HOSPITAL LOGISTICS: A BIBLIOMETRIC ANALYSIS

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Abstract - To investigate trends in hospital logistics, we compared the contribution of publications among different journals, through a bibliometric analysis. The increasing importance of logistics within hospital institutions is related to the fact that it is a differentiating area in the health sector and should be seen in an approach oriented not only towards cost rationalization, but also as a preponderant element in supporting health care delivery. The literature on hospital logistics and supply chain management in hospital institutions has been growing, mainly since 2005, and the expansion might continue at a rapid pace, although still very scarce and the number of papers about these topics are in a very small number, offering significant research opportunities. The objective of this paper is to present a bibliometric analysis, describing the state ofthe art on logistics in hospital institutions. The results show that the interest and relevance that hospital management has been giving to logistics has increased in recent years. This area is gaining importance because there is a recognition that logistics is an important component to obtain health cost control, without reducing the quality of the services provided.

Keywords - Logistics Hospital, Processes, Supply Chain Management, Healthcare

I. INTRODUCTION

Life expectancy has been growing and in 2017 average life expectancy at birth was 80.6 years, in OECD countries [1]. This is mainly due to improved living conditions and increased educational levels of the population, but also to healthier lifestyles and progress in health care.In most countries, the quality of health care delivery has improved overall, but these improvements have a cost: health expenditures are, around, 9% of GDP on average, being that hospitals represent around 40% of the total costs in health. Higher health expenditures are not necessarily a problem when the benefits outweigh the costs, but there is ample evidence of inequities and inefficiencies in health. Having sufficient financial and material resources is fundamental to the work of a health system, and the seresources need to be used wisely to avoid an inefficient spending. According to the WHO 2010 report "Health systems financing: the path to universal coverage", 20% to 40% of health spending is misused [2] due to inefficiencies.

A review of more than 300 studies on the efficiency and productivity of health care showed that hospital efficiency, on average, was about 85%, meaning that hospitals could do 15% more than they currently do with the same costs (more with less), or reach the same level of services with less 15% of costs (do the same with less) [3]. A large part of the total cost of a hospital's cost structure is related tologistics costs [4]. These logistics costs represent more than 30% of total costs, which means that more efficient logistics management will induce a substantial reduction in the hospitals total costs [5]. Given the relevance of the topic, we can identify a growing number of publications in recent years, materializing the increasing awareness about the topic. Thus, this bibliometric analysis focuses, essentially, on all the components and dimensions that belong to hospital logistics and their impact on improving hospital efficiency and effectiveness.

II. HOSPITAL LOGISTICS

Improving the efficiency and effectiveness of health processes not only saves resources but also contributes to achieving organizational goals [6]. Hospital managers can and should look at their structure and make decisions to achieve a policy of higher productivity in line with a policy of cost reduction, which presumes higher efficiency and effectiveness of all existing processes. It is in this context that logistics management can be a differentiating area in the health sector due to its specific characteristics and should be seen in an approach oriented not only towards cost rationalization, but also as a preponderant element in supporting the provision of health care to users. Although hospital logistics is often undervalued, it represents a considerable portion of hospital's operating budget. Polin(2003) mentions that more than 30% of total hospital costs are invested in several logistical activities and half of these costs can be eliminated using best practices [7]. Literature presents several different concepts about hospital logistics, without a conceptual consensus [8], being that one of the main difficulties is related to hospital logisticsborders. Pokharel (2005) understands hospital logistics as part of the planning, implementation and management of supply chain material flows, while Maruster and Jorna (2005a) [10] argue that logistics in hospitals comprises the design, planning, implementation, control and coordination between the flow of patients and the therapeutic and diagnostic activities. In the first definition, hospital logistics focus on the flow of materials, which is close to logistics management in the industry, with logistics activities involving purchase, reception, inventory management,

information systems, food services, transportation and home care services [5]. Regarding the second definition, hospital logistics is understood as responsible for the users management flows, closer to public administration services, considering that in hospitals, the process is the product and the user is the raw material to be transformed /treated. In addition, we must consider the absence of stocks, because the services are created and consumed simultaneously, which makes the use of total capacity a management challenge. Hospital managers believe that, unlike the industry managers, they cannot predict their demand and are therefore unable to control or plan their schedules [11]. The complexity of the patients and the average length of hospital stay can also be referred [12] as one of the problems in resource planning. As the demand can suffer considerable variations, problems arise in the definition of service capacity, use of the facilities and use of idle time, which are balanced by the waiting time felt by the client (or user) [8]. In hospitals there are two main supply chains: an internal chain and an external chain. The requirements of logistics services in the internal supply chain are immediate and have almost no delivery deadline. Hospitals therefore need to focus on two aspects: managing the external supply chain to minimize costs and managing the internal supply chain to maximize service levels. Customer satisfaction can be measured according to the performance of the processes to deal with internal customer needs [13].

III. METHODOLOGY

The method used in this paper is a bibliometric analysis, a technique that assesses relevant publications on a certain issue. Some authors [14] indicate that bibliometric analysis can be understood as a method that includes laws and statistical principles whose focus is mapping scientific production. Firstly, we chose the Web of Science database, secondly, we delineated papers selection, using the subsequent combinations of keywords: hospital and logistic, to cover all papers that relates the word “hospital” in the subject and keywords and “logistics” in the title. We made a more detailed analysis to papers with “logistic regression” in the title and excludedthe ones that were not directly related to the topic. No temporal filters, language filters or area filters were used. We obtained a total of 134 papers.

Using the function of co-occurrences of terms, which searches both in the title and in the summary of papers, the term hospital logistic, shown in figure 1, was constructed, and we can identify four different clusters. The formation of these clusters happened automatically, but after the minimum number of occurrences of the terms was selected (5 minimum occurrences), to simplify the understanding of the outcomes. It should be noted that a file provided by the software was used where we removed some words that frequently appear in papers and haveno direct connection with the topic (ex: logistic regression, euroscope). The networks were highlighted by different colors, being chosen arbitrarily by the software and not sustaining any relation of importance, used only for clusters signaling.

IV. BIBLIOMETRIC ANALYSIS ABOUT HOSPITAL LOGISTICS

To understand the relationship between the mentioned concepts, this paper is based on bibliometric analysis techniques, using the VosViewer tool. The procedure consisted in the analysis of papers referring to hospital logistics. From the analysis of co-occurrences of terms, we can identify four clusters (figure 1), which are scrutinized below. In the red cluster there are predominance of terms related to the patient's circuit within the hospital institutions. The green cluster relates logistics and hospital management in a holistic way. The yellow cluster relates terms that allow us to characterize the supply chain with logistics management in hospitals. The blue cluster includes terms that relate resources used in distribution and programming to the logistics management.

Red cluster – In the health care field, even though logistics is not visible to the user, may directly affect the quality of services. Supply chain management should aim to improve the quality of customer service by efficiently uses existing resources. In the hospitals analyzed in the literature, there is not a clearly defined orientation for the logistics related to the user. Some authors argue that for a fluid and more efficient information flow, departmental changes, as well as better users’ transportation, and improvement in communication channels must be developed. Metrics and indicators should be developed to measure waiting times,number of users and costs [15] or length of hospital stay after surgery [16]. To improve user logistics, there are studies that suggest that methodologies such as benchmarking, operational research, lean management and six sigma should be adopted [17]. Because users often need to move between departments within hospitals (emergency rooms, operating rooms, hospitalization), patient flow management cannot fail, otherwise it may cause a variety of problems, such as workload, errors and placement of users in inappropriate situations [18]. Some of the problems are the scarcity of capacity that is not adjusted to users’ demand; variability of the flow of the wearer leading to spikes and depressions and lack of coordination resulting in bottlenecks or underutilization. The time spent by the patient in the hospital must be managed in real time, from entering until discharge from the hospital, preventing bottlenecks and system bottlenecks [18,19,20].

Another important topic is the transport of users within large public hospitals and the costs associated with transportation within departments, wards and outpatient clinics. Chiarini(2013) [21] concluded that the greater the route traveled by a patient within the hospital, the greater the loss of comfort,the greater cost of transport, the greater the possibility of contracting illnesses, thus increasing users' dissatisfaction. The author suggests the application of lean methodologies to reduce distances and times traveled, allowing costs reduction related to the transportation of patients.

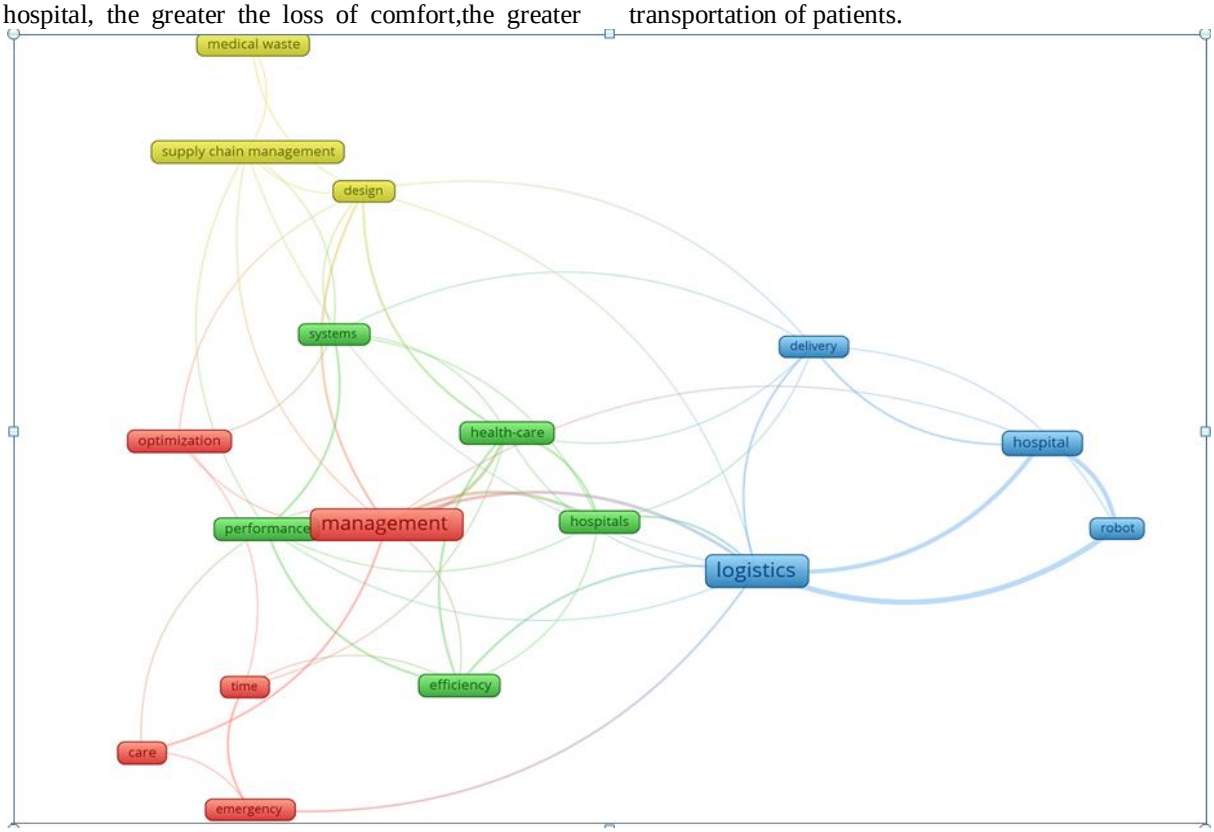


Figure 1: Map of co-occurrences of terms, developed from Web of science database,through VosViewer

Yellow cluster –Three main topics that integrate the supply chain management of hospitalswere identified: supply and purchasing; inventory management and distribution and scheduling. Due to the unpredictable nature of demand and the often-insufficient flow of information across the supply chain, the health sector differs from other companies that can estimate or predict consumer demand and manage the supply chain in accordance with their needs [22]. Much of the variability in health care is attributed to at least three different factors: clinical diversity of users, numerous diseases, levels of severity and responses to treatment; demand variability due to the unpredictability of user needs; variety of clinical approaches provided by physicians and caregivers [18,23].

Given these demand uncertainties, methodologies such as Just in Time (JIT) are considered inadequate for hospital supply, considering the potential consequences of an eventual stock breakage [24,25]. As a result, health supply chains maintain stockpiles for potential needs [25]. These are usually managed through an "Inventory Oriented Approach", whereby pre-established levels of refueling are agreed by hospitals and medical departments [26]; or a “Programming Oriented Approach”, for which procurement, replenishment, and supplier delivery operations are precisely programmed to ensure that resource availability is met, avoiding stock breakages [27]. One of the areas addressed in the topic of supply and purchasing concerns is the study of advantages and disadvantages of a purchasing center for a group of hospitals, allowing economies of scale to be leveraged due to the volume of purchases, enhancing price transparency and creating price ceilings through framework contracts. [28, 29, 30]. However, the creation of purchasing centers is not consensual, some authors mention the existence of a reduction of incentives for manufacturers to innovate and improve their product portfolio [31]. Another area covered in this topic is outsourcing and supplier collaboration. It is argued that strategic alliances and partnerships between hospitals and their suppliers can generate significant efficiency gains for both parties through supply chain integration initiatives such as continuous planning, forecasting and replenishment. Some authors emphasize the potential of the Vendor-Managed Inventory (VMI) and the inventory without stock in the health sector [32-35, 37, 38], as a way of significantly reduce stock in hospitals. However, the supply chain may be hampered by the lack of standards for information sharing and lack of

collaboration on pharmaceutical manufacturers [39]. Considering stock management, only in recent years this area has been identified as an important potential to achieve efficiency improvements without affecting the quality of services. Hospital supply is often based on one of three basic models: "Conventional Model", delivered to medical departments through a central warehouse; semi-direct delivery where suppliers deliver directly to the point of use; and direct delivery, is the closest to JIT, which means that the supplier assumes the responsibility of answering to users demand,restockingdirectly to the point of use [5]. Asidethe existence of various studies regarding the definition of the most appropriate stock policy (periodic or continuous) [39, 24, 40], there are several studies that address the issue of stock location: centralized or decentralized [39]. Regarding distribution and scheduling, there are not many studies that look at this topic. There are a few articles that address the issue of emergency product delivery to the hospital, delivery routing and collection of pharmaceuticals and hospital products or optimization of employee flows [41-43]. Finally, we can mention the definition and optimization of routes for collection and destruction of hospital waste [44-46] as important topics, also addressed in the literature.

Blue cluster –Issues related to distribution and transportation are often difficult for decision-making because complex constraints and costs need to be considered. The hospital's internal logistics services include the delivery and collection of materials and documents exclusively within the hospital's facilities, examples of these documents and materials are: patients clinical processes, medical exams results, supply of consumables and medicines and sterilized material. As the main objective is resources efficiency, distribution flows must fulfill certain constraints: while some services are limited by periodicity and time windows (meals and medicines), others must have its own routes because of the specific nature of the products (hospital waste and sterilized material) [47]. There are several researches in hospital delivery systems, including robotic post offices, automated guided vehicles and pneumatic tubes, being that reengineering and optimization methodologies can be promising in terms of cost-benefit and optimized material flow within healthcare institutions. Computational results show that solutions based on optimization and process reengineering can not only improve performance measurement by more than 50% but also reduce the resources needed to maintain the same service level by 16.67% [47]. It is noted that the use of information and communication technologies and robotic mail decreases daily operational costs, as well as improves the efficiency and effectiveness of various delivery systems [47]. With the riseof technological evolution, it is expected that new equipment will appear in the market, with new functionalities, improving the supply of materials, laundry, food, exams and clinical information inside the hospital, allowing annual cost reduction and the mean return time for hospital transport, and although the initial investment may be high,the long-term return may be very positive [47].

Green cluster–Hospital supply chain management has been identified as an important component for cost control, considering the continuous growth in health costs in industrialized countries. Hospital supply chains are very complex structures, with numerous internal and external flows of materials, information and people. In the literature, several authors approach numerous perspectives with the main objective of incorporating and developing hospital logistics optimization models with the objective of increasinghospital efficiency, without hurting the quality of services. We also found several studies covering topics related to the evaluation and redesign of logistics processes and the organization of the hospital logistics [32,48,49,50]. Other authors evaluate whether logistics concepts that are successfully implemented in other industries, such as lean, can be transferred to hospital logistics [51,39,52,53], most publications conclude that, generally, these concepts are applicable in the health area, but there are major obstacles that need to be overcome, for example [55], some improvements are closely related to an iterative implementation of processes, while there appears to be a general agreement on the potential of lean in the healthcare sector, it remains a challenge to quantify the potential and critically assess its impact.

CONCLUSIONS

With the elaboration of this paper we intend to identify and study the situation of hospital logistics. We found that, through time, the area of logistics was quite neglected, although in the last 20 years, there has been a reversal of this trend. Hospital managers began to look at logistics as a management tool and as away of controlling hospital costs without the, many times inherent, reduction ofservices quality. Then, an analysis of scientific articles was made using a search in the Web of Science database. The papers were analyzed and later a map of co-occurrences of terms was elaborated using VosViewer software. Analyzing the results, it was possible to verify, through the formed groupings, that the hospitals are very complex structures and that there are several areas where hospital logistics can be approached, like: patient circuit, internal supply chain, holistic supply chain, distribution and transportation. Finally, it was clear that the logistic study in hospital institutions has become a significant trend in recent years, since there has been an increase in the number of published articles, regardless of the different logistic branches. Nevertheless, there is still anenormous potential for future research in this area.

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