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# National Report of Healthcare Logistics in Spain

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## **1. Introduction**

Logistics activities involve “planning, designing, implementing and managing material flows in a supply chain to support functions such as procurement, distribution, inventory management, packaging and manufacturing” (1). Although hospital’s main function is providing healthcare, logistics is involved in every internal process developed in the hospital. The logistics activities in hospitals consists of purchasing, receiving and managing inventory, as well as managing information systems, food and laundry services, transportation and home care services (2).

The purpose of this report is to provide an overview of the Spanish Healthcare system and the logistics processes involved, in order to identify future trends and possible topics for healthcare logistics education development.

It is worthwhile to mention that the Spanish healthcare system can be very complex, involving many different types of management and organizational structures, generating many different ways of managing logistics and supply chains in hospitals.

## **2. A brief overview of the healthcare system of Spain**

### **2.1 Health policy and legislative framework**

The right for all citizens to enjoy health protection and care is stated in article 43 of the Spanish Constitution of 1978.

The main principles governing the exercise of this right are regulated by the General Health Law of 1986 which states that the National Health System is made up of both the State and Autonomous Community Health Departments and covers all the health functions and services for which the public authorities are legally responsible.

There are 17 Autonomous Communities in Spain, and gradually until 2001, the Central Government transferred to them the management of the health services under basic direction and coordination by the central state (Figure 1).



Figure 1 Autonomous Communities of Spain

The General Health Law was complemented in 2003 by the Law of Cohesion and Quality of the National Health System, aiming to define a common framework of action of the National Health System and of the health services that comprise it without interfering in the diversity of organizational formulas, management and service provision inherent to a decentralized State. This law intends that citizen attention to public health services respond to basic and common guarantees independently of the Autonomous Community they belong.

The distribution of power, according to the Spanish Constitution, the General Health Act and the Law for cohesion and quality in the National Health System can be seen in Figure 2, and will be explained in the next sub-section.



Figure 2 Powers of the Public Administrations on health matters (3)

## 2.2 Organisational structure and delivery of services

### 2.2.1 Governmental healthcare system

The Ministry of Health and Social Policy develops the policies of the Government of Spain in matters of health, in planning and delivery of services, as well as exercising the purview of the General Administration of the State to assure citizens the right to protection of their health.

According to the data available in the Spanish Statistical Office, in 2017, 46.5 million inhabitants reside in Spain, with a slight predominance of women (50.79%). The age group of less than 16 years accounts for almost 16% and age group of those 65 and older over 15%. Of the total population, 4.4 million are foreigners, representing 9.5 %.

The National Health System is structured into two health care levels: primary care and specialist care, in which there is an inverse relationship between accessibility and technological complexity (3).

Primary Care makes basic health care services available within a 15-minute radius from any place of residence. The main care services are provided in the facilities of the health care centers, staffed by multidisciplinary teams comprising general practitioners, pediatricians, nurses and administrative staff, and, in some cases, social workers, midwives and physiotherapists. Primary health care services

also deal with health promotion and disease prevention. Primary care also provides home care whenever this is necessary.

On the other hand, specialist care is provided in specialist care centers and hospitals in the form of outpatient and inpatient care. Patients having received specialist care and treatment are expected to be referred back to their primary care doctor, who based on electronic data from the patient's full medical history, provides a global clinical and therapeutic vision. This ensures the provision of continuous care under equitable conditions, irrespective of the patient's place of residence and individual circumstances, with care provided even in the patient's home if necessary.

The percentage of expenditure that the Spanish government devotes to the health sector with respect to the total of its Gross Domestic Product (GDP) is below the average levels of the 28 Member States of the European Union (EU). According to the last Eurostat data available, Spain would occupy the 17th place by dedicating 6.0% of GDP to Health.

The historical series shows that in the last four years, the percentage of Spanish public health expenditure with respect to GDP has slightly decreased, and that the best figure was obtained nine years ago, in 2009 when the 6.8% of the GDP that was dedicated to the health sector.

The Spanish National Health System is universal coverage-wise, almost fully funded from taxes and predominantly within the public sector (70/30). Health care is one of the main instruments of the Spanish redistributive income tax system, aimed to redistribute income amongst Spanish citizens: all citizens contribute to general taxation in proportion to their level of wealth, and receive health care services according to their own particular needs. Provision is free of charge at the point of delivery, with some exceptions. Financial flows across the System are described in Figure 3. Table 1 shows the Spanish health system financial cash flows as the sum of public and private funds allocated to public health care on different levels.

<b>Area of funding</b>	<b>Percentage</b>
Central government	3.00
Social security	2.53
Civil servers mutual funds	3.40
Autonomous Communities	89.81
Cities with Statutes of Autonomy	0.01
Local Councils	1.25
<b>Public Health expenditure</b>	<b>100.00</b>

Table 1 Spanish health system financial cash flows (4)

The Ministry of Health and Social Policy is in charge of:

- General organization and coordination of health matters
- International health, and international health relations and agreements.
- Legislation on pharmaceutical products

The Ministry plays the core role in the coordination of the 17 regional health systems, which are accountable only to the regional parliaments, not being hierarchically linked to the national level. The Inter-territorial Council of the national health system (CISNS, from its Spanish abbreviation) acts as the coordinating body between the 17 regional ministries of health and the national ministry.

Other stakeholders such as the national Ministry of Education and the Ministry of Science and Innovation play also a role in the overall structure of the National Health System.

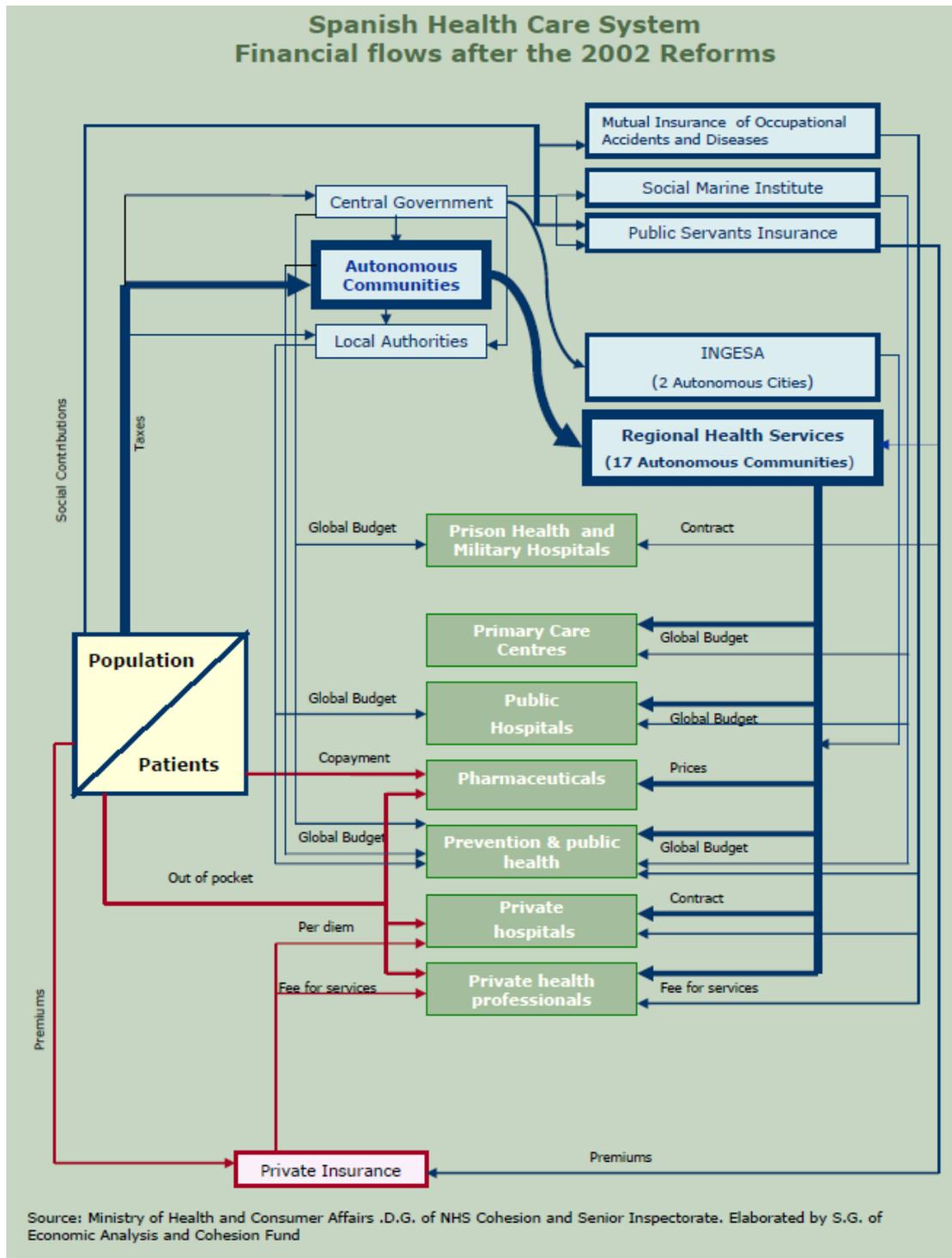


Figure 3 Spanish Health Care System Financial Flows (4)

### 2.2.2 Regional healthcare system

By 2001 it was completed the transfer of health care responsibility from the central administration to the regional level.

The Autonomous Communities hold powers for:

- Health Planning

- Public Health
- Health care

They are in charge and manage the functions and services, goods, rights and obligations relating to such powers, as well as the staff and budgets assigned to them.

Each Autonomous Community has a Regional Health Service, which is the administrative and management body responsible for all the centres, services, and facilities in its own Community, whether these are organized by regional or town councils or other intra Community Administrations. They are subject to the “Contractual law with public sector” (LCSP) for goods’ acquisition and their human resources are generally government employees. An example is Clinic University Hospital “Lozano Blesa”, located in Zaragoza, which depends on Aragon’s Health Service.

The principles governing health coordination on a nationwide level are set forth in the General Health Act 14/1986 of 25 April.

Table 2 illustrates the population that serves each of the Regional Health Services. As it can be seen, there are notorious differences among communities.

Autonomous Community	Population served (2017)
Andalucía	8,379,820
Aragón	1,308,750
Asturias, Principado de	1,034,960
Baleares, Illes	1,115,999
Canarias	2,108,121
Cantabria	580,295
Castilla y León	2,425,801
Castilla - La Mancha	2,031,479
Cataluña	7,555,830
Comunitat Valenciana	4,941,509
Extremadura	1,079,920
Galicia	2,708,339
Madrid, Comunidad de	6,507,184
Murcia, Región de	1,470,273
Navarra, Comunidad Foral de	643,234
País Vasco	2.194.158
Rioja, La	315,381
Ceuta	84,959
Melilla	86,120

Table 2 Population served by each Regional Health Service

### **2.2.3 Municipal healthcare system (Local Governments)**

The role of local governments in the system is limited, mainly playing a role in ensuring a healthy environment to the society, and sometimes also in collaborating in the management of health services. They are key players in the implementation of health promotion and drug addiction programmes and community and social care.

### **2.2.4 Private healthcare system**

The total expenditure of the Spanish health system amounted to 95,722 million euros in 2014; 66,826 million financed by the public sector and 28,895 million financed by the private. Expressed as the % of the Spanish GDP, it accounted for the 6.4% for the public sector and the 2.8% for the private one. In the period 2010-2014, public health expenditure increased a rate of -2.8%, while private expenditure grown by an average of 3.8% per year.

In Spain, there are mainly six different organizational models for hospitals (5):

1. Private hospitals: Funded, managed and controlled by private organizations such as private foundations, corporations or health insurance companies. Examples of this are ASISA or QUIRONSALUD, with a network of clinics, hospitals, medical centers and private physician covering the whole country.
2. Public hospitals: Funded, managed and controlled by their respective regional Health Service.
3. Health foundations: Non-profit organizations funded and controlled by their respective regional Health Service and that can be publicly or privately managed depending on the management rules established at the time of their creation by the governing body. An example is Fundación Hospital de Calahorra (La Rioja).
4. Consortia: A group of organizations (Regional Health Services, town councils and other non-profit entities) collaborate to provide public healthcare. Consortia's regulation is minimal; their bylaws establish the applicable legislative and organizational framework, their governing body and resource management criteria. Example: The Catalan Health and Social Care Consortium.
5. Concession: A particular type of public-private partnerships. The "Alzira model" was pioneer in this management model, whose premises are public funding,

public control, public property and private provision, i.e., public hospitals administrated by private management. Example: Hospital de Alzira (Valencia).

6. Other public-private partnerships: there is a huge variety of management models based on public-private partnerships. For example, the introduction of Private Funding Initiatives (PFI) practices in Madrid, Castilla-León and Baleares, in which a private organization enter into a long-term contract with the Health Service in order to finance, build and sometimes manage part of new hospitals.

These systems that mix public health with private management can be very complex and should overcome the risk of incurring in higher costs, decreasing quality, and take advantage of the capacity of enhancing the efficiency due to their flexible management tools.

According to estimations 30-45% of hospital budgets (independently of their management model) are spent in logistical activities. It also has been proved that almost half of the cost could be reduced by adopting best logistic management practices, without reducing service quality (6).

### **2.2.5 Occupational healthcare system**

The general Occupational Health and Safety (OSH) legislation in Spain, transposing Directive 89/391/EEC (Framework Directive), is mainly covered by Law 31/1995 on the Prevention of Work-Related Risks. It establishes the general principles for health monitoring of all workers (except domestic ones and self-employed) and its approval was the starting point for the development of the security system and health at work in Spain.

The main bodies concerned with occupational safety and health (OSH) in the Ministry of Employment and Social Security are the National Institute of Safety and Hygiene at Work and the Labor Inspectorate. The autonomous regions have certain competencies in OSH matters that are carried out by the regional labor authorities and the regional OSH centers or institutes.

In 2013, the Spanish National Institute of Health and Safety at Work published the final report of the strategy followed in the period 2007-2012, including an evaluation of its overall objectives (7). The report stated that, even though the safety and health of workers improved during that period, and the number of

occupational diseases and accidents was reduced, the progress made during the past years was not enough. It therefore calls for continued (policy) actions by all stakeholders concerned, including the development of a new Spanish Strategy on Safety and Health at Work (2014-2020) (8).

Another study (9) showed that the activities of OHS services and professionals in practice are considered overly formal and bureaucratic in what has come to be termed "defensive prevention", meaning that companies and OHS services direct most of their efforts towards their main objective of avoiding sanctions. It also revealed that the lack of integration of OHS activities in the management of companies is one of the main constraints for the quality of prevention in the workplace. Most of companies differentiate between production management and OHS management and delegate responsibility for prevention in other subjects mainly to external OHS services. There is significant room for improvement of training provisions for Spanish OHS technicians and training of occupational health professionals (occupational doctors and nurses) has also proved to be flawed and problematic. The current supply of training posts is reduced each year and is clearly insufficient to meet the needs of the working population.

### **2.3 Future of healthcare system**

SIS Foundation carried out a series of exercises in order to gather the opinion of three group of stakeholders (patients, professionals and policy-makers and manager) regarding different topics such as governance and funding schemes, public health and health care, future changes... Main expected changes are the following (10):

- Since the population is ageing, health care expenditure is expected to increase.
- IT developments will be the basis for having an accountable sanitary system.
- Managers will have a more professional profile
- Professionals will be paid using pay-for-performance schemes.
- Emphasis will be put more on hospital specialization, reducing the influence of primary care as the centre of the system.

- Information to patients/citizens will be the basis for the system's sustainability
- Information will be provided about how providers perform, and to help patients and citizens to choose the best options.
- Empowerment of citizens and patients, and informed (even shared) decision-making will prevail.
- Co-payment on drug and therapeutic innovation will be implemented, together with an evolution of the current co-payment scheme towards an income-based one.

### **3. Healthcare logistics**

It has been proved that, "improvements in hospital logistics could lead to excellent operating room and pharmaceutical management, better inventory management, enhanced vendor relationships and more effective work flow for hospital employees, and in turn, higher quality healthcare services." (11). However, logistic criteria may depend on the respective Health Service's strategies on the organizational model of the hospital.

The logistical processes within a hospital can be depicted as follows in Figure 4:

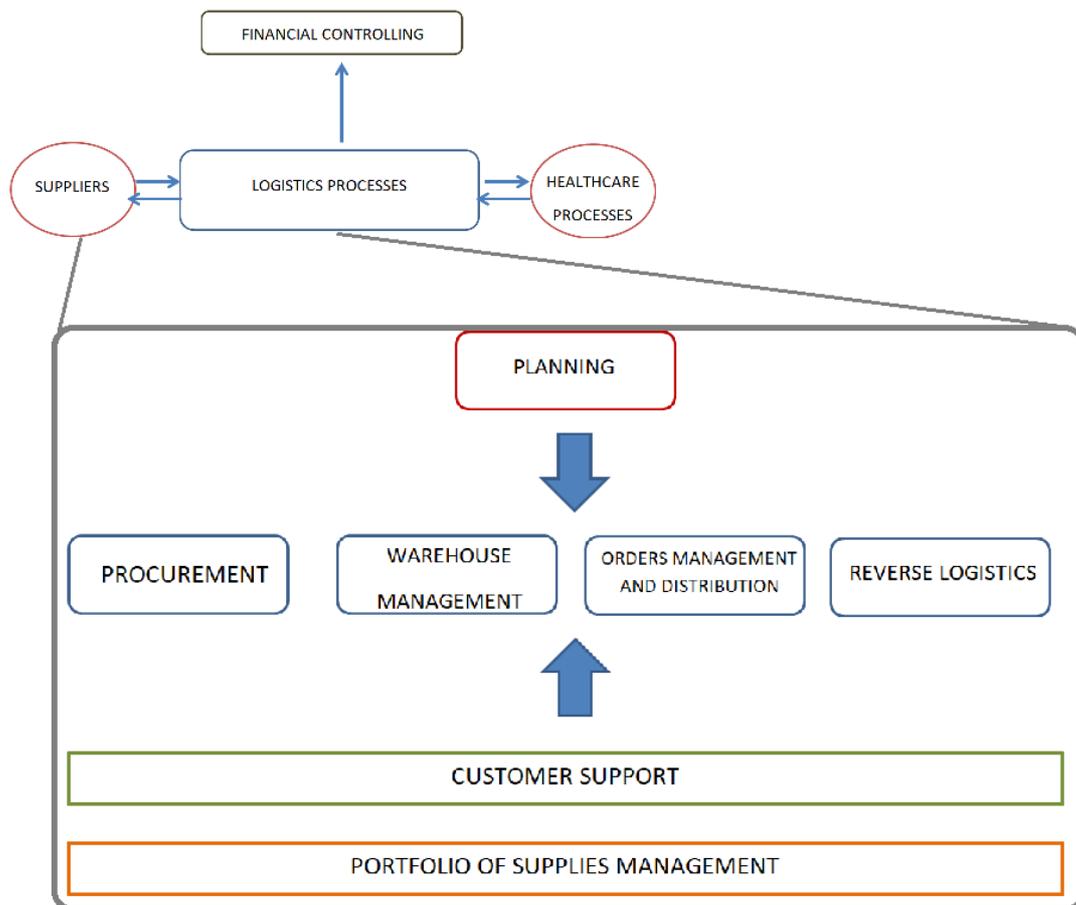


Figure 4 Logistical processes involved in healthcare (12)

### 3.1 Inbound healthcare logistics

Inbound logistics is linked to provisioning process, which includes the purchasing, reception and management of inventory, that is, all the processes that provide the healthcare system with the necessary resources for its function.



Figure 5 Provisioning subprocesses by CEL Committee (5)

From the organizational point of view, provisioning depends on the Financial Department, which controls and manages the budget and correct expenditure of goods and services within the hospital. Taking this into account and since a hospital is a very complex environment; there are three major systems in which the related departments can be arranged (13):

i) A single service of provisioning, under the direction of the financial department. This service would manage the provision of any material within the organization and it is articulated around two elements: a general central warehouse and a purchasing department. The first manages the supplies and the latter, the suppliers.

ii) A double system consisting on the above, plus a pharmacy department that takes care of the management of materials under pharmaceutical legislation (drugs, intravenous solutions, sutures,...) and some medical material.

ii) A multiple system based on the specialization of the procurement function in each of the departments. Due to the specificity and complexities among the different hospital units, this system is the most widespread.

Prior to the transfer of health competencies to the different Autonomous Communities, the former National Institute of Health (INSALUD) had a monopoly on purchasing, acting as a major national health purchasing center, which favored economies of scale. However, the definitive disintegration of INSALUD (in 2001) resulted in a new scenario with 17 different buyers, with the consequent

atomization of the demand. Since then, most of the regional health services have been making their procurement processes in a decentralized manner.

Under this scenario, each public health center (hospital / primary care center) manages its own purchases individually, generally carrying out public tenders to select the providers that present the best offers in relation quality / price. Although this new model allows the regional health services to manage their purchases with greater autonomy, the individual demands are much lower than before and, therefore, the possibilities of achieve economies of scale are much less limited.

At present, the pressing financial situation experienced by the different regional health services has contributed to increasing interest in the centralization of procurement processes by health authorities. In fact, along with the adoption of measures to promote the rational use of medicines, the creation of procurement centers for medical supplies is one of the most widespread measures to rationalize healthcare spending in recent years. Currently in Spain, both, a decentralized and centralized procurement models exist. However, the trend is towards the creation of central procurement platforms by most of the Autonomous Communities.

Below, general functioning of both, decentralized and centralized models are described.

#### 3.1.1 Decentralized procurement model

Hospitals that are funded publicly and provide public healthcare are subject to the “Contractual law with public sector” (LCSP). For public hospitals LCSP establishes a purchasing system whose procedures affect response time and leave no possibility of suppliers’ choice, control and evaluation. Legal requirements provide transparency but hinder provisioning process’ optimization and reduce management autonomy. In order to place the purchasing order to the suppliers, by request of the central warehouse of the hospital, each organization uses one or several different communication channels (telephone, fax, mail, internal electronic systems, EDI, etc.). With a complex system of need for authorization, these procedures, in general, tend to be little automated despite the fact that an important part of them are bureaucratic and routine that do not add much value to the strategic function of purchasing.

#### 3.1.2 Centralized procurement model

The creation of a central procurement platform (for different hospitals/health centers) implies the creation of a central administrative unit (a centralized contracting body, generally dependent on each regional health service but it can be also privately managed) that is responsible for jointly managing the procurement of all or part of the products and services used by the centers attached to it. In this way, each center requests the material it needs from that central unit and the same purchase conditions (price, payment term, delivery period, etc.) apply to all the centers. In this case, a Dynamic Purchasing System (DPS) is used for selecting the suppliers. A DPS is similar to an electronic framework agreement, with two exceptions, new suppliers can join at any time and it is to be run as a completely electronic process (less bureaucratic and time costly than public tender processes).

Before adopting this model, the creation of an unique, standardized catalog of products is needed, since different hospitals usually had different codification systems.

Under this procurement model, the medical supplies are supplied to one of the different warehouses centralized-managed and lately are served to the different hospitals and hospital units, under request.

On the other hand, some Autonomous Communities have gone beyond and have also set up logistics platforms in order to coordinate in an integral and centralized manner the different phases of the logistics process (orders, purchases, storage, billing and accounting, distribution). In this latter case, there is a public-private collaboration since one or more steps of the supply chain are managed by a private logistics operator.

On the other hand, private management of provisioning is also quite bureaucratized. Nevertheless, logistics management structure allows more flexibility, autonomy and leeway than public management of provisioning, so in some occasions they get better prices and suppliers' conditions. Many private hospitals also participate from a centralized procurement model, privately managed, that gives service to different hospitals from the same or different business conglomerate.

### **3.2 In-house healthcare logistics**

In house logistics is related to the stock management, involving the intermediate storage of products and transportation inside the hospital. It takes place in the general warehouse of the hospital, where the majority (around the 90%) of products are received and stored, managed and distributed from. It is the center of logistic activities since all provisioning and production processes take place there. Research studies (14) showed a lack of proper technology to manage stock and information, obsolescence of installations and a lack of qualified labor in logistics in most of Spanish hospitals.



Figure 6 Stock management subprocesses by CEL Committee (5)

A general warehouse is located in the same hospital or facilities nearby, usually is located at basement or ground levels, close to a loading dock where the vehicles unload the goods. Frequently, even when the procurement model is centralized by means of a logistics platform, the central warehouse is still in use. After the arrival, the supplies are checked by a warehouse worker (usually a healthcare assistant) who must sign the delivery note to accept that all goods were delivered in satisfactory conditions. The supplies are identified with a code and registered in the inventory system.

Drugs and some medical supplies are usually received at the Pharmacy Department, which is also physically located at the ground floor or at a basement level. The goods are received at a pharmaceutical general warehouse that can share space with the one dedicated to the rest of supplies, or not, and are stored under different procedures, depending on the nature of the drug itself (refrigerated storage carousel, ambient temperature storage carousel, conventional racking systems or controlled drugs cabinets ).

In all cases, warehouses are divided according to inventory composition. Thus, stock management is separated by type of materials, duplicating provisioning

and stock management processes and losing any possible synergy from joint internal distribution and information systems.

### 3.3 External healthcare logistics

This process is linked to the order's management and distribution, and implies the management and transportation of the products from the general warehouse to the different units within the hospital or outside it (e.g., dependent medical centers, specialized medical attention centers...) until they are consumed. It is focused on the optimization of the distribution of products inside the hospital and its main concern is synchronizing demand and supply, reducing delivery time and warehouses stock by revising internal transportation, distribution frequency and distribution system.

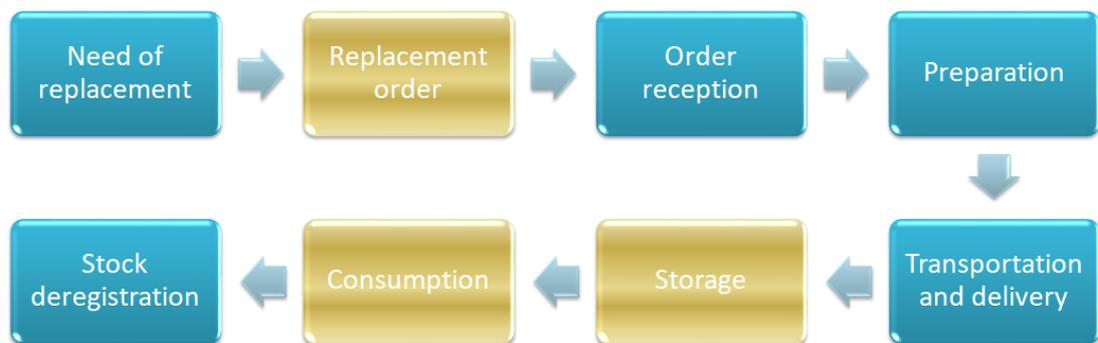


Figure 7 Order's management and distribution subprocesses by CEL Committee. Gold boxes take place in the each of the hospital stores whereas the blue ones are responsibility of general warehouses. (5)

Nurses and nursing assistants are responsible of the stock replacement in the hospital stores (storage of the materials in individual hospital departments) in almost every hospital in Spain. They place, receive and store the orders; so during this time they cannot perform their main functions related to healthcare. Furthermore, the lack of confidence in the supply process makes overstock materials and medicines that with frequency expire before they are used (14).

Once the medical supplies arrive at the central warehouse, the next step depends on whether the supplies are consumed by the majority of the units/departments of the hospital or the use/consumption is specific of some departments.

If they are common-use supplies, they are classified into families (e.g. medical supply, instrumental, other) and stored at the central warehouse. There is a smaller warehouse at each area unit/healthcare center that depends on the central one and places the orders to the general one. Usually, the nurses/nurses assistants check regularly the stock levels of those smaller warehouses and the replenishment is usually done at night by healthcare assistants. In the past, these smaller warehouses managed differently than the central one, using a different codification. Also, there is a tendency towards holding more stock than the needed, increasing the costs and promoting the expiration of the item. Effort is being put in order to avoid this.

When the supplies are not of common-use, the central warehouse acts as a cross-docking area, and the goods are directly sent to the specific unit they belong, where later will be stored.

Reverse logistics worth special mention. It refers to all operations related to the flow of products and materials from their consumption point to the point of origin in order to recapture value or proper disposal (Hawks, 2006). Studies show that orders to distribute are allocated following a schedule of deliveries by departments and the return is not taken into account, preventing the optimization of reverse logistics (14). The main products that intervene in this process are defective products, which are returned to suppliers; and obsolete products or waste which are disposed of or recycled.



Figure 8 Reverse logistics subprocesses by CEL Committee (5)

In the case of drugs and some medical supplies the process should be explained separately.

In the case of in-patients (patients admitted in the hospital and stay there for treatment till they are discharged), there are three general systems used for the distribution of drugs to in-patients (15):

- 1) Individual prescription order: drugs are given to the patient through a nursing station that manages the supplies for each of the individual patients.
- 2) Complete floor stock system: drugs are given to the patient through a nursing station that controls the drug supplies typically used on the unit.
- 3) Unit dose system: In the unit-dose system, drugs are received in the pharmacy prepared in mono doses. Once there, they prepare personalized unit doses for each patient (according to the medical prescription). The technological level of the system depends on the hospital size and the pharmacy budget of it. This is the most widespread model since reduces errors and frees time to the nurses; however in the units where it cannot be predicted which drugs are going to be administered to each patient at every time it cannot be used. Examples of these areas can be the UCI, the surgery room or Emergency area.

On the other hand, in the case of out-patients (those patients not occupying beds that are at the hospital for primary care purposes or a specific treatment, temporary) usually there is an out-patient department is equipped with an automated warehouse in order to distribute the drugs.

Figure 9 illustrates the entire logistics process for medicines.

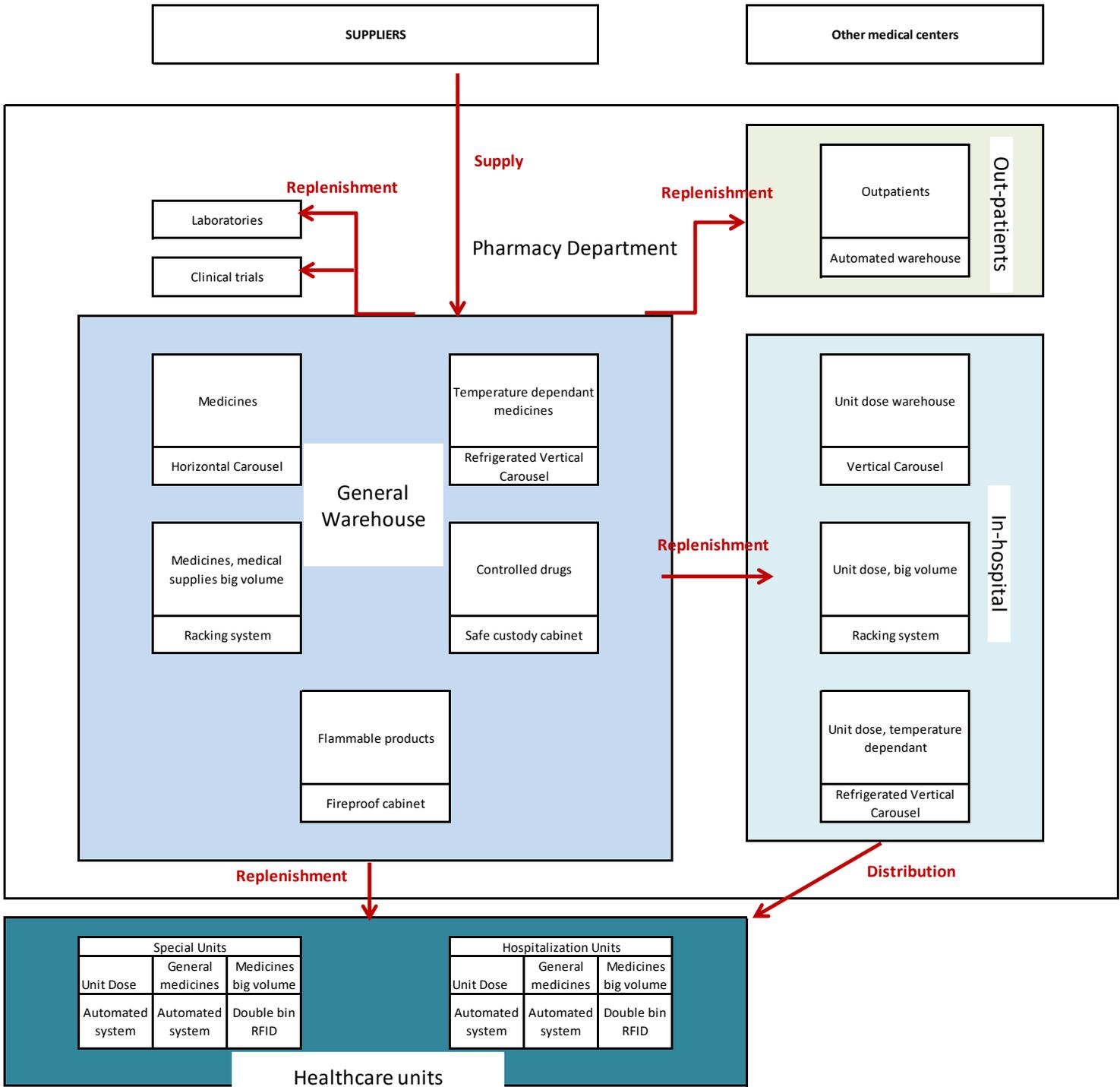


Figure 9 Drugs route inside the hospital (13)

The spaghetti diagram depicting the physical flow of medicines inside the pharmacy department is illustrated in Figure 10.

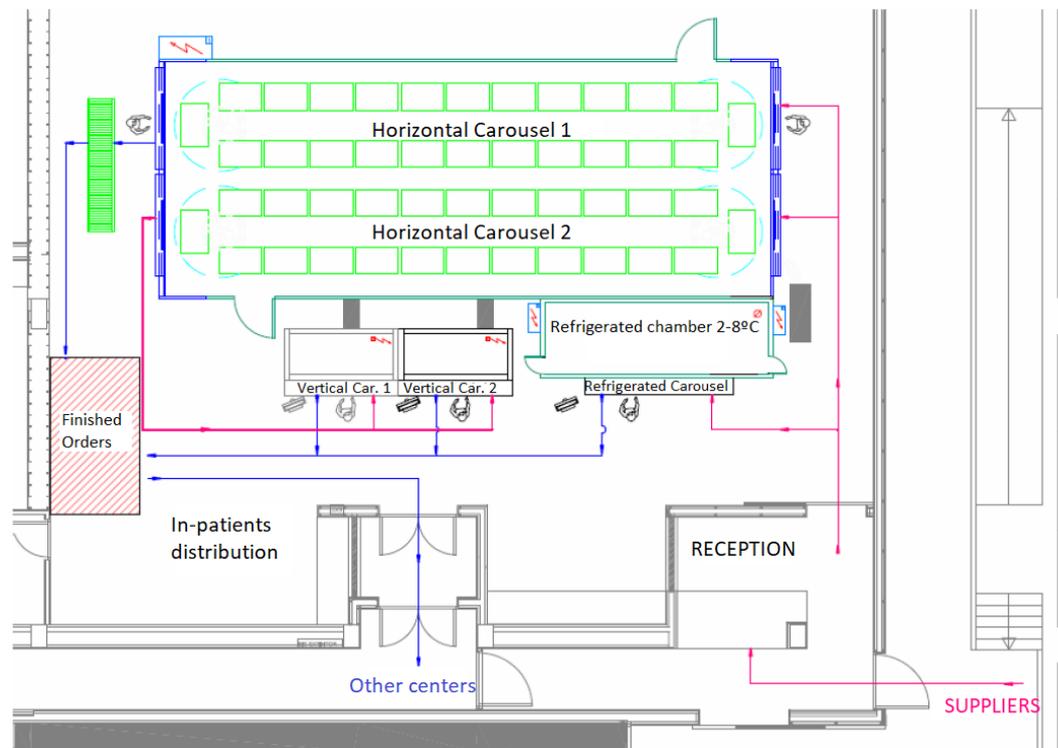


Figure 10 Flow of medicines (13)

### 3.4 Example on healthcare logistics in a public sector organisation

The Virgen Macarena University Hospital is a public hospital located in the Spanish city of Seville. Its management depends on the Andalusian Health Service. The hospital gives service to a population of about 525,000 people. Its area of influence comprises 2 hospitals and 3 centers for medical specialties with a total of 955 hospital beds and 27 operating rooms.

In the period from 2005 to 2010, this hospital underwent to a process of implementing a comprehensive logistics management plan based on lean management principles and technological investments. Because of this, the current logistics operations involved are described (15).

From the logistical point of view, the hospital comprises 350 delivery points of which 65 are other warehouses (6 operating rooms, 3 centers for medical specialties, 9 medical centers and 47 area units). This example covers the non-

medicine medical consumables (26% of the total budget for goods and services of the entire hospital).

### Logistics platform

The old central warehouse at the hospital was replaced in 2007 by a logistics platform of a total surface of 2,800 m<sup>2</sup> at a distance of 14 km from the hospital facilities. The platform has a storage capacity of 2,359 pallets or 137,83 m<sup>3</sup>. Processes can be done automatically or semi-automatically and there are a total of 1,081 different SKUs:

- 340 SKUs are stored in the picking area
- 380 SKUs are stored in pallets of different heights.
- 361 SKUs are stored into an automated vertical carousel

The platform workforce is composed of healthcare assistants belonging to the regional healthcare system (mostly civil servants).

### Information System

A Logistics Information System for warehouse management (WMS) is integrated with the ERP (SAP based).

The warehouse workers are equipped with RFID readers so the stock levels can be updated on real time and human errors are minimized.

### Distribution

The distribution of the supplies to the different delivery points (area units, medical care centers, ...) is outsourced to a service provider (public tender).

### Unit warehouses

The materials are supplied by the service provider to the different unit warehouses (twice per week), managed under a Kanban system with two-bin method. Kanban cards are checked by the service provider workers, who are in

charge of the replenishment. However, in the event of an urgent service, the logistics platform is open the whole year at any time.

### **3.5 Example of healthcare logistics in a private sector organisation**

The Accident Mutual Society of Zaragoza (MAZ) provides medical and hospital assistance to workers and self-employed workers who have suffered an accident at work or occupational disease. This mutual is the result of various mergers between different companies of the sector. In Spain, mutual societies are collaborating bodies of the Social Security and the management is private.

MAZ has more than 80 centers of its own, and is present in all the Autonomous Cities and Communities from the country. MAZ Hospital in Zaragoza is considered one of the most qualified centers in occupational medicine in Spain. It has three hospitalization floors with a total 119 beds, with special focus on orthopedics medicine and surgery and rehabilitation.

Procurement is made via public tender process. Besides the usual bidding conditions, such as technical specificities and cost, MAZ requires also to fulfil environmental and social criteria. Currently they manage a pool of 726 providers between sanitary (496) and non-sanitary (230).

The smaller size of this hospital compared to purely-public ones, allows some flexibility in logistics processes. With a lean perspective in mind, the management body is focus on eliminating waste so that all activities/steps add value from the customer's perspective. They shut down the general warehouse located at the hospital facilities two years ago so the stock is stored in suppliers' premises. Replenishment is made directly to the unit warehouses by the suppliers. Also, most of unit warehouses use a Kamban system and the invoicing is made once the particular supply is consumed. In the particular case of surgical implants, for example, each one has a RFID tag which is read when the implant arrives to the unit warehouse and indexed into the system. Once it has been consumed after a surgery, the tag is read again and the system sends two orders, one for invoicing the item and another one for its replenishment.

### 3.6 Future of Healthcare logistics

A study based on interviews with healthcare professionals and managers (16), identified eight disruptive best practices that will change the future healthcare supply chains. They can be summarized depending on the logistics activity in which they impact as follows and complement the interviews that we have carried out with private and public sector healthcare professionals:

Provisioning:

- 3D-printing/additive manufacturing: in-house manufacturing of medical, maintenance supplies and even some types of drugs instead of buying them from a third party.
- New information exchange protocols with suppliers: Blockchain for guaranteeing the traceability and security of the purchasing process.

Warehousing:

- Automatically Guided Vehicles: The AGV systems are used in material handling and transport, especially in repetitive tasks and without a driver.

Distribution:

- Chatbots: chatbots are computer programs with which it is possible to maintain conversation. This type of robots allows freeing work force in tasks such as customer service, helping to reduce costs and increasing efficiency.

Cross-cutting practices:

- Mobile devices for the treatment of information: new technologies will allow collecting information from different remote devices that can be used to analyse information and taking decisions.
- Internet of Things: use of sensors and devices for automatic capture of information in real time about inventories, movements or consumptions of materials.
- Big Data analytics for demand forecasting: tools that will allow the management of a large amount of information for analysis and identification of patterns. Among other applications, these types of techniques are used in

the industry to predict the demand in order to anticipate and accommodate the supply chain.

- Automation of administrative processes, especially in repetitive tasks that vary very little in each repetition.

#### **4. Competence needs in healthcare logistics**

In our view, basic competence needed in healthcare logistics include fundamental analytic tools, approaches, and techniques that are suitable in the design and operation of logistics systems and integrated supply chains. To accomplish this, the material should be taught from a managerial perspective. A particular emphasis is required on where and how specific tools can be used to improve the overall healthcare logistics performance while reducing the total logistics costs. In this sense, we should focus on the development of competences required to understand and use of fundamental models to demonstrate the underlying concepts involved in both inter- and intra-company operations.

The three areas that require competence development include:

1. Demand forecasting, planning, and management
2. Procurement, sourcing, and auctions
3. Inventory planning, management, and control
4. Transportation planning, management, and operations
5. Supply contracts and collaboration
6. Service Operations Management

Additionally, we believe that other topics need to be incorporated in competence development. These topics include:

1. Innovation in planning and control Management: RFIDs, data analytics, and sensors
2. Vehicle routing, scheduling, and fleet dispatching,
3. Supply chain network design
4. Management and minimization of supply chain uncertainty, and

## 5. Conclusions

Healthcare Logistics concerns to the movement of material resources such as pharmaceuticals, medical supplies, and medical equipment, among others to support healthcare providers. Efficient healthcare logistics deals with the design, planning, and control of material flows and related information flows in health institutions and their supply chain. It includes strategic, and operations tasks with scope ranging from a single piece of equipment to global supply chain. The essential business context of healthcare logistics is a dimension that is ever evolving over time. Technological innovations, business alliances, and global competitive positioning can all have significant influence on the essential context of manufacturing logistics. The movement of material and resources in healthcare can be classified into two broad categories that include external and internal logistics.

External logistics have been traditionally performed through established procurement processes in which different care units require the purchasing of various materials that might include drugs and a centralized (or decentralized) responsible engages in the securing of the requirements. Once these products or supplies arrive to the institution, it is triggered a process of storage, and eventual consumption and/or use of the goods purchased. If there is any waste and/or the product complete its life cycle, a waste management and/or reverse logistics process is conventionally triggered.

Recent research supports the idea that there are a large number of the opportunities to improve the management and performance of both categories. However, we find that internal logistics provide a fertile environment to leverage conventional and advanced logistic principles that lead to an optimal arrangement of scarce resources. We believe that a healthcare logistician should be able to understand the logistic nature of different material and equipment that intervene in the health-giving process. The different properties of these material provide cues to storage and management through its life cycle. Similarly, an understanding of the different managerial paradigms as well as its application in healthcare environments is paramount in achieving the rationalizing of the healthcare resources. Thus, a focus on internal logistics as well as the study of advanced techniques such as lean systems

is believed to be relevant to healthcare logistics education. For healthcare logistics research, the supply chain perspective brings into focus significant and relevant issues related to products, information, and transportation/distribution. The importance of uncertainty grows with the need for modeling complex systems with increased product proliferation, shorter product life cycle, and reduction in inventory. Nurturing knowledge of these dynamics processes is critical to assist healthcare institutions in focusing on healthcare activities while achieving efficiency.

The prospective courses structured for healthcare logistics should provide students with an overview of Internal Logistics within the Healthcare Supply Chain context. It should include discussions in how external information and internal flows of information and material may be coordinated to improve operational performance. The courses should focus on describing several storage and material management methods, operational strategy, and logistics issues pertinent to supply chains management in a healthcare environment. Particularly, Lean systems issues in hospitals should be explored.

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