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Review

Measuring the logistics performance of internal hospital supply chains – a literature study[☆]

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ABSTRACT

The patient care processes in hospitals are supported by a range of operational activities including inventory management and distribution of supplies to point-of-care locations. Hospitals carry large amounts and a great variety of items, and the issues of storing and distributing these items throughout the hospital supply chain are of great importance to providing high-quality patient service. Healthcare logistics encompasses the process of handling physical goods (e.g. pharmaceuticals, surgical medical products, medical equipment, sterile items, linen, food, etc.) and the associated information flows, from the reception of the goods within a hospital to their delivery at patient care locations. The medical supply costs constitute the second largest expenditure in hospitals, after personnel costs. A high-performing supply chain may realize improved outcomes (e.g. safe and quality patient service) and greater efficiency. Logistics managers need to identify opportunities to improve the logistics processes in order to lower costs and to improve patient care quality. However, in order to improve the logistics processes, you must understand how the healthcare supply chain is currently performing. Measuring the performance of the supply chain is fundamental to identify and address deficiencies in the logistics activities, and it serves as a good input for managerial decision-making. The purpose of this article is to present existing research on performance measurement at the internal hospital supply chain (e.g. inventory management, distribution activities), and more specifically in the operating theatre since it is among the most critical resources for a hospital. At the operating theatre, the requested items should be available at the right time at the right place, in the right condition, at the lowest cost possible. Furthermore, we will also discuss literature on multi-criteria decision-making techniques. It enables researchers to build a performance measurement framework and to prioritize between multiple performance indicators since a diverse group of stakeholders with conflicting interests is involved in the internal operating room supply chain.

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1. Introduction

The internal supply chain in hospitals is characterized by its complexity, uniqueness and operational challenges, such as extremely expensive products and medical devices used in operating rooms, difficult inventory tracking due to the urgency of treatments, and unpredictable demand for medical supplies [60]. Many different types of supplies are stored in multiple storage rooms within the hospital and many processes (clinical, logistics, administrative, etc.) interact to contribute to the achievement of high-quality patient care [82]. Therefore, it is beneficial to have effective logistics practices in a hospital for controlling and distributing the supplies to patient care units. In recent years, however,

the cost of logistics operations (e.g. handling, moving and processing of materials) has increased, ranging between 20% up to 45% of the total hospital operating budgets, partly due to the considerable amount of wastes in healthcare supply chain processes [54,97]. The operating theatre, in particular, turned into a major cost driver for a hospital [63,71], with the medical supplies and equipment used in the operating rooms taking up 40% to 60% of the hospital supply expenditures. However, effectively managing these supplies have long been a challenge [15]. The healthcare sector exhibits special features that directly affect the quality of patient care. Non-availability of materials may postpone a surgical procedure and possibly results in planning trouble and/or hazard of patient's health, whereas hidden stocks or overstocking of supplies in patient care locations increase costs and cause supply chain inefficiencies [26,30].

Healthcare Supply Chain Management (SCM) refers to “the information, supplies and finances involved with the acquisition and movement of goods and services from the supplier to the end

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user in order to enhance clinical outcomes while controlling costs” [27]. The companies that make up the supply chain need to interact and cooperate in order to fulfill the purposes of the logistics processes (i.e. supply, distribution and warehousing) [8]. Coordination and integration between the processes positively contributes to the performance of the healthcare supply chain. The fields of Industrial Engineering (IE), Operations Research (OR) or Operations Management (OM) provide (analytical) methodologies to support the supply chain or logistics operations of hospitals. Chase and Jacobs [20] define OM in healthcare as “the design, management and improvement of the systems that create and deliver healthcare services”. It is, however, a major challenge for operational researchers to ensure high-quality patient care by considering limited resources (e.g. healthcare professionals, operating rooms, supplies, etc.) and high process variability due to patient characteristics and physician preferences, and to engage multiple stakeholders with conflicting interests to cooperate. Stakeholders have different goals for efficiency management because there is no consensus on what constitutes efficiency and what actions to take to improve it [62]. The ultimate goal is to achieve “a well-coordinated system that delivers care with great efficiency and quality, at reasonable cost, matching the resources for care to where (and when) they are needed most” [40].

The scope of this article is limited to the internal hospital supply chain processes, and more specifically medical supply logistics in the operating room environment, with a focus on inventory control and distribution of medical supplies and equipment to ensure availability and cost containment. Rivard-Royer, Landry and Beaulieu [75] stated the internal supply chain as “the sore spot or weak link” in process integration and optimization. The internal supply chain processes are performed within the hospital and include product and information flows from receiving, replenishing, picking, etc. [80]. The functions of the internal supply chain include purchasing, inventory, distribution and consumption. In this article, the focus will be on inventory and distribution management in the operating theatre. Volland, Fügner, Schoenfelder and Brunner [95] review the relevant literature regarding the logistics activities of handling physical goods (e.g. pharmaceuticals, medical consumables, food, sterile items, etc.) in hospitals and investigate quantitative methods applied to hospital materials management (i.e. coordination of all activities related to material ordering, holding and administrating). The authors distinguish between four streams of literature across the hospital supply chain: supply and procurement, inventory management, distribution and scheduling, and holistic supply chain management to enable patient care. A streamlined process might lead to reduced costs, increased efficiency, materials traceability, information sharing, and patient safety, while simplifying the activities accomplishment by hospital personnel [82]. The Association for Healthcare Resource and Materials Management (AHRMM) presents valuable knowledge for materials management in healthcare as it helps realizing an efficient and effective functioning of the internal hospital supply chain.

1.1. Hospital supply chain strategy

The internal supply chain links the logistics processes and patient care services within the hospital. Today's hospital supply chains face several issues, including fragmented supplier base, supply chain inefficiencies, excessive administrative expenses, poor management, inappropriate care, waste, etc. Hence, an effective supply chain management can positively impact the hospital's bottom line [88]. With supply chain operations taking up to 40% of the hospital's budget, implementing a successful hospital supply chain strategy is important. Hospitals that take a holistic view of their supply chain and focus on strategic issues may realize significant benefits, such as improved employee satisfaction, patient safety

and outcomes [45]. The key steps to strategic healthcare SCM include improved collaboration with vendors, align with physicians, focus on integration, automate the supply chain, adopt more and better standards and use process improvement methodologies (e.g. Lean). Dittmann [29] presents guidelines for planning an effective supply chain strategy by taking into account customer needs, internal assessment of supply chain capabilities (e.g. benchmarking), industry trends, evolving technologies, risks and competition. Hospitals can gain competitive advantage by effectively managing their supply chain and hence, achieve supply chain excellence. Finally, the right supply chain key performance indicators (KPIs) should be defined to track performance and evaluate the implementation of the supply chain strategy.

Unlike other industries, where SCM techniques are already successfully applied, the healthcare sector is lagging behind in adopting the logistics concepts due to several factors, including regulatory issues, outdated information technology (IT) systems, poor inventory and distribution management, lack of executive involvement, no process improvement culture, etc. [14,65]. Researchers should look beyond the healthcare sector when assessing the internal hospital supply chain capabilities [29]. They can learn a lot by looking at best-in-class practices from manufacturing or retail industry as a way to maintain a high level of efficiency (i.e. control costs) and effectiveness (i.e. high quality of patient care). For example, the Wal-Mart retail chain adopts Collaborative Planning, Forecasting and Replenishment (CPFR) and information is shared through Enterprise Resource Planning (ERP). Such concepts are key to get an integrated supply chain [19]. However, the unique characteristics in the healthcare setting, a diverse group of stakeholders, complex technologies and a dynamic internal and external environment make it difficult to transfer logistics concepts from the manufacturing or retail sector to the healthcare sector [27]. Toba et al. [88] discuss four areas as potential improvement opportunities in the hospital supply chain. A first opportunity for supply chain savings is in the area of physician preference cards and physician buy-in. The most cost-effective products are purchased by team consensus between clinical experts and sourcing staff. A successful partnership with a Group Purchasing Organization (GPO) provides another cost saving opportunity because they have a global network of suppliers and benefit from economies of scale. Furthermore, hospitals should improve on supply data management technology (e.g. Global Data Synchronization Network (GDSN)) and the integration with their purchasing systems in order to have faster and more valuable information in the supply ordering process. Finally, significant cost savings can be achieved by effectively managing inventory and distribution, which will be elaborated in Section 2 and 3.

Coordination and integration between the processes positively contributes to the performance of the healthcare supply chain [27]. In order to achieve internal coordination, the logistics processes such as supply, warehousing and distribution must be aligned with the organization's business strategy as well as with the supply chain strategy [21]. Healthcare supply chain management is concerned with five domains in order to get integrated supply chain processes [19]. First, demand can be managed by using forecasting techniques and by standardizing supplies. Effective order management practices should be in place by consolidating purchases. Third, supply chain actors should participate in GPO agreements to reduce the number of suppliers. A fourth area is related to logistics management by consolidating shipments. Finally, adopting automated point-of-use distribution, minimizing Stock-Keeping Units (SKUs), maximizing inventory turnover rates, increasing non-stock items, etc. all contribute to integrated management savings. Hence, hospital supply chains can become operationally efficient by adopting technologies, standards and best practices, and methodologies applied in other industries for managing supply chains. Balcazar-

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