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A Review on laboratory logistics management information system in HIV commodities supply

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Abstract

This review starts with a discussion of the literature review and conceptual framework, which describes a pull/push system of logistics management. It also discusses conceptual review which covers areas such as the definition of logistics, history of logistics/supply chain management, logistics management of health commodities, maximum-minimum inventory control system, logistics management information system, records and reports and logistics reports. The chapter is concluded with empirical review of related studies on LMIS.

Keywords: laboratory logistics, management information system, in HIV, commodities supply

Introduction

Conceptual Framework

A conceptual framework is an analytical tool with several variations and contexts, which is used to make conceptual distinctions and organize ideas. It contains both narrative text (such as the hypotheses and key factors, constructs or variables) and a schematic, which illustrates the relationship between them. A thorough framework also helps researchers make meaning of their findings.

Pull or Push System

Once a choice of the maximum-minimum system for a programme has been made, the designer of a programme must also decide where the decision-making power lies for determining reorder quantities; whether it will be a pull or push system. The system is a "pull" if the personnel receiving the supplies make the decision but if the personnel issuing the supplies make the decision then it is a "push" system. HIV/AIDS programmes in Nigeria use the "pull" system, where the facilities use the logistics data they collect to determine their own order quantities (FMOH, 2011).

Logistics

Cooper and Ellram (1993) defined logistics as the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from point of origin to point of

consumption for the purpose of conforming to customer requirements (Ughweroghene *et al*.,2017).

Edward (2002) defined logistics as the flow of materials, information and money between consumers and suppliers. It incorporates the planning and execution of activities to move products from origin to destination.

Owens and Warner (2003) in their publication, "Concepts of Logistics System Design", see logistics as the time related positioning of resources while Chandani (2004) defined logistics as having the right item in the right quantity at the right time at the right place for the right price.

Larkia (2008) sees logistics from two fundamentally different forms. One optimizes a steady flow of material through a network of transport links and storage mode while the other coordinates a sequence of resources to carry out some project.

Logistics is the process of strategically managing acquisition, movement and storage of materials (inventory) through the organization and its marketing channel in such a way that profitability is maximized through cost effective fulfilment of orders (Stock and Lambert, 2001). It forms part of the supply chain process that implements, controls and ensures an effective flow of stored goods, services and related information from the point of origin to the point of consumption (Hugo *et al*., 2002).

The Chartered Institute of Logistics and Transport (CILT) of the United Kingdom defined logistics as the management of the flow of goods, information and other resources, including energy and people, between point of origin and the point of consumption in order to meet the requirements of consumers. The Institute concluded that it involves the integration of information, transportation and inventory, warehousing, material-handling and packaging.

History of Logistics/Supply Chain Management

According to Stock and Lambert (2001), Logistics has always been a critical part of the 4Ps in marketing; Product, Price, Place and Promotion. The "Place" component ensures that the product is at the right place, at the right time, in the right quantity and the right quality.

The prevalent view is that the term logistics comes from the late 19th century: from French logistique (logger means to lodge). Others attributed a Greek origin to the word: λόγος, meaning reason or speech; λογιστικός, meaning accountant or responsible for counting (Tepic *et al*, 2011). Logistics is considered to have originated in the military's need to supply themselves with arms, ammunition and rations as they move from their base to a forward position. In ancient Greek, Roman and Byzantine empires, there were military officers with the title "Logistikas" who were responsible for financial and supply distribution services. This was done to enable the soldiers to move from their base position to a new forward position efficiently, which could be a crucial factor in determining the outcome of wars. This also involved inflicting damage to the supply locations of the enemy and safeguarding one's own supply locations. Thus, this led to the development of a system which can be related to the current day system of logistics management (Coyle and Novack, 2006).

Logistics Management of Health Commodities

A logistics system that manages health commodities should have established infrastructure which supports the supply chain as a whole in order to manage and move the commodities (FMOH, 2011). The required infrastructures are:

I. A commodity resupply pipeline
II. An information system for gathering and using commodity data
III. Storage facilities, including cool storage facilities
IV. A distribution system (pickup or delivery), based on the availability of reliable transportation
V. Staff/human resources to implement the system

Maximum-Minimum Inventory Control System

Maximum-minimum (max-min) system is a system that allows objective resupply decisions based on need, using established levels of safety stock, to ensure that the products are available each and every time they are needed. This is very important and of primary concern to implementers of an HIV/AIDS programmes given the life-saving nature of ART and the public health risks associated with the emergence of ARV drug resistance (John Snow/DELIVER, 2001; John Snow/DELIVER, 2003; USAID/DELIVER 2008; FMOH, 2011).

The maximum stock level for HIV/AIDS commodities in Nigeria is four (4) months of stock, and is based on factors such as lead time (the amount of time needed to place an order, receive commodities, and make them available for use), safety stock (also called buffer stock), and the review period. When products are ordered to the maximum stock level, it helps to ensure that all products are regularly available. As consumption increases or decreases, the maximum stock quantity self-adjusts (based on the most current rate of consumption), hence facilities consistently maintain four months of stock (FMOH, 2011).

According to John Snow/DELIVER (2001), John Snow/DELIVER (2003), USAID/DELIVER (2008) and FMOH (2011), the different types of max-min inventory control systems, with each having slightly different transportation, personnel training, and storage requirements, etc. are:

a. Forced ordering: This involves the placing of all orders at regular intervals and the resupply of what is ordered to bring the products to the maximum stock level.
b. Delivery truck variation of forced ordering: In this type of the max-min system the service delivery facilities are visited regularly (the length of the reporting period) by a resupply truck from the supplying facility rather than submitting orders to the supplying facility and data are collected and resupply quantities are determined and delivered at the time of the visit.
c. Continuous review: Here the using facility places orders each time any product reaches its minimum established stock level and resupply is made to bring the product to the maximum stock level.
d. Two-bin variation of continuous review: Bin sizes are determined by the system designers so that one bin equals the estimated consumption for one reporting period. When the contents of one bin have been distributed (i.e., at the end of the reporting period), a new bin is resupplied to the dispensing facility.
e. Standard: In this type, there is the placing of orders at regular intervals, but products are ordered only if they have reached their minimum stock level and resupply is made to bring them to the maximum stock level.

In the design of a logistics system, one of the first decisions made is the type of max-min inventory control system to use. HIV/AIDS programmes in Nigeria use the forced ordering type of max-min inventory control system, where the facilities are "forced to order" all commodities at the end of every review period when they review their HIV/AIDS commodities and order all stocks to the established maximum level. The review period and order interval is every two months (bi-monthly), so that at the end of every two months, the facilities must place an order for their products (FMOH, 2011).

Logistics Management Information System

According to FMOH (2011), "the purpose of a logistics management information system (LMIS) is to collect, organize, and report information to other levels in the system in order to make decisions that govern the logistics system and ensure that all six rights of logistics are fulfilled for each client".

Logistics Management Information System is the system that helps personnel involved in the management of a programme commodities in the timely collection and management of the information necessary to support sound and objective decision making in managing the supply chain of the commodities, so as to ensure an uninterrupted supply of commodities and to identify any problems in the supply pipeline. LMIS and the inventory control system have a close relationship: the LMIS provides the data required to maintain the inventory control system. It is composed of all the forms and documentation used to maintain records and produce reports on the logistics system (John Snow/DELIVER, 2004).

The data collected through the LMIS helps the facility store manager to determine how many months of stock are currently kept at the facility and therefore to know if the supply is above, below, or within the established maximum and minimum stock levels, or whether an emergency order should be placed. At the end of the order interval, the store manager compares current stocks to maximum stock level and order the quantity needed to bring stock levels to maximum (John Snow/DELIVER, 2004; FMOH, 2011).
Supply Chain Management System (SCMS) uses the LMIS to track trends in overall consumption and for the adjustment of national-level procurements as needed. They also use the information to identify overstocks of products and therefore redistribute them to prevent wastages. The supplying facility can also use the data to identify exceptionally high levels of product expiry, and then initiate action to prevent this

situation from recurring (FMOH, 2011; John Snow/DELIVER, 2004).

The LMIS for HIV/AIDS programmes in Nigeria includes the following three essential data items (FMOH, 2011):

a) Consumption Data: The quantity of drugs dispensed to users or the quantity of lab tests and consumables used on clients during the reporting period.
b) Stock on Hand: The usable quantities of stock held at a facility at a particular point in time
c) Losses and Adjustments: Any quantity of stock that leaves the pipeline (facility) for reasons other than dispensed/used—transfers of stock from one facility to another at the same level, expiry, or damage

This logistics data are used by the service and supplying facilities to answer the following questions:

I. How long will available stock last; do we need to order more commodities now?
II. Where are our supplies in the pipeline; do we need to move supplies from higher to lower levels or between facilities at the same level?
III. Where is consumption the highest? Do those facilities need more commodities?
IV. Are we experiencing losses from the system that require us to take action?
V. Are supplies flowing regularly through the pipeline? Do we need to adjust the pipeline to eliminate bottlenecks in the system (John Snow/DELIVER, 2004)?

Records and Reports

The purpose of a logistics system is to collect and process data to support decision making. A well designed logistics management information system includes records and forms that collect and then report the three essential data items of LMIS (John Snow/DELIVER 2001; USAID/DELIVER, 2008 and FMOH, 2011).

According to FMOH (2011), the records and forms for HIV/AIDS programmes in Nigeria are:

- Consumption records that capture data about the products being used or dispensed e.g. usage logs, dispensing registers or consumption registers.
- Stock-keeping records that collect information about products in storage e.g. stock cards, bin cards, inventory control cards or tally cards.
- Transaction records that collect data on the movement of stocks from one point to the other e.g. delivery notes, requisition and issue vouchers, combined Requisition, Issue and Receipt Form (CRRIRF), record for transferring/returning commodities, and waybills.

Logistics Reports

Reports are forms on which data are moved from one level in a logistics system to another. They are the mechanism through which logistics information is communicated from one level of the system to another. Logistics records are used mainly to collect primary data while logistics reports typically include processed or aggregated data, stock on hand, and losses and adjustments. Logistics reports are transmitted from the lower levels to the upper levels of the supply chain John Snow/DELIVER (2001; John Snow/DELIVER, 2003; USAID/DELIVER 2008).

The following reports are used to manage HIV/AIDS commodities in Nigeria (FMOH, 2011):

i. The Combined Report, Requisition, Issue and Receipt Form (CRRIRF) which is used to report the three essential logistics data items in an LMIS and to calculate the service facility order quantities, as well as to provide the information that is needed to monitor whether the facilities are maintaining stock according to plan, i.e. no overstock, shortages, or stock outs. It is also used to report consumption/usage during the reporting period and the stock on hand at the time of reporting, and to complete requisitions and issues of commodities. Furthermore, it serves as a transaction record, which tracks the quantities of products requested by the facility, issued by the supplier to the facility, and received by the facility from the supplier (John Snow/DELIVER, 2001; John Snow/DELIVER, 2003; USAID/DELIVER, 2008.

ii. Feedback Reports: Feedback reports are often used to provide information from the higher (supplying facility) to the lower (receiving facility) levels of the system. In this way, lower-level facilities can gain an appreciation of how the

work they do fit within the overall system and see how lower-level operations can be improved. Feedback reports also give the facilities information about what they could be doing better (i.e., in filling out their forms) and shows them that the information that they are submitting is being used and disseminated throughout the system (John Snow/DELIVER, 2001; John Snow/DELIVER, 2003; USAID/DELIVER, 2008). In Nigeria, data reported to the Logistics Technical Working Group is aggregated, processed and analyzed to produce feedback reports that are used by programme and commodity managers to monitor the performance of the HIV/AIDS commodities logistics system (FMOH, 2011).

Empirical Review

The concept of logistics has for years been the key or architect of many organizations. It has been used and studied as a variable in different forms by several researchers for the purpose of finding solutions to organizational problems and development.

A number of studies conducted to assess the status of LMIS for the implementation of HIV/AIDS programmes, had majority of them showing that implementation of LMIS is a serious problem in many areas as indicated by presence of inaccurate logistics data, frequent expiration and frequent stock outs of key commodities and that logistics management tools did not capture the three essential logistics data items (stock on hand, consumption and losses and adjustments) required for decision making (Allers & Riwa, 2001; JSI/DELIVER, 2003; Jabulani *et al.*, 2005; Akwei *et al.*, 2006; Francis *et al*, 2006; Andy *et al.*, 2008; Pharasi, 2007; Butao *et al.*, 2009).

Review of Related Studies

The Influence of Family Planning Logistics Systems on Contraceptives Use

Ali (2006) studied the interaction between logistics activities and a wide range of other factors that influence contraceptives use and concluded that contraceptives use would drop by nearly one-fifth in developing countries with less efficient supply chain management. According to him "because well-functioning supply chains improve contraceptive availability and because contraceptive availability heavily influences utilization, investments in logistics systems are among the best ways to extend the reach of family planning programs".

Assessment of HIV/AIDS Medical Supplies and Laboratory Commodities Supply Chain in Lesotho

Pharasi (2007), in an assessment that was conducted in Lesotho to see the status of laboratory capacity to support the scale-up of ART(HIV/AIDS) programme, reported that laboratories experienced frequent and prolonged stock-outs of key reagents. Haematology reagents were stock out for months. Most of the laboratories did not set minimum and maximum stock levels. Also, most of the laboratories had no stock/bin cards to track laboratory commodities. He also reported that there were no developed LMIS guidelines on how to determine orders and few laboratory staffs were trained in LMIS. Storage spaces were inadequate and poorly ventilated. Some laboratories reported that reagents were not stored according to the first expiring first out (FEFO) practice. None of the laboratories practiced the separation of damaged/or expired supplies from usable products and storage spaces were small. The author concluded that the placing of orders was erratic and inconsistent and data collected in the LMIS was not reliable due to poor record keeping.

Zimbabwe HIV and AIDS Logistics System Assessment

A cross-sectional facility-based survey which was conducted in Zimbabwe by Jabulani *et al*. (2005) showed that 34.4% and 31.9%of the facilities studied reported that they were stock out for Unigold and Determine HIV rapid test kits (RTKs) respectively during six months before the assessment. In 3.2% of the facilities assessed there was stock out of Unigold and Determine HIV test kits on the day of visit. Average duration of stock outs was 24 and 21 days for Unigold and Determine HIV test kits respectively. Also, 25.9% and 19.7% of facilities had less than the minimum stock levels for Unigold and Determine rapid test kits respectively. Furthermore, 38.9% and 30.6% of facilities had higher than the maximum stock levels for Unigold and Determine HIV test kits respectively. Seventy five percent of the facilities maintained stock/bin cards for rapid test kits from which 80% of them were updated. Sixty percent of the facilities recorded stock on hand that differed from the physical inventory on the day of visit. None of the facilities had expired Determine and Unigold test kits.

Eighty percent of facilities maintained the ideal storage conditions. They reported that majority of laboratory staff were not trained on LMIS.

Preliminary Assessment of HIV/AIDS commodity needs and Logistics Capacity in Tanzania

A study that was done in Tanzania by Allers and Riwa (2001), which was earlier before the introduction of LMIS, showed that there was no logistics data (consumption, stock on hand, losses and adjustments), no standardized inventory control systems, physical inventory and monitoring of expiration dates were not carried out. The authors concluded that logistics information for laboratory commodities were unavailable, outdated or underestimates demand because of underreporting and inaccurate logistics data.

Commodity Availability for Selected Health Products Baseline Survey for Integrated Logistics System in Tanzania

Another study that was done in Tanzania by JSI/DELIVER (2003) showed that 14 % of hospitals were stock out for rapid test kits on the day of visit. Nineteen percent of hospitals were stock out for rapid test kits during six months before the assessment. Highest duration of stock outs were for Determine test kits which was 184 days. Seventy-eight percent of facilities had received supervision for LMIS. Sixty-eighty percent storage areas were in compliance with storage guidelines. The overall condition of the storerooms and their inadequate size were the two weakest areas noted in the storage conditions of the survey.

Assessment of Ghana Laboratory Logistics System and Services

A study in Ghana showed that there was no minimum /maximum stock level for laboratory supplies, LMIS was limited to HIV test kits, and laboratories did not maintain stock cards and laboratory staff were not regularly aware of the stock status in the stores due to minimal communication between the storekeeper and the laboratory staff. Moreover, there was no standard ordering schedule and procedures in the system. Storage facilities had adequate space and 83.3% of facilities followed FEFO guidelines. Expired laboratory commodities were not removed on time (Akwei *et al.*, 2006).

Assessment of Uganda laboratory logistics system

A health facility survey conducted in Uganda showed that many laboratories experienced frequent stock outs and delay in receipt of key commodities, such as HIV rapid test kits, chemistry reagent and chase buffer. There were no standardized LMIS forms and many staff members had not been trained in LMIS. The authors concluded that supply chain deficiencies affected the availability and the quality of laboratory services in the country (Francis *et al.*, 2006).

Malawi Laboratory Services and Supply Chain Assessment

A study in Malawi showed that minimum/maximum stock level and emergency order points (EOP) were not set for laboratory commodities and that 70% of hospitals had stock/bin cards for laboratory commodities in the store. However, majority of the stock/bin cards were not kept up-to-date. Also, no stock/bin cards were used in the laboratory store, all hospitals used standardized LMIS format. Twenty-eight percent and 60% of facilities were stocked out for CD4 and glutamate oxaloacetate transaminase (GOT) reagents respectively. Eight percent and 25% of facilities were stock out for Determine and Unigold test kits respectively on the day of visit. Furthermore, 50% of the storage facilities were in compliance with proper storage guidelines, separate storage of hazardous reagents and absence of written storage guidelines were the two weakest storage conditions found (Butao *et al.*, 2009).

Survey of HIV/AIDS commodities supply chains in Tanah Papua

A study conducted in Tanah Papua region in Indonesia by Andy *et al*. (2008) showed that supply chain of HIV/AIDS laboratory commodities was well maintained. However, the authors reported that there were challenges such as poor inventory management with stock holdings out of balance, poor logistics data and record keeping, poor management of expiry dates due to the “push” logistics management information system that is practiced in that country.

Supply Chain Assessment for ARV Drugs and HIV Test Kits

A cross-sectional descriptive and qualitative assessment of supply chains for HIV test kits in Sierra

Leone showed that there were no standardized LMIS for collection and reporting of essential logistics data on consumption, losses and adjustments, stock balances of HIV tests were not accurate, stock cards were in use at some of the facilities but they had not been updated in one or two years, the data on stock cards did not match the physical count. There were no standardized inventory control systems with procedures for monitoring and managing stock levels of HIV test kits at all levels of the logistics system. As a result, national HIV/AIDS Secretariat was unable to detect and address stock imbalances in a timely fashion to avoid stock outs and overstocking throughout the country supply pipeline (Allers *et al.*, 2007).

Assessment of Health Commodity Supply Sector in Rwanda

An assessment of health commodity supply in Rwanda showed that 42% of facilities had expired HIV related laboratory commodities, 69%, 53%, 22% and 11% of facilities had adequate stocks for Determine and Unigold rapid test kits, creatinine and bilirubin reagents respectively. Seventeen percent of facilities had Vacutainers tubes, GPT, GOT and glucose reagents. About 39% of facilities had stock outs of rapid test kits. 3.4% of facilities had stock outs for glutamate pyruvate transaminase (GPT), glutamate oxaloacetate transaminase (GOT) and alkaline phosphates (ALP) reagents. Inventory control procedures were poor and most proper storage conditions were not met by stores (Lijdsman *et al.*, 2003).

Integrated Logistics System Pilot-Test Evaluation in Tanzania

Assessment of integrated logistics system performance in Tanzania showed that 35% of laboratories were stock out. Of these, 10% were stock out for rapid HIV test kits. Order fill rate was accurate in which laboratories receive equal amount of quantities ordered. Thirty seven percent of facilities had stock/bin cards of which 69% were updated. Fifty-eight percent of facilities had stock/bin cards forms for rapid test kits of which 91% were updated. 16% of facilities had reported stock outs (Barry *et al*, 2005).

Impact of Ethiopian National Laboratory on Logistics System on the Harmonization of Laboratory Commodities

An assessment of the impact of the national HIV/AIDS laboratory logistics management information system on the harmonization of laboratory commodities in Ethiopia by EHNRI through technical support of SCMS claimed that, after implementation of the national HIV/AIDS laboratory logistics management information system, stock outs, number and frequency of emergency orders and commodity wastage were decreased dramatically. In addition, laboratory reagents and related supplies were arriving on time in quantities needed. As a result, patients waiting time for tests reduced significantly (Nigatu *et al.*, 2009).

Assessment of Laboratory Logistics Management Information System Practice for HIV/AIDS and Tuberculosis Laboratory Commodities

Desale *et al.* (2013) reported the existence of a well-designed logistics system for laboratory commodities, standard LMIS formats and established inventory control procedures for laboratory commodities in Ethiopia. They, however, reported that most laboratory professionals involved in commodities management were not trained in LMIS and that most of the facilities studied had stock out for at least one ART monitoring test reagents. Expired ART monitoring laboratory commodities were found in 73.5% of the

facilities assessed. They also reported the use of stock/bin cards for all HIV/AIDS laboratory commodities, but that very few were updated with accurate information matching with the physical count and that key ART monitoring laboratory commodities were stock out at many facilities for up to six months.

Baseline Assessment of the HIV/AIDS Related Commodities' Logistics System

A study by MAUL (2013) reported that less than 50% of the facilities assessed had staff that had not been trained on logistics management system of health commodities and that LMIS was available in only 5% of the facilities. None of the facilities had ordering tools for HIV/AIDS laboratory commodities. It also reported that 49% of the facilities had updated stock/bin cards on the day of visit and 96% of them practiced first to expire, first to out (FEFO). Furthermore, 73% of the facilities have adequate storage space and 23% had expired commodities, out of which 5% did not have the expired stocks separated from usable stock, thereby posing a risk of issuing out expired commodities. Sixty six percent of the facilities

studied reported to have made emergency orders for commodities in the 6 months prior to the study and 43% maintained the recommended mii-max 2-4 months of stock. Also, 22.7% of the facilities had internet connection and computer and electronic system in place to capture inventory and consumption of commodities.

Health Commodities Management System: Priorities and Challenges

Lastly, Ibegbunam and McGill (2012) conducted a study on the priorities and challenges of health commodities management system and recommended a coordinated and integrated health commodity management system, sustainable human resource and infrastructure development and an effective data management system to address the challenges identified in the system.

Conclusion

Logistics is the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. Logistics is the process of strategically managing acquisition,

movement and storage of materials through the organization and its marketing channel in such a way that profitability is maximized through cost effective fulfilment of orders. The maximum stock level for HIV/AIDS commodities in Nigeria is four months of stock, and is based on factors such as lead time, safety stock, and the review period. When products are ordered to the maximum stock level, it helps to ensure that all products are regularly available.

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