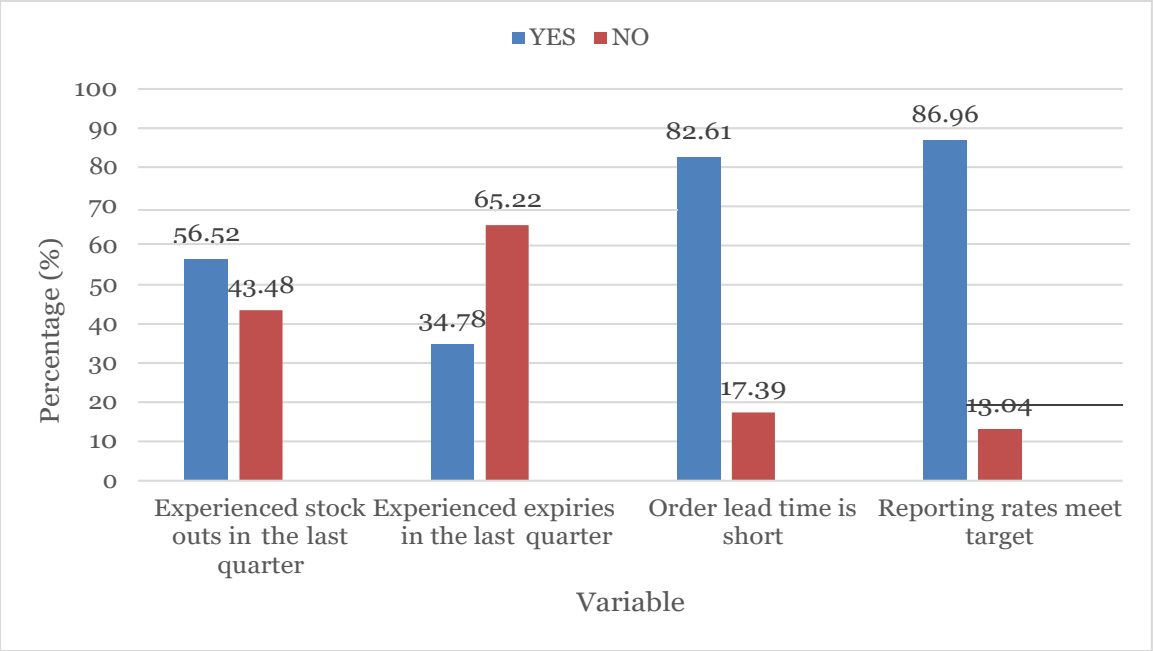

Figure 2. Supply chain performance according to respondents

Supply chain performance evaluation The total number of ARV medicines expected to be in stock were 41. The stock availability across the facilities ranged from a lowest of 16(39.2%) in Hospital F and G to a highest of 24 (58.5%) in Hospital H with an overall average across all facilities being 47.88%. The rest of the facilities had the following stock availability rates: Hospital A and E 19(46.3%), Hospital B 21(51.2%) and Hospital C and D 22(53.7%).

The order lead time ranged from the shortest of 11.3 days in Hospital B to the longest of 23.7 in Hospital A with and overall average of 17.8 days.

Stock wastage rate ranged from a lowest of 0% in Hospital E and G to a highest of 100% in Hospital B, with an overall average of 43.2%.

Table 4. Order lead time of ARV medicines supply

Hospital	March order lead time (days)	April order lead time (days)	May order lead time (days)	Average order lead time (days)
Hospital A	26	18	27	23.7
Hospital B	12	11	11	11.3
Hospital C	28	20	16	21.3
Hospital D	28	20	16	21.3
Hospital E	12	14	9	11.7
Hospital F	12	14	9	11.7
Hospital G	28	18	18	21.3
Hospital H	28	18	18	21.3
			Average	**18**

The reporting rates ranged from a lowest of 58.3% in Hospital G to joint highest of 75% in Hospitals A, B, C, E and F with an overall average reporting rate for all

the hospitals at 70.8%. The percentage reports on time ranged from a lowest of 58.3% in Hospital G to a joint highest of 75% in Hospitals A, B and F with an overall average percentage on time for all the hospitals at 68.8%.

Table 5. Facility reporting rates for the period Jan 2018-Dec 2018

Hospital	Actual Reports	Expected Reports	Percentage (%)	Reports on Time	Percentage on Time (%)
Hospital A	9	12	75	9	75
Hospital B	9	12	75	9	75
Hospital C	9	12	75	8	66.7
Hospital D	8	12	66.7	8	66.7
Hospital E	9	12	75	8	66.7
Hospital F	9	12	75	9	75
Hospital G	7	12	58.3	7	58.3
Hospital H	8	12	66.7	8	66.7
Average	**8.5**	**12**	**70.8**	**8.2**	**68.8**

Discussion

Inventory management practices

Scheduled (forced order) inventory control system was predominantly used and preferred since it helped prevent stock outs and was logistically viable because orders were placed only once at the end of the review period. Nepal's MoH adopted the forced order system due to difficulty of accessing facilities and order timing unpredictability thereby rendering the continuous review model impractical.[5] In a resource constrained setting like Kenya, it appears the scheduled inventory control system is most suitable. It emerged that the predominant forecasting methods in use in determining order quantities were the projective(100%) and morbidity methods (80.95%) which is in line with MSH recommendations for quantifying health commodities that have reliable data on consumption and number of expected patient attendances.[6] With historical consumption data for ARV medicines routinely reported and available on the National Health Information Systems and demographic data available from Demographic Health Surveys and national census, it is easy to see why these methods are in use.

Bin cards and the electronic inventory management tools were present, regularly updated and served as the source data for procurement and distribution decisions across all the hospitals. A similar study done in Uganda unveiled that having accurate stock cards available for each stock keeping unit was crucial in determining stock levels and status.[7]

Quantity dispensed, stock on hand and losses and adjustments emerged as the most essential logistical data reported on as recommended by USAID|DELIVER.[5] Even though safety stock was factored in the facility ARV orders using a formula, literature suggests that more complex advanced methods used to determine safety stock possibly offer little or no significant benefits over simpler techniques.[6] Dedicated storage of ARV medicines separate from other essential medicines or medical supplies being practiced in Nyamira county public hospitals contrast findings of a similar study done in Bungoma where nearly half of the surveyed facilities lacked dedicated stores for keeping essential medicines.[8] Selection and ordering of medicines which was exclusively done using the requisition method according to USAID|DELIVER benefits from the

users having the latest updated information necessary for decision making and developing a sense of ownership of decisions pertaining to orders.[5]

Inadequate training, inadequate staff, oversight and staff turnover unveiled as the causes of inaccurate stock records may have an adverse impact on the performance of inventory at other levels according to a study done in the United States.[9]

The prevalent methods used in preventing stock outs like use of buffer stock and conducting regular stock counts, were complementary to the recommendations of a study done in Tanzania. It advocated for reliable forecasting and proper inventory management as strategies to prevent supply interruption of ARV medicines.[10]

Challenges affecting Inventory Management

The challenges unveiled in this study were comparable to those found in other studies.[8,11] To overcome these challenges, the key informants notably recommended: facilitating more training, recruiting more pharmaceutical personnel and continuous mentorship and supervision which are in line with recommendations from other similar studies.[8,11–13] The possible causes of the high stock out rate discovered in this study are: short duration of expiry, inaccurate quantification and poor supply systems. The moderately high stock wastage was attributed to the change of treatment guidelines since majority of the expired ARV medicines such as Zidovudine/Lamivudine/Nevirapine discovered on the day of site visit were no longer preferred in HIV/AIDS treatment. The relatively short order lead time which was also perceived to be reasonable by the respondents seems to suggest that the central store and distribution system for ARV medicines was efficient. The unsatisfactory reporting rates is consistent with an assessment of health commodities supply chains in Kenya done in 2001 by JSI that unearthed poor reporting particularly on consumption patterns and levels of stock.[13] USAID|DELIVER recommends that for supply chain managers to make good use of data, just like the products, the right data of the right quality, must be in the right quantity, at the right time, in the right place and at the right cost.[5]

Notably, the below par reporting rates were attributed to a major health workers strike that happened in the year 2018 in Nyamira County.

Strengths and weaknesses of the study

This study had a number of strengths to highlight. First, mixed research methods namely, key informant interviews, questionnaires, checklist, and secondary data from the national health information systems were used. This provided rich and comprehensive findings on the inventory management practices and supply chain performance that were being evaluated. Secondly, we received a high response rate for both the questionnaires and key informant interviews which makes the data received representative. Third, all relevant health workers involved in ARV commodity management were invited to take part in the study, boosting the reliability and accuracy of the findings.

The study also had some limitations worth acknowledging. Firstly, since the study was only limited to public hospitals in Nyamira County due to cost and time constraints, the findings may not give a general picture of the inventory practices in the entire County of Nyamira since majority of the public health facilities offering ARV medicines are of lower levels, namely dispensaries and health centers. Secondly, the study

focused only on ARV medicines and therefore the findings may not be generalized to the inventory practices and supply chain performance of other health commodities such as reproductive health commodities, other essential medicines, laboratory commodities, vaccines and medical supplies in public hospitals.

Conclusion

Inventory management practices were according to the recommended best approaches despite various challenges. The supply chain performance metrics evaluated, with the exception of order lead time, were all found to be unsatisfactory owing to the high stock out rates, below par reporting rates and high stock wastage rate due to expiries discovered. The relatively short order lead time which was also perceived to be reasonable by the respondents seems to suggest that the central store and distribution system for ARV medicines was efficient.

Conflict of interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Contribution of Authors

JA conceived the study, collected, analyzed the data, and drafted the manuscript. PN & SM conceived the study and reviewed data. All authors revised the manuscript critically and approved the final version.

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