HOSPITAL LOGISTICS

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Abstract: *Hospital decision makers are facing various difficulties arising from unpredictability of patients and their arrival time mix. The complexity of flows - specific only for this industry branch – also contributes that. More efficient business with lower stocks and costs, as well as with quality services could be achieved through organized and developed logistics, which could be managed from separate sector. Properly management of this system could be achieved only if all flows and activities are analyzed together. This paper covers some of the hospital logistics difficulties and measures to overcome them, with special emphasis on the situation and problems in Clinical Center of Serbia.*

Keywords*: Clinical Center of Serbia, logistics, hospital flows*

1. INTRODUCTION

The basic function of a hospital, as one of the more important systems in every country, is providing health care to the citizens. Taking into account all available resources and aiming to more efficient basic function realization, every hospital needs logistics. The numerous kinds of flows are present in a hospital every day, but unlike manufacturing industry, here it is not possible to predict the patient mix or the demand for particular material, implying very complex logistics. The complexity of activities, flows and participants in hospital instituions' logistics requires extensive research for service improving and cost reduction. The literature contains different hospital logistics definitions and explanations by which either the traditional logistics definition is just mapped on hospital systems or the different forms of hospital logistics are seen as separate management values and areas.

While reviewing a literature, the different definitions of hospital logistics are observed. Thus, Aptel and Pourjalali (2001) suggest that logistics activities in hospitals include purchase, receiving, stock management, information system management, food service, transport and home care.

Logistics is a vital part of a hospital that is in charge of purchase, receiving, stock management, information system management, telemedicine, food-related services, transport and home care services (Kriegel et al., 2013).

In its comprehensive meaning, hospital logistics includes purchase management and all planning-related tasks, implementation and administration of agreements and methods leading to goal-oriented flows of objects, values and information concerning goods and services required within a hospital (Pieper and Michael, 2008).

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This paper covers hospital system characteristics, its inherent flows and factors that are important for its functioning. Certain fields, which are commonly considered in research conducted in several countries, are extracted. The separate chapter is dedicated to the state of logistics within Clinical Center of Serbia (CCS), distribution organization, stock management, as well as to the significance of certain systems within this complex, for whose elaboration the information were collected by conducting interviews with Central Pharmacy and Orthopedic Institute employees.

2. HOSPITAL LOGISTICS – FLOWS AND PROBLEMS

Hospital logistics is characterized by high-level division of labour, non-standard processes and a lack of relevant information. Due to these problems decision makers in hospital management are facing the challenge of ensuring resource availability every day, at any treatment place, and of constant improving of hospital services considering the capital, efficiency, costs and health care quality. One of the main sectors for ensuring resource availability is the hospital supply sector. Three factors are crucial for service redesigning and improving: costs, customer needs and the quality of service provided. Considering that hospitals should be focused on their basic activity, the secondary and tertiary services should be outsourced and this is the trend in other industries too.

Hospital complex flows are characterized by extreme complexity and they could be classified into goods flows and people flows (Fig. 1). Besides the patients, people flows include employee flows and visitor flows. Within this group it is possible to single out the operating room logistics, emergency logistics, logistics of patient admission and discharge and health care logistics. Goods flows include flows of medical (pharmaceutical products, medical material, instruments and devices, blood and organs for transplantation, laboratory samples) and non-medical material (food, hygiene items, clothing and laundry, beds and furniture, administrative materials, various waste categories). The patient flows are the main flows, which are the drivers of all other flows and activities. The arrival variability determines maximum and minimum points of demand for hospital resources, medicines, operating supplies etc., creating queues, delays, as well as the stress to hospital staff (Noon et al., 2003; Haraden and Resar, 2004).

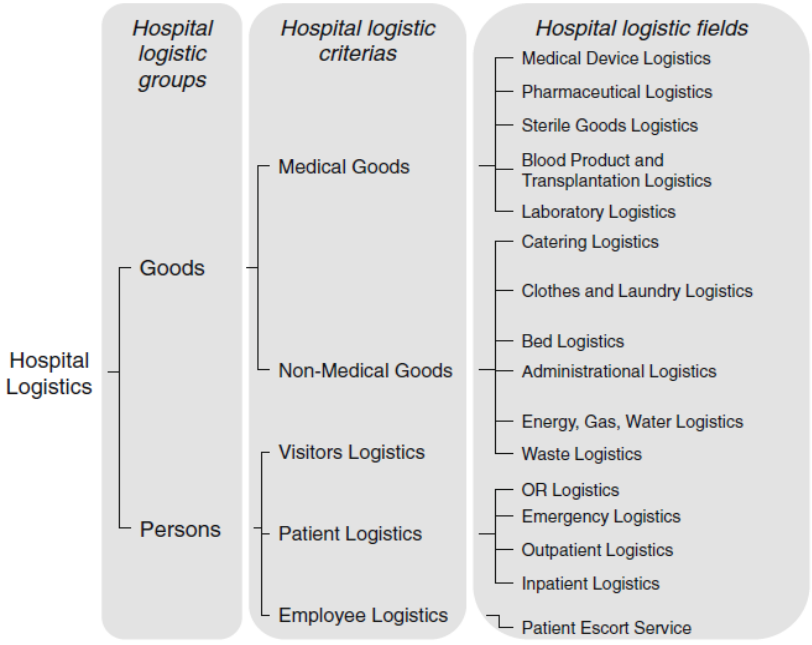

Figure 4. Division of logistics by fields (Kriegel, 2012)

Patient flow logistics deal with their movement through the different parts of a hospital (such as operating rooms, emergency, dispensary or ambulance) from the moment of the admission into the hospital to their discharge. Vissers (1998) suggested that following four problems are the main causes of failure in patient flow management: (1) a lack of coordination of different departments within hospital, (2) variability, (3) a lack of, and (4) inadequately allocated capacities. In addition, Butler (1995) and Haraden and Resar (2004) considered queues, delays and referring patients to inappropriate place, while Villa et al. (2013) considered the bottlenecks along the whole chain within a hospital, which interfere with the patient flow and the elective and emergency case overlapping.

3. REVIEWING THE RESERACH ON HOSPITAL LOGISTICS

Besides the patient flow analysis, the research on stock, material management and their distribution, partnerships and strategic alliances of hospital and suppliers also could be found in the literature. The various authors' opinions on these subjects will be presented in the following.

Pan and Pokharel (2007) were dealing with stock management problems. They identified three methods for stock management: ordering method, periodic filling method and periodic review and filling method. Two main approaches are defined for logistics activities planning in hospitals in Singapore, one stock-oriented and other schedule-oriented. The stock-oriented approach implies that hospitals or medical departments send their orders to their suppliers in the moment when their stocks reach the re-ordering level. The second approach is focused on making goods delivery schedule, which defines the times and quantities for every delivery. In the stock-oriented approach, Lapierre and Ruiz (2005) added that the supplying of a department is performed through the central warehouse (CW).

Aptel and Pourjalali (2001) provided three basic models: a delivery to medical departments through the central warehouse, a semidirect delivery through daily filling of small departmental warehouse. The first model represents the system with large stock quantity where the hospital bears the costs of storage. The stocks of commonly used medicines are stored in a departmental pharmacy, while those being unavailable are requested from central pharmacies. The second model suggests supplier's direct delivery of necessary quantities to the medical departments, without involving central pharmacies. Their application leads to stock reduction and, in addition, the time needed to delivery medicines to the departments is reducing. The third model, being the most similar to JIT (Just In Time), is characterised by very close relations of a hospital and suppliers who take hospital stock management upon themselves. Pan and Pokharel (2007) upgraded the previous authors' models, i.e. the first model is divided on two models: (1) direct delivery to central warehouse and then delivery to medical department for further using, and (2) direct delivery to central warehouse and then delivery to departmental warehouse.

Kim and Schniederjans (1993) identified three types of material management systems in hospitals: conventional, JIT and stockless. Heinbuch (1995) and Jarrett (2006) noted in their papers that effective material management and JIT deliveries could reduce the health care costs. Lapierre and Ruiz (2005) found two approaches upon which most hospitals organize their supply activities and these are two- or three-echelon stock systems. In addition to the questions whether to use two- or three-echelon system, there are also questions of what goods to order and when, how much stocks to store etc. Fig. 2 shows a two-echelon supply system. It could be seen that the key decision is whether to classify a product into the stocks or delivery it directly. If the product is stored in CW, the frequency of ordering from a supplier is reducing, the stocks in care units (CU) are reducing too, but CW's stocks are increasing. Avoiding CW will reduce the handling time and the need for space in CW, but this requires better coordination of receiving and delivery to CU.

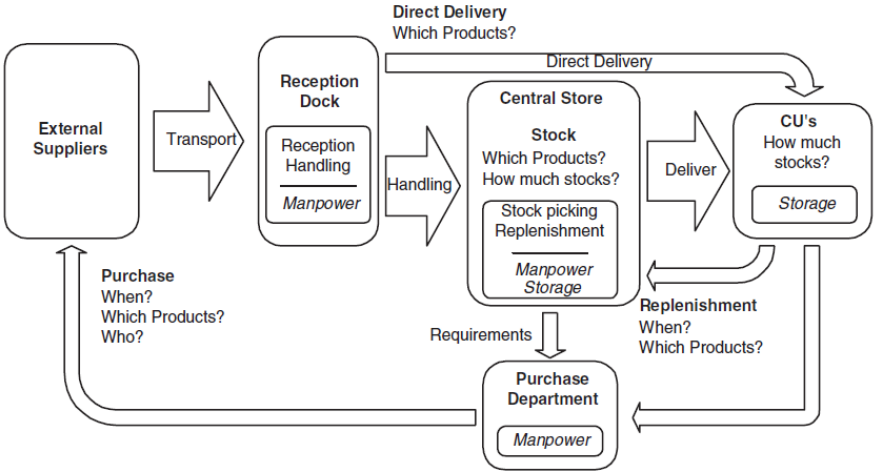

Figure 5. Key decisions in a supply system (Lapierre and Ruiz, 2005)

Aptel and Pourjalali (2001) and Kriegel et al. (2013) highlighted the importance and the advantages of the partnership with other hospitals and material/service suppliers. They considered that it is also possible to reduce the stocks in more complex industries such as medicine, as shown in the hospitals that were the subjects of their research. Improved cooperation among supply chain participants has a positive impact on total costs and service performance improving. Pan and Pokharel (2007) indicated that hospitals in Singapore don't see the associating with suppliers as a strategic option, so they rather decide to outsource logistics services and add that their goods mainly come from local distributors.

4. THE SITUATION IN BELGRADE – CLINICAL CENTER OF SERBIA

CCS complex, located on 34 hectares area, has 41 organizational units in total: 23 clinics, nine centers, polyclinic and nine offices for service activities. Annually, in CCS dispensary units 90,000 patients are treated, 50,000 operations are performed, more than 7,000 childbirths are made and more than 950,000 hospital days of treatment are realized. Annually, 25,000 patients are treated and more than 5,000 operations are performed in day hospitals. Emergency Center has 298 beds at disposal, where 167 of them are in intensive care unit. This number is not sufficient regarding that their average occupancy is 99%.

For every category of goods CCS announce a tender based on annual plans, which are made by each clinic manager on the basis of the consumption in the previous periods. The contract is signed with each supplier and after that the goods are ordered according to demand of each clinic. CCS might request a greater quantity than contracted one only if the suppliers are able to meet this request. The goods are shipped to the central pharmacy warehouse (CP), from where the distribution is performed by CP fleet to the departmental pharmacies (DPs), located on every clinic, and then they are forwarded to the departments for further use. This supply system generates the stocks in three levels: in CP, in DPs and in departments. Within CP is the central server which provides information on a stock status (for every type of goods and for every clinic, at any moment), that are necessary for determining quantities and moments of sending orders to the suppliers. CCS tends to reduce the stocks in clinics, i.e. in DPs and in departments. For some types of goods it is necessary to store greater quantities at any moment, especially when it comes to the functioning of Emergency Center. The stock level of these goods must not drop to the zero, because the costs of out of stock (loss of life) are much greater than costs of additional stock storage. However, due to a priori contracted quantities, there is a decrease in stocks as the year comes to the end and in some cases this could cause the lack of required goods. In these situations the problems are solving by the cooperation of clinics within a complex, by the cooperation of CCS with other hospital systems (Military Medical Academy) or by the use of the

goods considered adequate substitute and being available in a sufficient quantity (e.g. a gauze can be replaced by a compress).

4.1 Central pharmacy

CP building is situated on the edge of CCS complex and consists of two levels (ground and first floor). It consists of four departments: finished drugs (antibiotics, analgesics, etc.), operating supplies (cotton, gauzes, syringes etc.), solutions (sterilization) and oficina (e.g. production of eye drops). The departments are spatially disorganized, consist of several areas that could be on different levels (e.g. operating supplies are stored on both ground and first floor, while solutions only on first floor but at many locations). The space for expensive operating supplies storage (surgical suture) and medicines requiring a special temperature mode is also located on the first floor. The main problem of multi-floor warehouse organization is the vertical transport while the main problem of the admission and dispatch of goods is the only one loading ramp, wherefore the dispatch time (7-9 a.m.) and delivery time (after 9 a.m.) are defined.

4.2 Blood, food and waste flows

Institute for Blood Transfusion is located within Emergency Center (EC), from where all the clinics within CCS complex are supplied. Due to its specificity, EC should have it at any moment. The blood is delivered to the clinics only in cases of scheduled operations, but if there is a lack of it, it comes to their cancellation. Since its lack is a big problem during summer months, the voluntary donor flows are arising as an additional problem.

The specialized company, which cooperates with CCS technical service, is responsible for food supply. The kitchen is situated next to CP, from where the distribution to the clinics is starting. The special smaller elevators are used for vertical transport. The technical service workers delivery the food three times a day and then distributed it within every clinic and to all patients by using handcarts.

The communal service removes non-hazardous waste generated by CCS and ecology and technical service remove hazardous waste. The departments use differently coloured bags for every types of waste (black one for communal waste, yellow one for infective waste, brown one for pathoanatomic waste etc.). Waste disposal is performed up to several times a day in containers with capacity of 220 l in departmental warehouses of clinics, which then the technical service takes over, transport and store it in a hazardous waste warehouse, situated next to CP. After accumulation the waste is being dispatched on further treatment.

5. CONCLUSIONS

Although there are many models of distribution, stock management, material management, flow management etc, it is not possible to map their application from one to another hospital system, but it is necessary to conduct a comprehensive research in order to adjust the model to specific case. However, this is a major challenge for logistics sector, considering all participants, flow diversity and problems that could arise and that are partially covered by this paper. Reconfiguration of such a complex system, like a hospital, requires major infrastructure, financial and staff training investments. These changes of entire or a part of the system are similar to those in other industries, accompanied by participants' repulsive attitude. Several studies showed that hospital systems with more developed and organized logistics, as well as with separate sector for managing these activities, have more efficient business with less stocks, lower costs and better quality of service provided to patients.

CCS complex is characterised by a bad spatial layout, which in some situation leads to the incompatible flows crossing. The cause of this is that goods flows and supply system are not

considering when planning and the consequences involve difficulty and inefficiency in flow realization within the complex, congestion occurrence and disruption of patient flows and basic activity. The current functions of some facilities being inappropriate for their primary purpose are also aggravating circumstances. This observation is confirmed in CP facility where the large-turnover goods are stored at not so suitable places, causing unnecessary manipulations, cost increasing and storage in/off time increasing. In addition, the lack of cooperation of various sectors responsible for different flows' optimization results in inefficient functioning of the entire system.

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REFERENCES

[1] Aptel, O., Pourjalali, H. (2001). Improving activites and decreasing costs of logistics in hospitals: A comparison of U.S. and French hospitals. The International Journal of Accounting, 36, 65-90.

[2] Butler, TW. (1995). Management science/operations research projects in health care: the administrator's perspective. Health Care Management Review, 20(1), 19–25.

[3] Haraden, C., Resar, R. (2004). Patient flow in hospitals: understanding and controlling it better. Frontiers of Health Services Management, 20(4), 3–15.

[4] Heinbuch, S.E. (1995). A case of successful technology transfer to health care: total quality materials management and just-in-time. Journal of Management in medicine. 9(2), 48-56.

[5] Jarrett, P.G. (2006). An analysis of international health care logistics: the benefits and implications of implementing just-in-time systems in the health care industry. Leadership in Health Services. 19(1), i-x.

[6] Kim, G.C., Schniederjans, M.J. (1993). Empirical comparison of just-in-time and stockless material management. Hospital Material Management Quarterly. 14(4), 65-75.

[7] Kriegel, J., Jehle, F., Dieck, M., Mallory, P. (2013). Advanced services in hospital logistics in the German health service sector. Springer.

[8] Kriegel, J. (2012). Krankenhauslogistik, SpringerGabler, Wiesbaden.

[9] Lapierre, S.D., Ruiz, A.B. (2005). Scheduling logistic activities to improve hospital supply systems. Computers & Operations Research, 34, 624–641.

[10] Noon, CE., Hankins CT., Côté MJ. (2003). Understanding the impact of variation in the delivery of healthcare services. Journal of Healthcare Management, 48(2), 82–97.

[11] Pan, Z.X., Pokharel, S. (2007). Logistics in hospitals: a case study of some Singapore hospitals. Leadership in Health Services, 20(3), 195-207.

[12] Pieper, U., Michael, M. (2008). Healthcare logistik. Gabler logistik lexikon, 214–220.

[13] Villa, S., Prenestini, A., Giusepic, I. (2013). A framework to analyze hospital-wide patient flow logistics: Evidence from an Italian comparative study. Health Policy, 115, 196-205.

[14] Vissers, J. (1998). Patient flow-based allocation of inpatient resources: a case study. European Journal of Operational Research, 105, 356–370.