Indian Journal of Pharmacy Practice., 2023; 16(3):181-190.
https://www.ijopp.org

Review Article

Healthcare Commodity Logistics Management Systems: A Review

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ABSTRACT

Health commodities are critical and indispensable component of the total healthcare package needed to deliver quality healthcare to patients and communities. Effective delivery of healthcare will hardly be possible without drugs (medicines) surgical consumables, palliative materials and other items like diagnostic kits, medical laboratory chemicals, reagents and other sundry patient care commodities. Good knowledge and competence in the management of health commodities is important for health practitioners who are often the custodians of such products. Unfortunately, the study of commodity logistics and management in the health-based faculties of many universities especially in the developing nations is either completely lacking or do not receive adequate credit loads. The purpose of this review is to present in a narrative manner the basic concepts and language of logistics and commodity management, for the benefit of the Pharmacy and other health discipline teachers, students, practitioners and researchers. The introductory part of the work briefly reviewed the history and definitions of logistics as wells as some basic concepts encountered in health commodity logistics practices Attention was also devoted to some functional concepts and tools used in commodity management especially in health facilities. The expanding roles of logistics and commodity management in waste management, reverse logistics, green environment and effective healthcare services delivery were also reviewed. The simplicity and rudimentary approach and language employed in the review will likely stimulate the understanding and interest of the readers and researchers in the subject of commodity logistics and logistics management systems.

Keywords: Commodity, Logistics management, Inventory management, Supply chain management, Stock statues, Green logistics, Reverse logistics.

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Received: 19-01-2023;
Revised: 13-03-2023;
Accepted: 06-04-2023.

INTRODUCTION

Prehistoric commodity management activities were believed to have evolved from early man's need for food, shelter and security. There was always the need to move out from man's place of abode to sources of food meat and water and the necessity to convey these materials to his home, distribute them to his kits and kins and then store enough for future use. Researchers are however, of the view that modern logistics thoughts and practices had their origin in ancient Greek and Roman Empire wars and the British military operations.[1] Probably due to the swift nature of military engagements, organised equipment and material supply systems were always a vital component of operational readiness and the core mandate of the military logistics department. Healthcare commodities are as vital in the healthcare systems as are arms and ammunitions in war times. Efficient and effective commodity supply, management and distribution system is very critical for effective healthcare delivery services as espoused in the popular saying, "no commodity, no program." Hardly can healthcare services be complete without health commodities like drugs, treatment, diagnostic and surgical consumables and diagnostic materials like test kits, laboratory chemicals and reagents among others. Seamless supply of both treatment and preventive commodities was a major tool the world utilized to overcome the COVID-19 pandemic and the HIV/AIDS out breaks. Given that health commodities are usually subject to expiry, are used only on true need; often supplied on third party demand and are generally life-saving, their efficient stock control is important to avoid losses, misuse and stock outs. It is also necessary that healthcare commodity managers acquire relevant knowledge on commodity logistics and supply chain management. On the contrary, many health practitioners, teachers and researchers in health-related disciplines hardly have even rudimentary knowledge of formal commodity logistics management systems. Many University faculties of Pharmacy do not have health commodity management in their training curricula; yet, many of them in practice get involved in the management of large volume

DOI: 10.5530/ijopp.16.3.30

health commodities. The current review was, an attempt to fill the gap between training and practice and to support trainers enrich their current knowledge of the basic concept of health commodity logistics and logistics management systems.

Definition and description of logistics

The term logistics has attracted variety of definitions from authors, researchers and even experts, possibly due to its abstract nature and the newness of formal training and research on the subject. Some authors have actually confessed the use of logistics and logistics management interchngably.[2] Literature is also awash with variety of definitions logistics, logistics management and logistics management systems. The Global Health Learning Centre defined logistics as, "the process of getting goods through the supply chain from the point of origin to the point of consumption"[3] while Izwan *et al.*[4] defined it as, "the management of the flow of products or services from the point of origin to the point of consumption". In his definition, Bowersox[5] (2013) highlighted the information transfer aspect of logistics while defining it as "a wide range of important activities for the transfer of goods, services and related information from one point to another." The definition that tend to capture the wider scope and essence of logistics was given by the Council of Supply Chain Management Professionals (CSCMP) which described 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 and which includes inbound, outbound, internal, and external movements and return of materials."[6] This review chooses to define logistics as all the range of relevant operational and documentary activities that facilitate the transfer of goods, services and related information from a point of origin to the point of consumption or use and the associated inventory management as well as the reverse activities by which materials or by-products (including wastes) may be transmitted from the original destination back to their sources or to other points for reuse, recycling or disposal. This definition highlights not only the movement aspects of commodities from one point to another but also the role of documentation and the inclusion of backward movement of usable or non-usable components of the commodity to new destinations for destruction, recycling or redistribution.

Logistics system

A logistics system may be described as a combination of specific logistics activities that are put together and that interplay in a systematic manner to achieve the logistic goal of an organization such as a hospital, health program, and government ministry or department. Different organizations may adopt different product delivery modes, different reporting tools and reporting/review period, maximum and minimum stock levels, commodity delivery lead times, push or pull systems and so on. These specific activities and how they interact to achieve a logistics outcome defines the logistics system of an organization.

Logistics management system

The Council of Supply Chain Management Professionals defined Logistics Management System (LMS) as, "the part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirement."[6] This definition views LMS as the logistics level version of performing the wider functions of organizational management which encompass planning, implementation, monitoring and controlling of the daily activities of an organization. A more simplistic definition is that given by Behzadi *et al.*[7] which viewed LMS as, the peculiar approaches adopted by an organization for conducting the basic function of management specifically to achieve the mandate of the logistics department. The resources managed in logistics can include physical items, such as health commodities and abstract items, such as time, information, records and data.[8]

Functions and the six "rights" of a logistics system

The restaurant model has become an acknowledged model for demonstrating the operation and function of the logistics system. In this classical illustration, the customer who goes to the restaurant to buy food is the consumer while the food is the commodity. The kitchen is the point of origin of the food while the customer's table is the point of consumption. All the activities deployed to ensure that the right quality and quantity of customer's choice of food is delivered to him at a good cost and time and in a manner that elicits the customer's satisfaction constitute the six rights and functions of a logistics system. Restoration of the patient's health by provision of needed health commodities is the primary function of the health commodity logistics systems. These functions are summarized in the so called six rights of logistics which include; "Right commodity in the Right quality in the Right quantity delivered to the Right place at the Right time for the Right cost."[2] Failure to uphold any of these rights will impact negatively on the logistic services and affect the quality of health services delivery and patent's satisfaction.[9]

The logistics cycle

Several interconnected activities namely; product selection, product quantification and procurement as well as inventory management of commodities are carried out in a cyclic fashion to support and keep the logistics system running effectively and ensure continuity of service that guarantee the six rights of logistics and patient satisfactory health outcomes. The major and components of the logistics cycle are shown in Figure 1. The logistics cycle generates and provides information to the central Logistics Management Information Systems (LMIS) for the

supervision, monitoring, organization, control and evaluation of the entire logistics system.

The ultimate aim of the logistics cycle is "serving customer" or patient (in case of health commodities). Product selection, quantification and procurement are carefully carried out to meet the specific and general needs of the patients. Every other component of the logistics cycle, therefore, derives its relevance from its role in serving the patient/client. Inventory management ensures commodity security for the patient while product selection is also determined by the needs of the patients as well as other factors like, the National Essential Medicines List (EML), disease prevalence, existing stock statues, budget outlay and regulatory approvals.

Quantification is the process of estimating the quantity and cost of the products required by the program, facility or state for a given period of time. The maximum – minimum stock level (see below) principle is a vital logistics tool for determining the quantity of commodities to procure. Similarly, procurement activities depend not only on quantification figures but also on availability of fund, supplier options, internal procurement policy regulatory issues and product availability. In most public sector health systems, selection, quantification and procurement are done centrally at the central medical stores or by institutional procurement board/committee. Down line facilities pick their products from the Central Medical Store (CMS) by pull or push methods. Efficient procurement system ensures uninterrupted availability of commodities at all levels and at affordable costs. Procurement should follow a set of specific procedures that ensure an open and transparent process which supports the six rights of logistics systems.[10]

The inventory management, commodity storage and distribution are other vital elements of the logistics cycle. Commodities must not just be delivered to various logistics levels but ultimately to the service delivery points like health facilities (hospitals, health centers, health posts and health outreach centers). More importantly the inventory management activity delivers commodity to the patient and ensure its continuous availability by maintaining proper stocking and re-ordering system.

Figure 1: The logistics cycle.[2]

The so-called engine or heart of the logistics cycle is the central Logistics Management Information System (LMIS) which represents management activities that support, evaluate, control and motivate the other elements of the cycle. The double-headed arrows in the figure illustrate the two-way relationship between the elements and the management. The management receives periodic logistics information from different points and uses such information and data for planning, decision making and control.

In the logistics cycle, quality monitoring moves along with other components emphasizing the need for quality of commodity, information and services. Each of the elements of the LC expects quality input from the preceding element while being expected to give high quality output to the next component. Prevailing organizational and governmental policies and regulations, competitions and cultural issues are some of the factors that constitute the environment of the logistics system. They must be logistics and commodity friendly for optimum logistics operation. Robust logistics system must also be flexible and adaptable to constantly changing realities like epidemic, decline in funding, unexpected demand for products, disruption in supplies and other unexpected circumstances.

The Logistics Management Information System (LMIS) and the Combined Report, Requisition, Issue and Receipt Form (CRRIRF)

Logistics Management Information System is the component of the logistics cycle that collates and presents logistics information and data in a comprehensive, easy-to-understand and useable manner. The purpose of an LMIS is therefore, to collect, organize, report and present information and data for use in the same or other logistics levels.[11] The LMIS utilizes variety of forms also known as LMIS tools to generate both primary and secondary records and data. The most generally used primary tools include; the daily consumption register, inventory control records (stock and bin cards), commodity receiving/transferring records or issue records and the transaction records. The Combined Report, Requisition, Issue and Receipt Form (CRRIRF) is the major secondary tool/form that collates analysis and reports information and data received from the various primary forms.[12] Figures 2-5 shows some LMIS tool/forms.

Essential logistics data elements

Three major logistics information generally known as the three essential logistics data elements are indispensable for logistic planning and decision making. These elements which are captured on every CRRIRF tell the concise story of the performance of the logistics system. Top managers need them for evaluating, monitoring, planning and predicting system activities. The essential elements which are in columns A, C and

D/E of the above CRRIRF include: stock on hand, consumption and losses/adjustments.

Stock on Hand (SOH) refers to the commodities that are physically available and in good condition and ready to be used or dispensed to patients. SOH does not include expired or spoilt stock even if such are currently in the store or warehouse. However, it includes the totality of such commodity in the pharmacy store, main pharmacy/ dispensary, satellite points and even the ward stock. Commodities already dispensed to in-patients (including those yet to be administered), commodities on transit and commodities issued to other sites (even if they are still within the issuing facility) are not considered as stock on hand.

Consumption is the quantity of commodity dispensed or issued to /for patient service within a particular period generally referred to as reporting period. The term "consumption" is used when the commodity is directly taken/ingestion by patients by any route of administration (oral drugs, food supplements creams, inserts and others). For consumables like test kits, reagents, chemicals, surgical disposables, orthopaedic and rehabilitation materials, the term "issued" is preferred.[13] Average Monthly Consumption (AMC) refers to the average quantity of each commodity consumed or used in the immediate past three months represented in equation 1.

$$AMC = \frac{Total\ quantity\ of\ commodity\ used\ or\ issued\ in\ 3\ months}{3} \quad \text{..... eqn 1}$$

The choice of three months is arbitrary but conventional.

Losses and adjustments

Losses refer to the quantity of drugs or other commodities permanently lost from the logistics system. Such losses may result from expiry, spoilage/damages, theft or manufacturing defects. Losses are not recoverable and are as such removed from both physical stock and the stock cards. Losses are entered in column E of the CRRIRF usually preceded by negative mathematical sign. However, when usable commodities are received or moved between two facilities at the same logistics level entries are made as adjustments. Adjustments are also made to stock records when previous wrong entries cause discrepancy between physical stock balance and stock card balances or when already dispensed items are returned back to the stock for any approved reason. Adjustment may be positive (+) or negative (+) depending on whether the adjustment increases or reduces the current stock on hand. Adjustments generally decrease the stock of the issuing facility while increasing that of the receiving facility. Adjustment records are entered into column D if it is received into the facility

DRUG DAILY CONSUMPTION REGISTRE

Facility: ---------- Location: ---------- Date: ----------		Drug A	Drug B	Drug C	Drug D	Drug E	Drug F
S/N	Name of patient/Client						
1							
2							
3							
4							
5							
etc							
Total Qty Dispensed Page Subtotal							
Total Quantity dispensed all pages to date this month							
Prepared by Name:---------- Signature: ---------- DATE: ----------							

Figure 2: Commodity daily consumption register.

Name of Facility: _____ **Product Code:** _____

Item Description: _____ **Batch Number:** _____

(Name, Strength, Dosage Form) **Expiration Date:** _____

Unit of Issue: _____ **Location/Shelf No.:** _____

Date	Voucher / Ref. No.	Received From / Issued To	Quantity			Balance	Signature	Remark
			Received	Issued	Losses & Adjustments			

Figure 3: The bin card.

Name of Facility: _____ Store Name: _____

Item Description: _____ Product Code: _____

(Name, Strength, Dosage Form) Location/Shelf No.: _____

Unit of Issue: _____ Maximum Stock Level: ____ Months of Stock

EOP: _____ Minimum Stock Level: ____ Months of Stock

Date	Voucher / Ref. No.	Received From / Issued to	Quantity			Balance	Signature	Remark
			Received	Issued	Losses & Adjustments			

Figure 4: The inventory control card or Stock card.

COMBINED REPORTS, REQUISITION, ISSUE AND RECEIPT FORM

Name of facility---------- **Reporting Period;** ----------**to** ---------- **Year** ---------- **Maximum Stock level = 4 months of**

Facility Code ---------- **Minimum Stock level = 2 months of**

Facility Addres. ---------- **Date Prepared**----------

Facili Address. ----------

S/N	Product name and descripti on	Pack size in dispensing units	Begining balance (store + Dispensary)	Total Quantity Recieved During the Period	Total Quantity Dispensed during the Period	Losses ans Adjustments		Ending Bal Phys Count (Store + Dispensary + Others)	Mximum Stock quantity (Max)	No. Of Patients		Qty Required for Expected New Patients for 2 Months	Quantity to Order
						Positive (+)	Negative(-)			Continu eing	Expec ted		
			A	*B*	*C*	*D*	*E*	*F*	*G = C x 2*	*H*	*I*	*J*	*K= G+(Ix2)- F*
1													
2													
3													
4													
5													

Figure 5: Combined Report, Requisition, Issue and Receipt Form (CRRIRF).

Figure 6: Logistics record, report, decision, instruction and implementation cycle.

stock but into column E if it is issued out from the facility. Commodities received through the formal logistics pipeline from higher level to lower levels are not generally entered in the CRRIRF as adjustment but as quantity received (column B). Transfer adjustments may be activated when a facility has excess or near-to-expire products that need to be redistributed to other service delivery points for timely use/consumption. It may also be on the approved request from another facility experiencing unexpected demand for a particular commodity. Generally, products that can still be used within the logistics system irrespective of location are not treated as losses.

Health commodity management

The basic activities involved in proper management of health commodities include; ordering, receiving, documentation, storage, safekeeping, distribution/issuing, record keeping and preparation of review period reports of commodities. Disposition of spoilt, unusable or expired health commodities as well as health commodity wastes management are other extended functions of the health commodity managers. Although specific steps may vary from one logistics system to another, this review will briefly discuss the most general approaches adopted for procedures in health commodity management.

Ordering, receiving and storing of health commodities

Protocol for ordering and/or receiving commodities vary across logistics systems. However, in almost all systems, adequate information like; name (brand or generic), dosage form, strength and pack size (for medicines), manufacturer's name (if laboratory consumables), minimum shelf life acceptable and other specific information must be included. The quantity to order should

bring the stock on hand to the maximum stock level approved by the facility. For receiving commodity supplies, the following steps are recommended; Delivery notes must be crosschecked against supply order. All spoilt, expired and damaged items must be sorted out before the delivery note is signed.

Proper storage of health commodities is essential to avoid spoilage, pilferage and to preserve quality. It also facilitates easy movement of persons and goods within the store areas and ensures adequate ventilation, lighting, temperature and humidity monitoring and control. Cartons should be placed on pallets and positioned with the arrows pointing up. Expired and/or spoilt commodities must be labeled as such and separated from good ones. It is recommended that cartons be stacked at least 10 cm (4 in) off the floor, 30 (1 ft) cm away from the wall and adjacent stacks and that each stack should not be more than 2.5 m (8 ft) in heigth.[2]

Health commodity distribution

Commodity distribution ensures that products get to the points where they are needed and eventually to the patient. The pull-push systems represent two major approaches for commodity distribution.

The pull-push commodity supply system

Every commodity logistics system involves the supply and receipt of commodities from one point to another. This process may involve the push or pull systems. In the pull system, the receiving or user facility determines what it needs, places order and the supply facility supplies strictly based on the order received. In the push system, the supplying facility determines what should be supplied to the receiving level and as such supplies based on its considerations. Push system is common in cases of overstocking of near-to-expire commodities at the central stores or in cases of public health emergencies or drug donations or in times of product scarcity during which commodities are rationed. Hybrid distribution system involving a combination of the pull and push systems is also practiced in some logistics systems.

The concepts of first-in-first out and first to expire first out

In general purpose commodity management, the standard product issuing practice is that for a given commodity, items that were received into the store earlier are issued out before the ones received thereafter. This concept is known as "First In, First Out and Last In, Last Out" (FIFO-LILO). However due to the nature of health commodities and their tendency to expire, the first batch to be received may not necessarily be issued out or dispensed first if its expiry date is farther than that of a batch received later. Therefore, in health commodity logistics, the practice is "First to Expire, First Out" Last to Expire, Last Out (FEFO – LELO). The FEFO – LELO system is the accepted approach for prioritizing the issue of health commodities from available stock.

Assessment of stock statues

A good logistics system is that which ensures uninterrupted availability of commodities and that avoids stock outs, yet minimizing over stocking and commodity losses. To ensure this objective of a logistics system, logisticians make use of many tools and concepts which serve as checks and balances for stock management. Stock assessment may be described as the process of gathering, calculating and evaluating stock information in other to get quantitative information on the consumption rate, current stock holding and determining how long available stock would last as well as the additional stock to order and when the order may be placed so as to maintain an uninterrupted supply of health commodities in a given logistics system. To be able to do this, commodity managers depend on several commodity management tools and calculations including; Stock on Hand (SOH), Average Monthly Consumption (AMC), losses and adjustments, Months of Stock (MOS), Maximum-Minimum (Max-Min) stock levels, review period, reorder level, emergency/ buffer stock, reorder quantity, lead time and reporting cycle. SOH, AMC and losses and adjustment has been discussed above.

Lead time: Lead time means the time period between the date a supply order is placed and the date the ordered commodities are received and are available for the patient or clients use. Logistics system designers determine the lead time of the system taking into consideration factors like, the distance between the supply point and the receiving facility, the supply response and supply efficiency of the supplying facility, the delivery /transportation system, social and climatic issues and seasonal peculiarities. Usually, worst case scenario (worst expected conditions) is used to determine the lead time. For instance, in calculating how long it will take to deliver a product, the slowest available means and route of transport, or most unfavourable climatic conditions should be assumed. Complementary to lead time is the Lead Time Stock Level (LTSL) which is the quantity of each commodity consumed or issued between the time order is placed for new stock and the time the stock is received and available for use. The importance of this information is to ensure that new order must be placed before the stock on hand falls below the LTSL.

Months of stock: Months of stock is a logistics concept that describes how many months the available stock would last without occurrence of commodity stock out. It is easy to calculate this value once the Average Monthly Consumption (AMC) is known. For instance, if the AMC of metronidazole tablet is 3000 tablets per month, 4 months of stock would be 12,000 tablets (3000 x 4). Similarly, if a dispensary has 8500 capsules of Ampicillin and its average monthly consumption is 1500 capsule, its current stock

level is 5-months of stock, meaning that the available stock would last for 5 months. Equation 2 is used to calculate MOS.[2]

$$\text{Months of stock} = \frac{\textit{Stock on hand}}{\textit{Average monthly consumption}} \quad \text{----- eqn 2}$$

Maximum and minimum stock level: Every logistics system decides what minimum and maximum quantities of each health commodity it will stock at every moment. The idea is to ensure that the system does not experience avoidable stock outs or be overstocked. Commodity stock out can disrupt service delivery and/or endanger the patient's life or treatment success. On the other hand, over stocking may lead to wastage, expiry, space constrained and over-worked logistics staff. Countries and institutions adapt specific max-min systems based on factors like volume of stock holdings, available storage and distribution facilities and funding resources, Nigeria and Ghana operate 4-months of stock as maximum stock level and 2-months of stock as minimum stock level in their public health systems.

Logistics review period and review period stock

Review period is the routine interval of time between one stock assessments and the next one. The essence of stock review is to determine the stock statues of individual commodities. Unlike stock taking which involves conducting physical count of available stock to determine the current balance, stock review seeks additionally to determine other vital parameters like, consumption rate, stock on hand, months of stock and the need or otherwise for placing new orders. Stock taking is, therefore an aspect of stock review. Review period is usually fixed by logistics policy instrument or based on previous operational experience. Large stock holding facilities or programs operate longer review period whereas lower logistics levels are associated with shorter review periods. Review period stock is the quantity of commodity, consumed during a given review period. If the review period is monthly, the review period stock will be equal to the monthly commodity consumption or usage.

Safety or buffer stock

When determining the quantity of each commodity to stock, consideration is given not only to the average monthly consumption but the likelihood of unexpected increase in demand. To provide for such unforeseen demand, an excess quantity of stock known as safety or buffer stock is provided for by ordering or holding additional quantity of the commodity. Sudden increase in demand may occur during epidemic or sudden outbreak of diseases or due to relocation of people during festivities. Safety stock serves also as a buffer against delay or disruption in delivery of ordered products. It is expressed in terms of "months of stock. During initial designing of a logistics system, the quantity to order is calculated using equation 3.

Quantity to order = (Average monthly consumption + 1 month safety stock) x (required months of stock). .... eqn 3

The value obtained is equivalent to the maximum stock level.

For a running logistics system, the quantity to order is calculated according to equation 4.

Quantity to order = approved maximum stock quantity – stock on hand. 4

Safety stock is already included in the approved maximum stock. Safety stock is conventionally set to be equal to or a little greater that half of the review period stock, (Safety stock ≥ ½ review period stock).

Emergency Stock Level (ESL) and Emergency Order (EO): Any level of stock that fall below the minimum stock levels is regarded as an emergency stock level and such triggers immediate placement of an emergency order irrespective of the review point or the point at which the stock fall was noticed. Emergency orders may also be made when there is clear evidence that the system will experience extra ordinary level of commodity demand that may overwhelm the stock on hand before the next review date. Emergency order quantity is calculated to bring existing stock to the maximum stock level.[14]

Logistics records and reports

Logistics records are information and data generated at a logistics point and kept within the same point for future references or use. Stock cards, bin cards, expiry records, daily consumption register and transfer records are examples of logistics records. On the other hand, logistics reports are information and data generated at a logistics point and transmitted to a higher level for use in making logistics decision. Typical example of a logistics report is the Combined Report, Requisition, Issue and Receipt Form (CRRIRF) which transmits summary information on stock statues to the management level. When decisions are made based on the reports, subsequent instructions are transmitted downwards for implementation. Figure 6 is a schematic representation of the movement of reports generated from records kept at the lower logistics level to the management level where decisions are made and from where instructions are passed to the lower level for implementation.

Reverse logistics and waste management

The Council of Logistics Management (CLM) defined reverse logistics as a reverse of all the components of their earlier definition of logistics. This implied that all logistics activities that result in reverse process of planning, implementation and movement of raw materials and finished products from point of origin to point of consumption constitute reverse logistics process.[14] However what we consider as the most encompassing

and descriptive definition was given by, the European Working Group on Reverse Logistics RevLog (1988) which described RL as "The process of planning, implementing and controlling backward flows of raw materials, in process inventory, and finished goods, from a manufacturing, distribution or use point to a point of recovery or point of proper disposal."[15] Contrary to the conventional forward logistics which moves commodities from point of production to point of consumption, reverse logistics may be described as all logistic activities leading to the reverse movement of materials from the point of intended use/consumption back to their original source, point of recycling, place of disposal, reuse or reprocessing. These definitions suggest that reverse logistics must not always involve backward movement of unusable or waste materials like expired or spoilt drugs, used syringes and needles or packaging materials to point of destruction but may also involve backward movement of defective products or semi-processed materials back to factory for reprocessing or return of products to the warehouse for redistribution to other facilities.

Inbound and outbound logistics

Healthcare commodities like other items may be subject of inbound or outbound logistics. From the point of view of a manufacturer, inbound logistics involves the movement of goods from raw material suppliers to the production facility for manufacturing purposes. For examples the supply of paracetamol raw material from a chemical company to a pharmaceutical manufacturing company for processing into tablets is a typical inbound logistics activity. On the contrary, outbound logistics involves the forward movement of finished products from point of manufacturing to the point of use.

Healthcare waste and waste management

Waste may be described as any material with no current or potential usefulness for its usual purpose. Health Care Wastes (HCW) are widely generated in hospitals and other health facilities, laboratories and research centers, mortuary and autopsy centers, animal research and testing laboratories, blood banks and collection service centers, nursing homes, and pharmacies.[16] A good logistics system should, provide for proper and safe protocol for collection, segregation, treatment and disposal of HCWs. A World Health Organization (WHO) document classified healthcare wastes as; (i) Infectious wastes which are wastes contaminated with blood and other bodily fluids, (ii) Pathological waste which include human tissues, organs, body parts and contaminated animal carcasses, (iii) Sharps waste such as needles, scalpels and blades, (iv) Chemical wastes including laboratory solvents and reagents, used disinfectants and sterilant as well as heavy metals contained in medical devices (e.g. mercury in broken thermometers) and batteries, (v) Pharmaceutical waste including expired, and unused drugs and vaccines and packaging materials, (vi) Cytotoxic wastes containing substances that are, mutagenic, teratogenic or carcinogenic, and (vii) Radioactive waste: such as products contaminated by radionuclides including radioactive diagnostic or radio-therapeutic materials.

Green logistics

Many healthcare logistics activities have high tendency of impacting negatively on the environment thereby posing some dangers to human, animal, plant and aquatic safety. Transportation and disposal of infectious, pathological and radioactive waste could be a source spreading them within the environment. Disposal of such commodities by improper incineration, burying and burning may affect the surrounding soil and water quality or produce serious environmental pollution. Similarly heavy trucks and other vehicle used to convey commodities are often sources of hazardous carbon emissions. These and other relevant facts have recently led to increased consciousness on the need to control the negative environmental impact of logistics activities through the adoption of what is now known as green logistics. Green logistics is described as a logistics system that is designed and implemented to be environmentally and often socially friendly and which has the capacity to measure and minimize the hazardous effects of logistics activities on the environment.[8] Such measures form part of Environmental Impact Assessment (EIA). Waste recycling, proper coverage of both goods and wastes while in storage or transit, control of the use and exposure of infective and radioactive pharmaceutical materials and strict reporting of measures and hazards (when they occur) are all aimed at reducing or eliminating the negative effects of materials and wastes on the environment. As part of her green logistics project, world renowned logistics service provider, DHL implements the "DHL-Go Green Solution" which provides an efficient system for reporting, measuring and accounting for their supply chain Carbondioxide (CO_2) emission and emission offsetting measures.[17] IKEA, another global furniture company reduced CO_2 emission by converting wooden pallets to paper types as their green logistics strategy.[18] Other strategies used to implement green logistics include; use of green building materials, use of electric vehicles in place of fuel engine, minimization of the use of air freights, selection of biodegradable and environmentally friendly packaging materials among others.

Third party logistics

Sometimes, due to the large volume of logistics component of a program or company or, in attempt to leverage on the expertise of other organizations, an institution may outsource her logistics activities to a third-party organization under a Third-Party Logistics (3PL) services agreement. A third-party logistics services agreement is a contract between a contracting party and

a third-party logistics services provider wherein the provider holds, transports and provide other specific logistics services on a commodity but does not take ownerships of such.[19] Depending on the terms of the services agreement, the provider may offer bundled services that cover more than one aspect of logistics.[20]

Future of healthcare commodity logistics

Healthcare commodity availability and proper management has become a priority component of the total healthcare delivery package. As many health programs (both governmental and nongovernmental) and health development partners expand their components, contents and coverage and, confronted with frequent global pandemics, epidemics and other disease outbreaks, the need for efficient supply chain and robust commodity logistics management systems will continue to grow. Sophisticated commodity planning, procurement and distribution systems which were, hitherto the preserve of manufacturing and merchandizing conglomerates will find even greater relevance in the health sector supply systems due to the lifesaving nature and fixed shelf life of healthcare commodities. More universities and professional training institutions are also including health commodity logistics and supply chain management as part of their curricula thereby creating pool of future experts, researchers and informed practitioners. The likely outcome will be increased patient benefits and satisfaction through timely availability of required commodities in the right quantity and quality and at affordable costs.

CONCLUSION

This review has successfully discussed the basic concepts of logistics and logistics management systems and their application in health commodity management. Logistics is an independent discipline and as such the concepts and practices so discussed are not limited to health commodities but are rather universal. Health programs and services do benefit immensely from deployment of modern logistics procedures and are likely to experience improved services, cost reduction, greater inventory control and avoid both stock out and overstocking. Health practitioners, especially those involved in commodity management but did not have formal training in logistics would benefit immensely from this review. A major challenge encountered was the paucity of scholarly literature on health commodity logistics management.

ACKNOWLEDGEMENT

The author hereby acknowledges Partners for Development (Pfd) for sponsoring some trainings on health commodity logistics and management.

CONFLICT OF INTEREST

The author has no conflict of interest to declare in respect of this work.

ABBREVIATIONS

3PL: Third party logistics; **AMC:** Average monthly consumption; **CLM:** Council of Logistics Management; **CMS:** Central Medical Store; **COVID-19:** Coronavirus disease of 2019; **CRRIRF:** Combined report, requisition, issue and receipt form; **CSCMP:** Council of Supply chain management professionals; **EIA:** Environmental impact assessment; **EML:** Essential medicines list; **EO:** Emergency order; **ESL:** Emergency stock level; **FEFO-LELO:** First to expire, first out-last to expire, last out; **FIFO-LILO:** First in, first out-last in, last out; **HCW:** Healthcare waste; **HIV/AIDS:** Human immunodeficiency virus/Acquired immune deficiency syndrome; **LMIS:** Logistics management information system; **LMS:** Logistics management system; **LTSL:**Lead time stock level; **Max-min:** Maximum-minimum; **MOS:** Months of stock; **RevLog:** Reverse logistics; **SOH:** Stock on hand; **WHO:** World Health Organization.

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Cite this article: Omeh R. Healthcare Commodity Logistics Management Systems: A Review. Indian J Pharmacy Practice. 2023;16(3):181-90.