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Recent Review Article on Pharmaceutical Inventory Models

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Abstract: *The inventory management system plays a vital role in a pharmaceutical industry. For every business, managing an inventory is important whether it is small or big, domestic or international business. In a pharmaceutical company, the raw materials have an expiry date associated with them so it becomes important to set a minimal safety stock for such items. The companies mostly try out keeping a minimum stock of products which will help in tracking our business easily. In this article, we present an overall review of the Pharmaceutical Inventory literature since the early 1968 and the models available in the relevant literature have been suitably classified. The motivations and extensions of various models in each subclass have been discussed in detail. In this review paper, a project whose purpose was to develop and implement a workable inventory control system is discussed.*

Keywords: Inventory, Perishable Items, Pharmaceutical Inventory, RFID Technology, Drug Inventory.

I. INTRODUCTION

Pharmaceutical is one of the most sensitive and major industry that deals with human and animal life. Purity is highly deserved in this industry. Quality, security, identity is the most important to maintain. Inventory is referred as the stock of pharmaceutical products retained to meet future demand in pharmacy operations. The inventory represents the largest asset in pharmacy, and its value continues to rise because of the growth in the variety and cost of pharmaceutical products. In both financial and operational perspectives, the efficient inventory management plays a great role in pharmacy [1]. Tarde's conception of invention provides a corrective to two common place ways of conceiving of technological invention in general, and the inventive practice of chemistry in particular [2].

There are three types of costs associated with inventory in pharmacy: procurement costs, carrying costs, and shortage costs. The procurement costs are costs associated with purchasing the products, which include placing and receiving orders, stocking and paying invoices. The carrying costs refer to costs associated with product storage, which also include costs incurred as a result of crises [3]. The shortage costs also known as stock-out costs are the costs of not having the product on the shelves when needed. There are two main goals for managing an inventory for a pharmacy. The first is to ensure medications are available when patients need them and the second goal of inventory management is to keep medication costs at a minimum. Properly managing stock by using medications before they expire and processing returns regularly can help keep medication cost down [4].

II. CLASSIFICATION

Classification of the Pharmaceutical Inventory Models -

The pharmaceutical inventory models are available in the relevant literature which can be classified broadlyon the basis of pharmaceutical characteristics. Here we consider the following six categories:

1. Models for inventory control techniques for pharmacy
2. Models for inventory with perishable pharmaceuticals
3. Models for inventory management of pharmaceutical with hospital
4. Models for Pharmaceutical inventory with RFID technology
5. Models for Pharmaceutical inventory with drug pharmacy
6. Models for Pharmaceutical inventory with blood pharmacy

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1. Models for Inventory Control Techniques for Pharmacy –

Drug inventory management helps in designing Appropriate corrective measures. ABC analysis, popularly known as "Always Better Control", is an Important tool used worldwide, to identify items that Need greater attention for control. According to it, 10% items consume 70% of budget (Category A). Next 20% consume about 20% of the budget (Category B) and the remaining 70% account for just 10% of the budget (Category C).5 The limitation of ABC analysis is that it is based only on monetary Value and cost of consumption of items. Some items of low monetary value are vital or lifesaving. Their Importance cannot be overlooked simply because They are not in category A [5]. Therefore, an additional Parameter of assessment is their criticality by VED Analysis. "V" is for vital items without which a Hospital cannot function, "E" for essential items Without which a hospital can function but may affect The quality of the services and "D" stands for Desirable items, unavailability of which will not Interfere with functioning [6]. The medical store is one of the most extensively used facilities of any hospital where a large amount of money is spent on purchases on a recurring basis [7].

This analysis of inventory control of drug store of a 1296-bed tertiary care teaching hospital in Pune, India for the financial year 2011-2012 was Undertaken to identify the items belonging to the Categories mentioned above, to determine whether Further improvement is needed, and if yes, to find the Corrective interventions in the drugstore, if any. The Present study was planned to analyze the annual Consumption of items of pharmacy and expenditure Incurred on them for the year 2011-2012[8].

2.Models for Inventory with Perishable Pharmaceuticals –

Perishable inventory research to date has made simplifying assumptions such as the focus on a single inventory echelon deemed necessary to make the problem tractable But limit its applicability to more complex inventory problems such as the pharmacy problem[9].

In the hospital pharmacy setting, medication inventories are generally stored in one of two stages. Stage 1 is composed of raw materials that have longer shelf lives, six months to one year. Stage 2 is the finished good (e.g., IV) made by processing the raw material and has an unrefrigerated shelf life of less than one day. Patient demand is for the Stage 2 items. Regardless of the stage of inventory, the shelf life is deterministic and finite. We assume that the pharmacist reviews the inventory level of the raw material and the state of the demand process on a periodic basis (e.g., once per shift) and plans the production of Stage 2 (finished goods) products [10]. It is important to note that in the context of hospital pharmacy operations, often stock outs may be fulfilled from either a supplier or another hospital for an additional expediting fee. We consider two scenarios that dictate the type of expediting (internal vs external) for fulfilling shortages.

The first scenario restricts expediting to external suppliers, and the second scenario permits internal (i.e., production from on-hand raw material) and external expediting. External expediting is defined as ordering finished goods from an external source, for Example, a nearby hospital. External fulfillment may be the only alternative to procure additional finished goods of a medication that has a long lead time to produce. For Example, some paediatric medications must be compounded and quarantined for quality assurance, a process that may take up to two weeks. In contrast, internal Expediting is defined as the process by which additional finished goods are prepared internally after the initial batch is produced (e.g., some hospitals have compounding facilities which allow them to produce finished product internally). We develop a model for this scenario for those medications with same-day production lead time [11].

3.Models for Inventory Management of Pharmaceutical with Hospital –

Inventory control in hospital pharmacy is very essential in a developing country like India [12]. As resources are limited, it is essential that the existing resources be appropriately utilized. With the existing drug budget, if rational drug use and improved drug management practices are followed, a greater number of patients can be served. It is essential that health managers use scientific methods to maximize their returns from investment at a minimal cost [13].

Drug inventory management stresses on cost containment and improved efficiency [14]. Each item may be considered critical and there is a perceived need to supply very high levels of service [15]. There is no denying that stocking hospital pharmaceuticals and supplies can be expensive and tie up a lot of capital, and bringing efficiencies to such important cost drivers – often 30-40% of a hospital's budget – can present meaningful savings [16].

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Thus, a hospital materials manager must establish efficient inventory system policies for normal operating conditions that also ensure the hospital's ability to meet emergency demand conditions.[17] But, it is impossible and unnecessary too to monitor every drug used in the health system. High-cost and high-volume drugs come in priority, whose intervention is likely to cause the greatest clinical and economic impact. In the whole process, it is important to trace the costliest medicinal products first, those that consume the major portion of the budget, and then design a strategy to further study and identify their use pattern. The study of use pattern will help in designing appropriate corrective measures. ABC analysis is an important tool used worldwide, identifying items that need greater attention for control [18].

4.Models for Pharmaceutical Inventory with RFID Technology –

Radio frequency identification (RFID) is a technology that uses tags and readers to identify and collect asset information. In pharmacies, this usually means RFID is used for high-cost equipment or pharmaceuticals [19]. RFID applications have been in use for many years but recently gained traction in health systems. The RFID market is expected to reach $18 billion by 2012[20]. Hospitals have already started to use RFID Technology but some remain skeptical about its benefits. Yet, documented implementation of the technology in interventional cardiology has already increased reimbursement for expensive supplies, reduced inventory and improved patient safety [21].

Motivated by the benefits of RFID in hospitals, we conducted a case study at a radiology practice that has two 1.5T MRIs. The quality of an MRI depends on a patient's body characteristics, and can be improved by injecting contrast media [22]. Prior to the implementation of RFID, the radiology practice was using the barcode technology to tag the contrast media vials and it was reviewing the vial inventory by a periodic review policy. Before each order was given, the vial inventory was counted manually. The manual counting increases the ordering cost per order placed. After switching to the RFID technology, the practice switched to automatic counting and a continuous review policy. This research aims to identify and quantify the impacts of this switch on operational and economic aspects of a single-item inventory (i.e., contrast media) [23].

5.Models for Pharmaceutical Inventory with Drug Pharmacy –

Inventory is a detailed list of assets held by an organization or institution like goods in stock, drugs and equipment. It is a method of maintaining stock of drugs at a level of lowest purchasing and stocking cost. The effective and efficient management of medical stores entails close supervision of important drugs, prevention of the pilferage and priority in purchase and distribution of drugs. An efficient inventory control system would help the optimize use of resources and eventually help to improve patient care, by ensuring the availability officials stocks and preventing stock-outs. The multivariate interaction of the raw materials' physical properties can be critical to the quality of the final drug product. A detailed discussion of the objective function used is presented in the article [24]and also reports the results of implementing the method to the manufacture of pharmaceutical drug product in a commercial manufacturing setting. The effective management of medical stores entails supervision [25] of important drugs and the priority setting in purchase and the distribution of drugs.

The inventory management at tertiary-care settings in explore of the optimal drug inventory management technique suitable for a secondary care hospital. Drugs stored in pharmacy department [26] according to their cost and criticality to access the inventory of drugs at SKIMS, the area of study included main drug of pharmacy store. The medical store [27] is one of the most extensively used facilities in the hospital and hence it is essential that the health managers use scientific methods to achieve management and patient satisfaction. The article [28] provides drug inventory control system seamlessly connected with the physician order-entry system and the control system application allows inventory functions to be faster and mor e efficient in the real time.The cost and need of these medicines vary widely depending on the level of health care and the population catered. Effective and scientific drug inventory management techniques are necessary for efficient health care delivery[29].

6.Models for Pharmaceutical Inventory with Blood Pharmacy –

The primary use of the optimal decision rule will be to establish minimum cost inventory levels for blood cell inventories for a hospital blood bank or a transfusion service. Blood product is growing faster than donor recruitment,

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so the efficient management [30] of the available blood supplies is of great economic and social importance. The blood models dealt with two main issues-expiration of blood products and limited shelf-life vs minimizing blood inventory shortages and the blood storage technologies have resulted in the extended shelf lives for some blood products, as well as the ability to uses synthetic blood products at an additional cost. Blood banks [31] are facilities which procure, store, process, and dispense blood and the effectively in the faceoff both random supply and random demand, sizable buffer stocks of the blood are maintained. The analysis of the whole blood inventory problem at the individual hospital as well as the regional level, presents a realistic model of blood inventories for both the individual and regional cases, and analyzes the effects of several alternative inventory policies.

The frequency of blood delivery [32] has no significant effect on the net saving of blood in the blood recycling plans evaluated. The implementation of an automatic blood recycling program, a practical and effective method for reducing blood outdating in a multi-hospital regional blood system, is discussed in detail. A number of methodological contributions [33] have been made in the areas of inventory theory and the combinatory optimization that can use other products or systems. The optimal inventory level,[34] daily demand level, the transfusion to cross match ratio, the cross-match release period and the age of arriving units that determine the shortage and outdate rate and the blood bank administrator should establish optimal target inventory levels based on a simple equation relating these factors. This rule indicates that its implementation can lead to a very low shortage rate and a reasonable low outdate rate if use the blood bank administrator makes efforts to control the cross-match release period and the average transfusion to cross match ratio[35].

III. CONCLUSION

This article, we have provided an up-to-date review literature of Pharmaceutical Inventory Models. Invent ory management can make it easy and effective and reduces material handling time and counterfeiting of the pharmaceutical products up to a high rate. There are two main goals for managing an inventory for a pharmacy. The products that are regularly kept in stock are based on the needs of the pharmacy and its customers. Efforts should be made to keep the medications used regularly in stock and available for use not outdated or damaged, while some rarely used, extremely expensive or cumbersome products may be ordered in needed. Properly managing stock by using medications before they expire and processing returns regularly can help keep medication cost down.

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