

Managing Medicines in the Hospital Pharmacy: Logistics Inefficiencies

Alejandro Romero

Abstract—This paper attempts to gain a better understanding on the main issues affecting the management of medicines in hospitals by defining and analyzing the main logistics inefficiencies executed by the hospital pharmacy. This field research was conducted in a North American hospital which represents the main research site. Three other hospitals and other healthcare organizations have been involved in order to validate empirical evidence. We relied on multiple sources such as observations, process mapping and semi-structured interviews in order to allow triangulation and strengthen the validity of results. From the reception of medicines at hospital docks to their distribution to the hospital pharmacy, we identified an important number of inefficiencies, namely incorrect inventory management, medicine shrinkage, intensive manual labor, long procurement cycles, time-consuming product recalls and improper use of technology.

Index Terms—Supply chain management, logistics processes, medicines, pharmacy hospital, map process.

I. INTRODUCTION

HEALTHCARE systems around world are facing a period of deep transformations. Governments have to adapt their national health systems to their economic, demographic, technological and organizational contexts. In economic terms, spending on health has known a strong growth. In 2010, United States spent more than 17.4% of their GDP in medical services while Canada spent 11.7% [1]. Demographically, the cost of this industry increases with the rise of the elderly population. On the technological background, equipment innovations and more sophisticated medicines permit to improve the quality of healthcare services; however it has imposed important economic costs. On the organizational level, healthcare system of OECD countries are considered as dysfunctional. For example, staff shortages limit the patient's accessibility to health services and actual processes don't allow the optimal use of medical resources. Thus, the quality of health care is seen severely limited [2].

Medicine represents a critical component of healthcare but impacts negatively the quality of healthcare systems because medicines face serious issues such as medical

errors, adverse impacts on the environment and the growing presence of counterfeit products. One of the most important issues affecting the sustainability of healthcare service is medicine cost. They represent the third largest budget item for the Canadian health care system, 32 billion in 2011 [3], just after the hospitals and medical staff. An aging population, an over-reliance on prescription medicines as well as an over-utilization of these pharmaceuticals may explain such substantial costs. Even if medicines benefit to health population, their management is not necessarily optimal. Throughout their supply chain, medicines must be manufactured, packaged, distributed, stored, prepared, administered and disposed following rigorous procedures [4, 5]. This leads to major expenses for such management because it requires specialized personnel, sophisticated technologies and control procedures [5]. Despite medicines specifications and inefficiencies could contribute to their increasing cost in the healthcare sector, very little research has been published on the main issues affecting the management of medicines in hospitals. This paper attempts to gain a better understanding of this under investigated issue.

Within the scope of this paper, we will concentrate on analyzing the hospital pharmacies processes related to the medicine management. More specifically, it is proposed to analyse and define the main inefficiencies of logistics processes executed by the hospital pharmacy. The paper is structured as follows. The next section offers a review of medicines processes throughout their supply chain. The research design is exposed in section 3. The main results obtained from process mapping and interviews are presented and discussed in section 4, while the last section offers some concluding remarks.

II. MEDICINES MANAGEMENT

From the point of view of healthcare sector, medicine management is the ability of healthcare and pharmaceutical organizations to optimize the pharmaceuticals use [6]. Some authors state that an appropriate management of medicines must ensure patient safety in accordance with the five "R": the right product or the right service to the right patient at the right time using the right way and in the right quantity [6, 7]. Shaeffer [7] and Dumitru [8] add three new "R" to this principle: right communication, a right reason and a right documentation.

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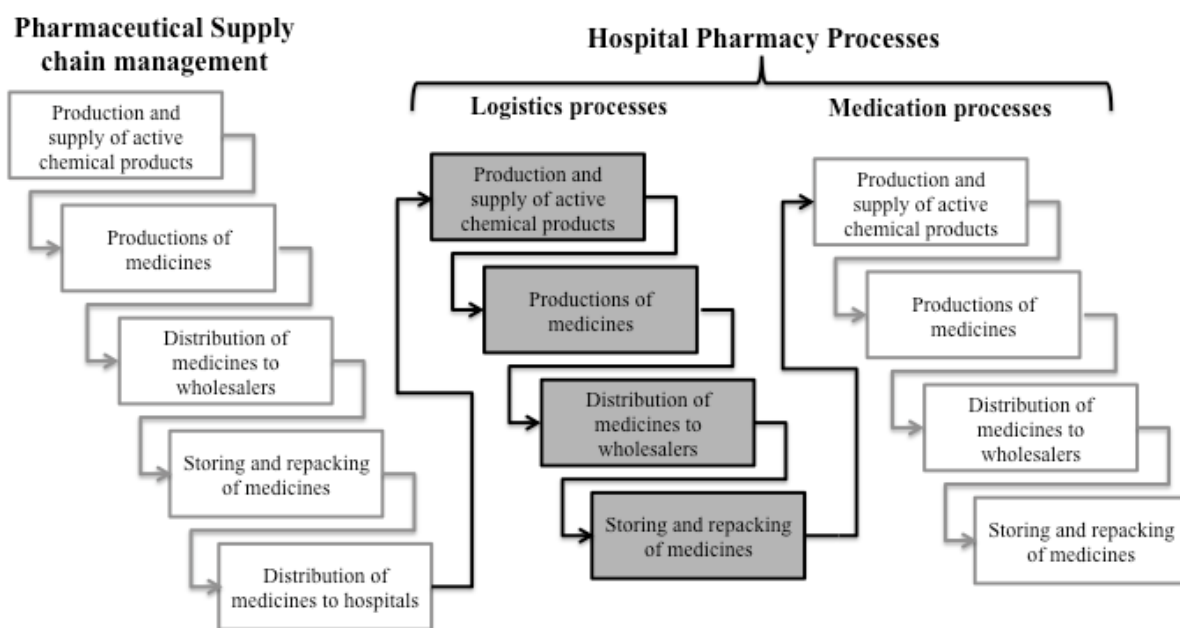


Fig. 1. Medicine supply chain

In order to better understand the different management processes for medicine use, we have opted to analyze the medicine supply chain into a “product centric” approach. Figure 1 shows a simplified and generic product value chain for medicines that includes the full range of activities from their production to their administration to the patients in the hospital. This paper focuses on logistics processes of the hospital pharmacy (central part of the figure 1).

The following sections present the main issues related to the management of medicine at the pharmaceutical supply chain level and at the hospital pharmacy level.

A. Medicines supply chain

From the healthcare perspective, the supply chain management is characterized "by the information, goods and money necessary to purchase and transfer the goods and services from the supplier to the final user in order to control costs" [9, p.10]. It is estimated that the healthcare supply chain management spends hundreds of millions of dollars per year [10], which suggests that hospital financial priorities must be re-defined.

The healthcare supply chains are more complex and more immature compared to other industries [9, 11, 12]. This can be explained by different reasons. First, supply chain management has an impact on human health requiring adequate and accurate medical supply conforming to the patients’ needs [13]. If medical supplies are out-of stock, distributed to the wrong patient or are prepared inadequately, patients may experience adverse events, and in some cases death [6, 7]. In fact, it is estimated that one million medication errors occur each year in U.S. [14] accounting for 7,000 deaths and entailing a cost of about \$2 billion a year [15]. Second, medical products, medicines and equipment are not totally standardized. Medical professionals are responsible for their selection, but their choice depends on the physical characteristics and health status of each patient [9]. Indeed, they can request different

kinds of products for patients undergoing the same treatment. Consequently, several products, medicines and equipment are required, resulting in differentiated and complex health services and generating negative impacts on the hospital finances [9]. Third, hospital operations must deal with a complex distribution network composed of several storerooms and warehouses where different medical supplies are stored following a variety of regulations [16]. Fourth, caregivers conduct a staggering number of logistics activities that do not fall under their formal responsibilities: For instance, Landry and Philippe [17, p. 3] estimated that “nursing staff will spend on average 10% of their time performing logistics tasks instead of taking care of patients, which can not only have cost and care implications, but in countries where there is a shortage of healthcare professionals, social implications as well, such as stress-related diseases.” Fifth, healthcare supply chains are characterized by multiple stakeholders that work together in order to ensure the flow of products and services. Inside and outside hospital, medicine management requires a wide variety of human intensive processes which are poorly supported by technology [9, 12]. This results in an increased workload and a higher possibility of errors. Sixth, healthcare supply chains are high regulated and must respect a number of standards and procedures [5]. In fact, national and international healthcare organizations and government have defined several standards for the distribution, storage, preparation and administration of medical products and materials [4]. Finally, healthcare supply chains are vulnerable to terrorism and criminal facts. According to many observers, this industry experiences a strong possibility of being affected by the presence of counterfeited products [18, 19, 20]. From the above-mentioned reasons, one can conclude that healthcare supply chains are indeed inherently complex.

B. Hospital pharmacy processes

The hospital pharmacy plays a vital role in patient care. It focuses on ensuring that the prescribed medication is precisely and timely dispensed to the intended patient [21]. The hospital pharmacy must purchase, store and distribute medicines. These activities are known as pharmacy logistics processes (central part of the figure 1 and focus of this paper), which are under the responsibility of specialized staff because medicines must be managed under specific conditions and standards. Logistics activities include (i) planning of medicine supply, (ii) request of purchase order, (iii) reception of medicines, (iv) validation of package delivery, (v) fitting and sorting of medicine packages, (vi) storage, (vii) preparation for distribution, (viii) distribution of medicines to the primary and secondary pharmacies and to automated equipment, and (ix) reverse logistics.

Hospitals in general and hospital pharmacies in specific look forward to reducing operation costs while ensuring the patient security [22]. However, pharmacy logistics processes are related to several issues that impact negatively the cost and quality of the medication services. Several studies show different inefficiencies, namely out-of-stock [23, 24, 25, 26], high costs [27], excessive manual labour [28, 29], shrinkage [23, 28, 30], high frequency of reorders [23, 28], counterfeit products [31, 32, 33] and product recalls [31].

Improving the efficiency of this logistics function is an indispensable option for ensuring the profitability of the healthcare organizations. Past research work shows that hospital pharmacy can adopt several managerial approaches such as Just-In-Time [23, 25], Virtual Inventory [23], Stockless Materials Management Programs or Vendor Managed Replenishment (VMR) [34, 35], Collaborative Planning, Forecasting and Replenishment (CPFR) [25, 29, 35], simulation and outsourcing [28]. These managerial transformations must be supported by information technologies, namely Exchange Data Interchange (EDI) [23, 25, 29], e-commerce [25, 29, 35], barcode and RFID [36, 37].

III. METHODOLOGY STRATEGY

A. Research site

Hospital A represents the primary research site but other healthcare entities, government institutions, associations and technology organizations also gave valuable inputs and insights (see Table I). In total, eighth organizations and 38 healthcare professionals and key managers participated to the field research study.

The hospital A has undertaken a review process program in order to improve their medical services. Hospital pharmacy has been chosen because of its importance and the quantity of different pharmaceutical products, which are received, stored and distributed. Hospital B, C and D are also reviewing their pharmacy processes in order to standardize their activities and ensure a future consolidation. All hospitals involved in this research offer their services in North America. The government institution is involved in different programs for decreasing medication errors by

automating the medication process and is also involved in the technological and managerial projects undertaken in hospital A. The pharmacist association represents the perspective of pharmacists and pharmaceutical scientists. The technology provider works with different healthcare organizations in order to develop new equipment and review medical processes. This provider is involved in the projects undertaken in hospital A.

B. Participants

The vast majority or 76% of individuals who were interviewed are well aware of the characteristics of medication processes and are involved in the improvement of hospital pharmacy processes. 58 of participants are involved into the logistics function of the hospital pharmacy. In contrast, fewer participants (21%) are knowledgeable about pharmaceutical supply chain processes. Table 1 shows the profile of participants.

C. Data collection strategies

We rely on multiple sources of empirical evidence in order to allow triangulation and strengthen the validity of results [38]. Data collection was based on:

(i) Mapping process permits us to analyze the logistics function of the hospital pharmacy and identify the main sources of inefficiencies.

(ii) Multiple on-site observations allowed us to carry out the logistics process mapping.

(iii) Semi-structured interviews were conducted for the validation of the medication process mapping and for the analysis of the different inefficiencies.

The process mapping has been built on the mapping procedures undertaken by the National Health Service Modernization Agency and was based on process flow observations from the field research. The process mapping at the macro level and more detailed level was then validated with key participants in two points in time and served as an anchor for assessing the relative inefficiencies of the hospital pharmacy. In particular, AS-IS process maps were developed for each of the sub-process. The AS-IS process map reflects the actual situation of the pharmacy logistics function. By analyzing the AS-IS process map, we were able to assess the relative issues related to the use of medicine in hospitals. These inefficiencies were then discussed, validated, and compared through three rounds of the semi-structured interviews in order to capture systematically their relative importance across interviewees.

IV. RESULTS

The mapping of the hospital pharmacy logistics processes and the subsequent validations with the key participants have allowed uncovering several inefficiencies of the pharmacy logistics function.

Through a thorough content analysis of the comments of the 38 key participants, the following six main issues were identified:

TABLE I
PARTICIPANTS' PROFILE

Organization	Number of beds	Participants	Number	External logistics	Related to Logistics operation	Medication process
Hospital A	630	Chief pharmacist	5		√	√
		Pharmacist	6			√
		IT project manager	2			√
		Material manager	3	√	√	
		Physicians and nurses	6			√
		Pharmacy clerk	4	√	√	
Hospital B	490	Chief pharmacist	2		√	√
		Project manager	1		√	√
Hospital C	320	Chief pharmacist	2		√	√
		Project manager	1			√
Hospital D	230	Chief pharmacist	1		√	√
		Project manager	1		√	
Total			34	7	19	26
Other organization	Number of beds	Participants	Number	External logistics	Related to Logistics operation	Medication process
Government entity	N.A.	Medical technology director	1		√	√
		Medical project manager	1		√	√
Pharmacy association	N.A.	President	1	√		
Technology provider	N.A.	Project manager	1		√	√
Total			4	1	3	3

- Incorrect inventory management: It is essential to maintain adequate inventory levels that ensure zero stock outs. One chief pharmacist stated “in most hospitals with clinical operations, a pharmacy inventory of the order of \$100 to \$200 per bed is considered as reasonable.” However, hospital pharmacies must hold enough medicines to guard against fluctuations in demand, to take advantage of bulk discounts and to withstand fluctuations in supply and, as a result, the pharmacy stocks higher levels of pharmaceuticals than necessary, even if medicines can become obsolete. The pharmacy warehouse clerks manage expiration dates and storage conditions of medicines at the lot level because actual processes cannot support the management of medicine at the primary package level, even less at the unit level. This results in a poor inventory management. A pharmacist pointed out that “even if we are trying to improve the management of our inventories, we may find a few medicines that have expired or will expire soon.” Another pharmacist mentioned that “clerks can update the inventory system with the wrong information resulting in an inexact control of medicines and in an incorrect planning for supplies.” An inappropriate inventory management can produce over- and under-procurement, out-of-stock, medicine shortage and multiple and unnecessary storage locations such as storage in care units or in the physicians’ and nurses’ offices.

- Excessive losses: Poor inventory control may lead to misplaced medicines and to theft. There is however a consensus from the key participants that losses occur mainly from the fact that “medicines could become obsolete before its utilization because they were expired or they were not stored under the proper conditions,

such as, for example, in amber, air-tight and moisture-resistant containers.”

- Intensive manual labour: Several processes must be executed manually. A technical assistant stated that “approximately 60% of medicines require repackaging and most of the inventory controls are conducted manually.” The same situation is observed for the inventory control. As pointed by one pharmacist “even if pharmacy relies on visual, periodic/cycle counting or perpetual inventory systems, it requires the pharmacist to look manually at the number of units in inventory and compare them with a listing.”

- Lengthy procurement cycles: Patients could be affected if their medication doses cannot be delivered in time to the care unit. Several pharmacists mentioned that the procurement cycle might be too lengthy for two main reasons. First, at the reception point, hospital could receive medicines that do not correspond to the purchase order or, in rare but documented cases, could receive altered or counterfeited products. Second, it could take a rather long time to distribute a medicine from the hospital dock to the care unit if the pharmacy staff cannot properly and immediately identify the medicines.

- Time-consuming product recalls: Due to quality problems or safety issues, pharmaceutical laboratories and governmental agencies could request hospital pharmacies to return some medicines. Known as medicine recalls, this procedure represents a critical issue for the hospital pharmacy due to the complexity of tracing medicines and its associated cost. For recovering medicines, several actions can be undertaken. If the required batch of medicines is still in the pharmacy warehouse (level 3 and 2), the pharmacy clerks place

them in a special container. However, if the required batch of medicines has been distributed to the primary and secondary hospital pharmacies or went through automated equipment, the pharmacy clerks and technical pharmacists must retrace the flow of medicines. According to several pharmacists and chief pharmacists, retracing entails high costs since the pharmacy staff must verify manually the inventory of medicines in primary and secondary pharmacies.

- **Improper technology use:** Even if medicines are delivered to the hospital in cases or in bundles with a linear barcode for its identification, most of the hospitals do not use the same barcode for supporting their internal medicines logistics processes. A pharmacy clerk stated “if he had a barcode reader during the reception and management of boxes, he would use the barcode label for their automatic identification and verification.” However, current practices are as follows: at the reception point, the pharmacy clerks identify and manage medicines by reading the label in characters placed on the cases or bundles. Pharmacy clerks validate the received packages by verifying manually their correspondence with the purchase order. A pharmacist indicated: “Several errors may occur with the manual verification because clerks can confuse or misinterpret the medicine information. Unfortunately, these errors are identified once medicines are distributed to the primary or secondary pharmacies.”

V. CONCLUSIONS

Based on qualitative and quantitative methods, this study identifies from the reception of medicines at hospital docks to their distribution to the hospital pharmacy an important number of inefficiencies, namely incorrect inventory management, medicine shrinkage, intensive manual labor, long procurement cycles, time-consuming product recalls and improper use of technology. These inefficiencies affect severely the sustainability of healthcare system in general and the patient security in particular.

Several lines of actions can be envisioned. First, healthcare organisations are faced with huge losses estimated to be roughly at least one-tenth of their revenues, with increased medical errors and with tighter regulations. Efforts have been made to strengthen the efficiency of the pharmacy logistics function but the knowledge, analysis and process review have to be improved. Logistics activities could also be streamlined. In particular, existing relabeling and repackaging practices need to be closely examined in order to avoid medical errors. Second, technology can help by ensuring the efficiency of logistics processes. Track and trace systems for medicines could bring interesting benefits in order to improve inventory management, decrease procurement cycles and automate time-consuming processes. Nevertheless, the observed inefficiencies cannot be totally resolved by a track and trace system. Hospital pharmacy logistics function must be supported with other information technologies, the redesign of business processes, and the commitment of hospital staff.

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