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Analysis of the impact of the implementation of Electronic Health Records in the hospital pharmaceutical supply chain

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Index

Abstract	4
Chapter 1: Health Information and Communication Technology: Electronic Health Record Systems	5
1. Introduction	5
2. Health Information and Communication Technology	5
3. E-Health	6
3.1. Overview on e-health interest.....	7
3.1.1. From the European Commission.....	7
3.1.2. In Belgium	10
3.2. E-health Stakeholders.....	11
3.2.1. E-health Stakeholders in Belgium	14
4. Electronic Health Record (EHR) systems.....	16
4.1. Introduction to Electronic Medical Record systems (EMR) and Electronic Patient Record (EPR) systems	16
4.2. Introduction to Electronic Prescription (ePrescription)	17
4.3. Introduction to Electronic Health Record systems (EHR).....	17
4.3.1. Advantages and disadvantages of EHR systems	18
4.4. Development of EHR systems.....	21
4.4.1. Worldwide.....	21
4.4.2. In Belgium	24
4.4.2.1. Traditional Health Records	24
4.4.2.2. Arrival and current state of EHRs	24
4.4.2.3. Barriers of implementation	28
5. Conclusion.....	30
Chapter 2: Impact of EHRs and ePrescriptions in hospital pharmaceutical supply chain	32
1. Introduction	32
2. Hospital Logistics	33
2.1. Introduction to Hospital Logistics.....	33
2.2. Main Logistic Activities in a hospital.....	33
2.3. Flows in a hospital	35
3. Pharmaceutical Supply Chain in Hospitals.....	37
3.1. Introduction to Pharmaceutical Supply Chain in Hospitals	37
3.2. Pharmaceuticals Management in Hospitals	37
3.2.1. Triggering pharmaceuticals supply chain	37
3.2.2. Physical Flow of Pharmaceuticals.....	38
3.2.2.1. In the Healthcare Sector.....	38
3.2.2.2. Within the hospital	40
Actors involved	40
3.2.3. Pharmaceuticals distribution methods	43
3.3. Inventory Control	48
3.3.1. Classification systems for materials	48
3.3.2. Techniques for Inventory Control	50
3.3.3. Production of pharmaceuticals	51
4. Value chain analysis.....	52
4.1. Concept of “value” adapted to the hospital.....	52
4.2. Adapted to pharmaceutical supply chain.....	53
5. Opportunities to increase value with EHRs and ePrescriptions	57

5.1. In the Pharmaceuticals Management	57
5.2. In Inventory Control Strategies	62
5.3. In the organization.....	62
5.4. Graphical summary.....	65
6. Possible causes of inefficiencies with EHR and ePrescription systems	66
7. Conclusion	68
Chapter 3: Roadmap for implementing EHRs in a hospital	71
1. Introduction	71
2. The implementation process of EHR and ePrescription systems	73
2.1. Preliminary definition	73
2.1.1. Definition of the objectives	73
2.1.2. Study of the economical and financial feasibility.....	73
2.1.3. Selection of the software provider	73
2.1.4. Project planning	74
2.2. The process of implementing EMRs and EPRs	75
2.2.1. Technology infrastructure	75
2.2.2. Implementation of the software	76
2.3. Renewal / Updating	77
3. Conclusion	78
Conclusions	79
Further research.....	81
List of acronyms and abbreviations.....	82
ANNEX	84
Interviews to Mr. Bruno, Warehouse Manager at Hospital Logistics	84
ANNEX I: 2004 e-Health Action Plan: Overview of actions	86
ANNEX II: Organization of the Health system in Belgium	90
ANNEX III: List of SUMEHR contents	98
ANNEX IV: Legal and regulatory facilitators	99
ANNEX V: Impact of logistics on the cost structure of a hospital	103
ANNEX VI: Classification systems for materials	104
Bibliography.....	105

Abstract

Health Information Technologies (HIT) play an important role in supporting decisions making, health care delivery, and management of health services. In recent years, new technologies have emerged in this field, such as ePrescribing, Computerized Physician Order Entry (CPOE), Bar Code Medication Administration (BCMA), electronic Medication Administration Record (eMAR), Automated Drug Management Systems, etc. It is said that the development of these new technologies will be catalysed by the implementation of Electronic Health Record (EHR), systems that have begun to implement in many countries, including Belgium.

Once introduced into Health Information Technologies (HIT), the aim of this project is, at first, to describe Electronic Health Record (EHR) systems and study its impact on the healthcare system, as well as its maturity. The scope of our study was Belgium even though we extended our analysis to European countries as well as North America where EHR systems are mature. Secondly, the purpose is to analyse how the digitalization of information by using these new technologies could impact and improve pharmaceutical supply chain in hospitals. Finally, based on the findings from our research, a roadmap for Electronic Health Records (EHRs) implementation in a hospital is presented.

Chapter 1: Health Information and Communication Technology: Electronic Health Record Systems

1. Introduction

The aim of the first chapter is to introduce the concept of Electronic Health Records (EHR) systems, an application of Information and Communication Technologies (ICT) that has experienced a major growth in the healthcare sector in recent years, as well as describe its current state of maturity in Belgium.

2. Health Information and Communication Technology

The introduction of Information and Communication Technology (ICT) within the healthcare sector has become a tendency towards which many countries are endeavouring. That is due to ICT play an important role in the management of health services, in supporting decisions making and in health care delivery (Huvenne, 2012, pp. 20-23).

In recent years, many countries have been taking innovative initiatives to improve its performance and productivity on the healthcare sector by taking advantages of ICT. What is meant by “innovation in healthcare” is “those changes that help healthcare practitioners focus on the patient by helping healthcare professionals work smarter, faster, better and core cost effectively” (Thakur et al., 2011, p. 564). In other words, enable patient-centred improvements and better work processes for healthcare professionals at the same time.

The aim of this research and innovation in the sector is to increase the efficiency and effectiveness of healthcare systems in order to change for a better quality of healthcare at a lower cost. The author Pagliari et al. (2005) put those to words as “the application of Information and Communication Technology (ICT) in healthcare has grown exponentially in the last 15 years, and its potential to improve effectiveness and efficiency has been recognized by governments worldwide”. Nowadays, ICT in healthcare is often referred to as “health telematics” or “e-health” (Huvenne, 2012, p.21). That is why e-health can be broadly defined as the application of ICT to health and healthcare (Ryu, 2012, pp.159-160).

3. E-Health

Definition of e-health

There are many ways to define e-health, although unfortunately, as Fatehi (2012) mentioned, no single consensus, all-encompassing definition of e-health exist (Burgun, Quantin and Venut, 2013, p. 406). In this study there are two that are highlighted.

The World Health Organisation (WHO) defines e-health as *“the use of information and communication technologies (ICT) for health. In its broadest sense, eHealth is about improving the flow of information, through electronic means, to support the delivery of health services and the management of health systems”* (WHO, 2012).

The European Commission proposes another overview of the term. E-health represents *“the overarching term for the range of tools based on information and communication technologies used to assist and enhance the prevention, diagnosis, treatment, monitoring, and management of health and lifestyle”* (Andoulsi and Wilson, 2013, p.170).

Benefits of e-health

Many benefits can be obtained by using e-health technology. It covers essential areas and functionalities, which are *“the interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to-peer communication between patients and/or health professionals”* (European Commission, 2012). This way, e-health enables better practices for healthcare professionals while gives patients the opportunity to get more involved in their healthcare. The sector becomes more productive since efficiency and effectiveness is improved, what turns into a better quality delivery of healthcare system services.

Nowadays, many countries around the world are taking advantage of e-health technology. For instance, Denmark is a country that has already implemented national ICT systems in the healthcare sector. As it is mentioned from the European Commission (2012), *“The Danish information system is cited by several studies to be the most efficient in the world, saving doctors on average 50 minutes per day usually*

spent on administrative work". The Danish Health Data Network focuses on a "national centralized computer database which allows access to electronic medical records information [...] and communication between different health professional groups" (Kierkegaard, 2011) as well as enables patients to "access all of their medical information including medical records and test results" (Kierkegaard, 2011). These streamlined services for patients and healthcare workers "have led to cumulative savings of \$120 million a year" (European Commission, 2012).

In this study, it is conducted a research of an e-health application that is currently being implemented in many countries: Electronic Health Record (EHR).

3.1. Overview on e-health interest

The scope of this section is to make a brief overview of the initiatives regarding e-health that have been recently developed and deployed in Belgium, especially around Electronic Health Records. To meet this objective, it is interesting to make a review of the initiatives that the European Commission has been developing in the field of study for all the Member States of the European Union. This way makes it possible to analyse whether both institutions, the European Commission and the Belgian government, are following the same trajectory or strategy/roadmap in the sector.

3.1.1. From the European Commission

"The European Commission has been investing in e-health research for over 20 years" (European Commission, Information Society and Media Directorate General, 2011). It can be witnessed through the fact that, since the early 1990s, the European Union research programmes "have been supporting eHealth (...) co-financing research projects to the tune of €500 million" (Liikanen, 2004, p.4).

Since 2004, the European Commission "has been developing targeted policy initiatives aimed at fostering widespread adoption of eHealth technologies across the EU" (European Commission et al., 2011). This tendency started with the development of the 2004 e-Health Action Plan (eHAP). In this publication, there are three main target areas aimed to "address common challenges and create the right framework to support e-health [to all the Member States of the European Union]; set up pilot actions

to jump start the delivery of e-health; and share best practices and measure progress” (European Commission, 2012).

In the communication from the European Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions (2004), entitled "e-Health - making healthcare better for European citizens: An action plan for a European e-Health Area", are specified the actions proposed by the eHAP to achieve the main three target areas. These actions are outlined in the ANNEX I of the thesis.

In 2011, the European Commission Information Society presented a report analysing European progress towards e-health Strategies, known as “European countries on their journey toward national eHealth infrastructures”, where the 2004-eHAP progress was analysed as:

“Significant progress on several key dimensions of the eHealth Action Plan of 2004 was achieved. The most noteworthy one has been the strongly increased commitment of national and regional health authorities to provide leadership to eHealth implementation efforts, underlined also by the remarkable growth in assessment and evaluation activities. Whereas in 2006 only 5 Member States reported related intentions, in 2010 already a considerable majority of 21 states mentions such undertakings - this is the largest increase in attention of all topics surveyed. The scope and procedures used are very diverse, however. Furthermore, by now all countries surveyed have either established specific competence centres or/and have dedicated departments in ministries.” (Stroetmann et al., 2011, p.55)

After that, the European Commission has shown a desire “to exploit the full potential of online health systems and services within European e-health area” (European Commission, 2012) through diverse projects, such as the flagship initiatives Digital Agenda for Europe and Innovation Union that were launched as part of the “Europe 2020 – A strategy for smart, sustainable and inclusive growth”. Both initiatives, launched in 2010, incorporate an important role on the field of e-health. On the one

hand, “the Digital Agenda for Europe includes a number of targeted eHealth actions and goals as part of a wider strategy towards sustainable healthcare and ICT-based support for dignified and independent living” (European Commission et al., 2011). On the other hand, the Innovation Union strategy, “introduces the concept of a pilot European Innovation Partnership on active and healthy ageing, which will be launched in 2011” (European Commission et al., 2011).

In parallel, an update version of the 2004-eHAP took place. This, driven by Member States and supported by DG INFSO and SANCO, has been followed up by the creation of the eHealth Governance Initiative. Its aim is “to contribute actively to the shaping of the eHealth political agenda at EU level, with specific focus on interoperability” (European Commission et al., 2011). As a whole, summarizing, it is provided an opportunity “to consolidate the actions which have been addressed to date, take them a step further (...), in the context of the EU 2020 Strategy, the Digital Agenda for Europe as well as Innovation Union” (European Commission et al., 2011).

The strategic e-health applications to achieve these objectives focus on “patient summaries and EHR systems, ePrescription services as well as telehealth solutions” (Stroetmann et al., 2011, p.19). The overall objective regarding EHRs, object of study of this thesis, is to establish these systems in a regional and national level in all the Member States of the European Union aiming at promoting their interoperability. This way, it is contributed “the free movement of patients, health professionals, and services across Europe” (Kofler, 2011, p.1). Electronic Health Record systems can continuously:

“monitor patients’ health in real time, allowing health professionals to keep an eye on them from a distance (...) can also make it easier for patients, providers, and data to cross borders: a vital matter for EU citizens who can travel, live, and work anywhere in the EU’s 27 Member States.” (Kofler, 2011, p.1)

To sum up, it is an undeniable fact that Europe’s interest on e-Health has increased over last years. From now on, the implementation of EHRs in the Member States is

becoming a significant step to continue growing and achieving desired goals for a better quality of the healthcare system.

3.1.2. In Belgium

The European Commission commissioned studies in the Member States of the European Union to analyse their progress relative to the 2004-eHAP main priorities. Hence, it is provided a reliable framework to assess the general interest in e-health from the Member States as well as what have been done so far in these countries with regards to promoting e-health implementation (Stroetmann et al., 2011).

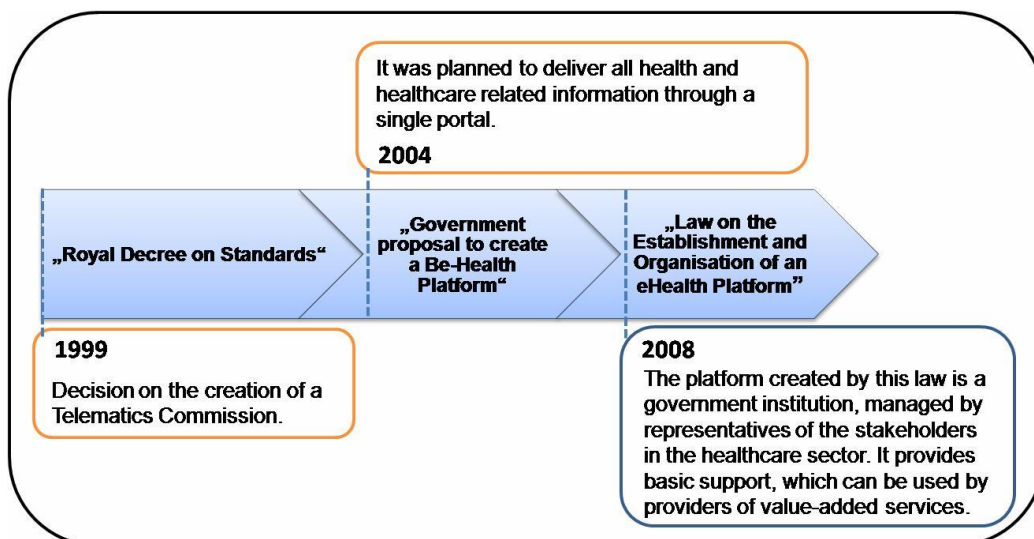
According to the study,

“Belgium has no official national eHealth strategy, but several laws and policy decisions have contributed to the shaping of the general developments towards eHealth use (...) these laws and official documents do not mention nor refer to the EU eHealth Action Plan.”

(Devlies et al., 2010, p.4)

That is due to Belgium’s initiatives in the field of study preceded the mentioned action plan. However, the fact that they were not initiated together does not mean that they are not linked.

Hereunder it is provided a schematic overlook at Belgium’s initiatives regarding e-health.



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Figure 1 Belgian documents policy related to e-health

Officially, Belgian governmental interest and actions concerning e-health started when Royal Decree installed a commission for "Norms related to telematics in support of the healthcare sector" in 1999. Its main purpose was to "advise the Minister of Health on the electronic data exchange of patient related data, promote electronic exchange between the different actors in healthcare and promote the use of Electronic Health Record by healthcare professionals" (Devlies et al., 2010, p.15). In 2004, the Federal government agreed on the creation of the BeHealth-platform. As a consequence, a new public organisation was created in 2008 called eHealth-platform, arising as an action to "support the national health policy (...) [and] optimise quality and continuity of care and patient safety, to favour administrative simplification for healthcare professionals" (Devlies et al., 2010, p.16). The platform took over the functions and tasks of the above-mentioned health telematics commission aiming at addressing and coordinating all issues related to ICT use in the healthcare system (Huvenne, 2012, p.27).

As has been seen above, it is true that at the beginning both institutions the Belgian government and the European Commission were not following the same strategy as far as e-health field is concerned. Their roadmaps were not linked. However, nowadays they focus on the same overall objectives, as well as implementing same e-health applications, Electronic Health Records. As a consequence, Belgium's government roadmap benefits European Commission's objective to establish EHRs in all Member States of the European Union in order to promote their interoperability.

3.2. E-health Stakeholders

In the published "Strategic Management: A Stakeholder Approach", R. Edward Freeman defined the term "stakeholder" in a broad strategic sense as "any group or individual that can affect or is affected by the achievement of a corporation's purpose" (Freeman, 2010, p.32). The aim of this section is to provide a general overview of the main stakeholders involved in the e-health sector of a country from the literature reviewed. After a research on the main actors that come into play on the field, it has been possible to briefly categorise, on a broad scale, all actors involved into several groups.

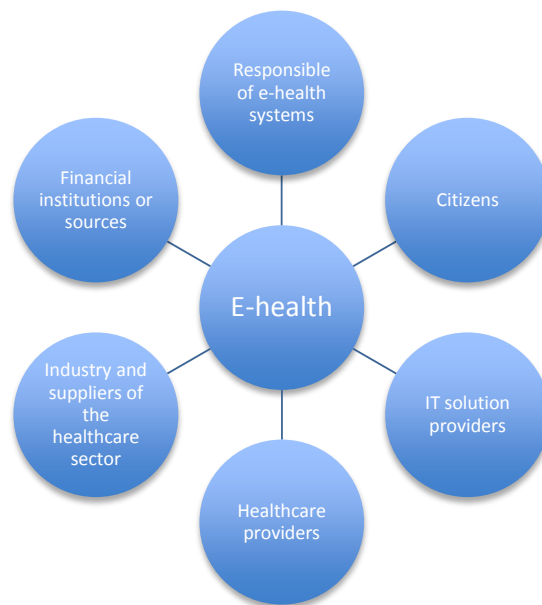


Figure 2 E-Health Stakeholders

At first, it is important to mention who is the responsible of e-health systems. It aims to support the research on the field and the identification, development, implementation and dissemination of new e-health applications for the most efficient preventive or therapeutic strategies (Daniel, 2014, p.438). “In the majority of countries responsibility lies largely with the Ministry of Health. In others (...), responsibility is more widespread across several ministries and/or agencies” (Stroetmann et al., 2011, p.9). By now,

“more than a dozen countries have established legal entities as specific consultative bodies or competent authorities under ministerial supervision. Their role is to develop, oversee and monitor the country’s strategic goals, and/or implement and manage eHealth infrastructure and application projects” (Stroetmann et al., 2011, p.9).

Secondly, there are the financial institutions or sources behind the sector, which are financing the development and implementation of e-health infrastructures and applications. In the case of Europe, “the primary sources of funding are government or quasi-public sources, (...) Considering that individual service providers usually do not have an incentive to establish such infrastructures for all” (Stroetmann et al., 2011, p.14). It is important to take into account that private and public insurance companies

or public technology or innovation agencies are involved in financing as well. Among the international sources of funding that exist, “EC RTD project co-financing as well as funding from European Structural and Regional Funds and the European Investment Bank” (Stroetmann et al., 2011, p.14) also contribute.

Thirdly, there are all healthcare providers, which means “not only health professional but all the staff employed in the health sector including nursing, care, and administrative staff” (Liikanen, 2004, p.8). E-health systems can “empower managers by spreading best practices and helping to limit inefficient and inappropriate treatment” (Liikanen, 2004, p.9) by taking advantages from e-health “applications that improve the services they offer and reduce medical risks” (Liikanen, 2004, p.12).

Moreover, the industry and suppliers of the healthcare sector, such as the pharmaceutical sector, is a necessary stakeholder area of the sector (Huvenne, 2012, p.16).

Furthermore, it is also important to mention the IT solution providers of the healthcare sector, bodies in charge of conception of IT structure that support e-Health and ensure interoperability. They aim to support organizations to address complex challenges, which include coordinate care, assume risks, the need to reduce costs and manage complex payment models.

At last but not least, all citizens form a significant group of actors as well. Apart from receiving a better quality service thanks to the use and sharing of better practices that e-health applications provides, “systems such as these are giving patients more information about their condition and choices, so that can take more responsibility for healthcare decisions” (Liikanen, 2004, p.12). Furthermore, “e-Health opens new opportunities for people who live in remote areas with only limited healthcare services, as well as marginalised groups” (Liikanen, 2004, p.12). This group also includes patient associations around healthcare system. “Las asociaciones de pacientes

se han convertido en un imprescindible (...) para labrar el futuro de la atención sanitaria” (Fundación Salud 2000, 2009, p.2)¹.

According to what has been seen above, on a broad scale the group affected by the achievement of e-health objectives is the healthcare system of the country, which directly affects all citizens of the region.

To conclude, it is important to take into account that “careful planning, organisational setup and stakeholder involvement are key success factors for eHealth (infrastructure) projects” (Stroetmann et al., 2011, p.9). It is needed an active cooperation between stakeholders, health authorities, professionals, consumers, industry, etc., to ensure a successful implementation of e-health applications and, this way, obtain beneficial objectives, thereby creating a win-win situation (Stroetmann et al., 2011, p.15).

3.2.1. E-health Stakeholders in Belgium

By following the mentioned groups of the main stakeholders that have been seen above, the purpose of this sub-section is to provide an overview of the main actors that are involved in the e-health field in Belgium.

To begin with the determination of the first group of stakeholders defined above, the responsible of e-health system in Belgium, it is important to have a general overview of the organizational structure of the Belgian Health sector. For this reason, in the ANNEX II of this study, it is provided a schema showing the organization of the health system at the federal level and the level of federated entities, with the most important departments, agencies and advisory bodies. As well, it is included a brief explanation of their roles. According to it then, responsibilities of Belgian Health System are shared between the federal state and the communities. On the one hand, at a federal level, the main entities that come into play in this group of actors are both institutions: The FPS Social Security, which controls all legislation concerning the social security of citizens what is specifically needed in the field due to the amount of patient’s

¹ “Patient associations have become an essential (...) to shape the future of health care.” (free translation)

information that e-health applications works with, and The National Institute for Health and Disability Insurance (NIHDI). This entity, together with the consultative body Belgian Health Care Knowledge Centre (KCE), offers ICT support. On the other hand, at a community level, the entity responsible of healthcare matters is the Flemish Agency for Care and Health for the Flemish Community, which is responsible for development, implementation and evaluation of policies concerning regional health and care responsibilities. For the French Community, it relays on the Directorate-General of Health within the Ministry of the French Community, in charge with public health policies, and the Regional Health Observatory, set up in the Walloon region, which aims specifically to improve health in the region and to contribute to health information. For the German-speaking Community, health responsibilities relay on the Department of Cultural and Social Affairs of the Ministry of the German-speaking Community (Gerken and Merkur, 2010, p.68).

As far as financial institutions or sources is concerned, “alongside the Ministry of Health, the National Health Insurance Institute is the main source of finance of initiatives and projects stimulating the introduction of eHealth in general” (Devlies et al., 2010, p.34). Apart from that, “project support through EC Structural Funds” is another main source of e-health funding in Belgium.

In particular, the Ministry of Health “pays mostly for infrastructure initiatives and interoperability” (Devlies et al., 2010, p.34). Funds from the National Health Insurance Institute aims to work on the mentioned eHealth-platform, the last significant initiative that has been taken place on e-health field. Both institutions, together, “hands out subsidies to the users of the certified EHR systems” (Devlies et al., 2010, p.34). Finally, international funding through EC Structural Funds focuses on “supporting the participation of Belgian industry and research organisations in European eHealth projects” (Devlies et al., 2010, p.34).

Healthcare providers involve all the staff employed in the health sector in Belgium’s healthcare facilities. As has been mentioned above, this group of actors represents physicians, nurses, care and administrative staff.

Apart from that, industry and suppliers of the Belgian healthcare sector is a significant group of actors. For example, “industry and pharmaceutical sector is also an important stakeholder area of the Belgian healthcare sector. It is represented in Belgium (...) by pharmaceutical companies and by community or hospital pharmacies, which distribute pharmaceutical to the population.” (Huvenne, 2012, p.16)

Regarding IT solution providers of the healthcare sector in Belgium, there are many groups providing integrated IT solutions to healthcare sectors such as AGFA HealthCare and Siemens as is specified on the Healthcare Belgium website.

Finally, Belgian population represents citizens, which is the largest stakeholder group (Huvenne, 2012, p.19). The population of Belgium take advantage of e-health systems, as their main goal is always a better care for patients. E-health also opens up the possibility to citizens to become more involved in their health care.

4. Electronic Health Record (EHR) systems

4.1. Introduction to Electronic Medical Record systems (EMR) and Electronic Patient Record (EPR) systems

To understand in depth EHR definition, in the below sub-section, it is important to take into consideration the terms of Electronic Medical Record (EMR) and Electronic Patient Record (EPR). Sometimes, both concepts are commonly known under the same term. However, the following distinction can be made.

On the one hand, Electronic Medical Record (EMR) is defined as “the electronic record of an individual in a physician’s office or clinic [seen as a single organization], which is typically *in one setting* and is provider-centric” (Stroetmann et al., 2011, p.19). On the other, Electronic Patient Record (EPR) is known as “the electronic record of an individual in a hospital or health care facility, which is typically *in one ‘organisation’ and is facility-centric*” (Stroetmann et al., 2011, p.19). EPRs are more patient-centric than EMRs and are managed, shared and controlled by the individuals.

In the context, one can also hear the term Patient Health Record (PHR), which is an electronic application through which individuals can access, manage and share their health information. It is understood as an EPR but in this case the information collected can come from different healthcare providers and healthcare facilities (Tang et al., 2006).

4.2. Introduction to Electronic Prescription (ePrescription)

According to the literature reviewed, the introduction of EMR systems within an organization is mainly accompanied by the use of Electronic Prescription (ePrescription) systems, or vice versa. This is also the case of EMRs implementation in Belgium (Deviles et al., 2010, pp. 19-22).

ePrescriptions are the computerized version of traditional handwritten or paper-based charts, commonly referred to as drug charts, where physicians prescribe patient's treatment plan in terms of pharmaceuticals. They are supplied according to the formulation details on these prescriptions. Both the handwritten and the electronic version are the basis for pharmaceutical supply and pharmaceutical administration (Goundrey-Smith, 2013).

Electronic prescribing aims at facilitating the prescription process, supply and administration of pharmaceuticals within a hospital. In comparison to the traditional prescribing, it allows capture a full prescribing history for a patient in a transferable manner and opens up the opportunity to add decision support tools to assist the prescriber in medicine selection (Goundrey-Smith, 2013).

ePrescriptions play an important role in the following chapter as their use may have a significant impact on pharmaceutical supply chain in a hospital.

4.3. Introduction to Electronic Health Record systems (EHR)

Up to now, in this study it has been emphasized the importance of the dissemination of Electronic Health Record (EHR) systems in the healthcare sector, application of e-health that has been already started to be implemented in various countries

worldwide with the overall objective to contribute on the improving of the healthcare systems.

The European Commission defines EHRs as “the *longitudinal* electronic record of an individual that contains or virtually interlinks data in multiple EMRs and EPRs, which is to be shared and/or interoperable *across healthcare settings* (inter-institutional) and is patient-centric” (Goundrey-Smith, 2013). In other words, EHRs are a shared, integrated or interlinked virtual record of all patient’s clinical relevant health and medical data and/or information independent of when, where and by whom it was recorded. It can also be understood as a patient summary or an account of their various encounters with the health system from divers providers (Goundrey-Smith, 2013).

Summarizing, EMRs are understood as patient’s records managed by healthcare providers, while EPRs are patient's records managed by individuals, all of them stored and available from the healthcare facility. EHRs are understood as an interface of these systems, which at the same time are interrelated with other healthcare provider's systems. They are managed for healthcare professionals and electronically available from different healthcare institutions.

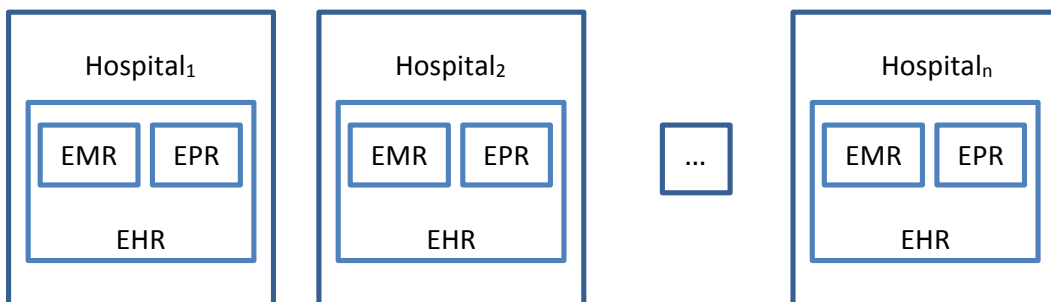


Figure 3 Representation of an EHR network

4.3.1. Advantages and disadvantages of EHR systems

Paper-based patient medical records are still in use in many countries. However, their computerized version is evolving via EMR and EPR as EHR systems. The aim of this section is to have a general overlook at the impact of implementing EHRs.

As it is said in *Medical Informatics: e-Health, Fundamentals and Applications* (2013), the digitalization of all patient's information and records into EMRs and EPRs in order to shape EHRs networks, has significant advantages to take into account aimed to:

- Facilitate the exchange of health information: the immediately availability, in real-time, of patient data from all components of the information system, is a huge advantage given by EHR. "The electronic data can be shared at large scale, beyond a single hospital, for instance at regional, national or international scales" (Cuggia, Avillach and Daniel, 2014, p. 68).
- Data protection, security and traceability: "The EHR provides better data traceability and the activities around the patient. All the actions of the users are stored (...). Moreover, each data entry is time stamped and signed." (Cuggia et al., 2014, p. 68)
- Facilitate decision support: EHRs work as a source of patient's information, which is especially useful for healthcare professionals when determining a patient treatment. Apart from that, there is the possibility to connect decision support systems to the EHRs, which "can help the physician by generating reminders and alerts (e.g. to detect drug adverse effects) or by suggesting, from the patient data, diagnosis or therapeutic strategy." (Cuggia et al., 2014, p. 68)
- Allow secondary reuse of the patient data: Apart from being a source of patient's data for healthcare professionals, EHRs systems are also a source of information for management, evaluation and research purposes. The secondary reuse of the data is easier by using EHR systems, compared to the paper-based version, due to computerized data. Consequently,
"Data extraction and statistical analysis can be carried out for studies or to provide indicators and dashboards for different domains, like for instance clinical research (...), epidemiologic survey (...) or evaluation of professional practices (...)." (Cuggia et al., 2014, p. 69)
- Teach activities: EHR systems can serve as a tool for teaching and training students due to the fact that patient data can be extracted to create pedagogical resources.

Therefore, according to “Electronic Medical Records: A Practical Guide for Primary Care”, and summarizing, three imperatives are driving towards Electronic Health Records development and deployment: interoperability, usability and health coordination (Skolnik, 2011, p.129).

Furthermore, various interviews have been done on the same publication to many physicians that have already started to use EHRs, that is, EMRs, aiming at providing first-hand experiences of the usage of these systems. According to their opinions, apart from the advantages that have been seen above, there are some disadvantages important to mention as far as EHRs implementation is concerned.

First of all, as Dr. David Dipietro mentioned, “the implementation process takes a few years” (Skolnik, 2011, p.17). He also pointed that during this process “you actually increase your staff as well as your overhead” (Skolnik, 2011, p.17) due to the amount of work that represents. However, after the implementation of the system, it should have the opposite effect due to the computerization and standardization of many activities. Moreover, Dr. David Dipietro added, “I feel like I am doing more work now that used to be done by the nursing staff” (Skolnik, 2011, p.18). The fact that with these systems all is computerized under standards results a work overload for physicians. As a consequence, many physicians complained that this fact is reflected on a decrease of the amount of patients they can visit per workday. For example, Dr. Jim King said that “Prior to EMR, I would see an average of 35-40 patients a day, now I see 30-35” (Skolnik, 2011, p.32). Regarding to patient interactions, EHRs have both positive and negative effects. On the one hand, according to Dr. David Dipietro, there is a loss of interaction because physicians “get so caught up with the computer and typing (...) that patients seem to be not happy with the EMR” (Skolnik, 2011, p.18). However, by making extra efforts “to make sure it didn’t appear that I was just a data entry person and not their doctor [as Dr. Jim King said] patients seem to be very receptive and appreciative of EMR” (Skolnik, 2011, p.32). As Dr. Keith Sweigard emphasized, it is important to keep in mind that “always, the ultimate goal is improved care for our patients” (Skolnik, 2011, p.36).

At an educational level, Dr. Cesar Ducque Gomez specified that

“An additional concern for us as a residency training site includes impact on the residents’ graduate medical education/training; they often get frustrated while trying to use the system, resulting in less time and energy for learning medicine, less interaction with their patients, and an overall sense of being rushed and distracted.” (Skolnik, 2011, p.26)

Finally, Dr. Patrick VanSchoyck highlighted that “With EMR if the electricity goes out (...) the EMR will shut off and you are faced with an office full of patients but no chart to look at” (Skolnik, 2011, p.22). This dependency on electricity is a serious drawback of EHRs. However, in the case of Belgium there are specified in its action plan the type of consumers that must retain their power of supply as a matter of priority (such as hospitals, emergency services, vital communication services). Therefore, electricity is ensured in hospitals in case of power shortage (Elia website, 2015).

To conclude, the advantages of implementing Electronic Health Records are significantly beneficial, in the long term above all, for the healthcare system improvement despite their mentioned disadvantages. It is important to take into account that the main finality of investing in these e-health applications is to deliver a better quality service of health care to patients apart from, moreover, improving interoperability, usability and health coordination. However, aiming at progressing in the field, there is a necessity to focus on improving and solving the highlighted drawbacks as well.

4.4. Development of EHR systems

The aim of this section is to provide a general overview of the current state of Electronic Health Records implementation around the world. That is, having an idea of the countries that have already started their way to national EHRs deployment as well as its maturity in Belgium.

4.4.1. Worldwide

The deployment and implementation of Electronic Health Record systems in the healthcare sector is a strategy that, at present, is being followed by many countries around the world. To make a brief but clear explanation, in this section it is

distinguished between three groups: European initiatives, American Initiatives and Other International Initiatives (Staccini, 2012, pp. 326-337).

As far as European initiatives on EHRs is concerned, as has been mentioned above, reliable information is provided by the European Commission through studies, which last version dates from 2010, in 31 European countries regarding e-health. Aiming at following the strategies proposed by the European Commission, the majority of these countries are currently working on improving their healthcare system by “establishing national/regional EHR systems” (Stroetmann, 2011, p.1). European initiatives in the field have been taken place in many countries such as Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Lithuania, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom and Turkey. It is important to note that the current state of maturity of the implementation of a national information system in each country varies depending on the region of study. E-health initiatives regarding EHR systems range from very small to very large, from local or regional to national or international, although there are not yet many large-scale national e-health procedures in routine operation. To exemplify this reality, below there is presented two countries in a different stage of creation of a national EHRs network.

On the first hand, and as has been mentioned above as "The Danish Information system is cited by several studies to be the most efficient in the world" (European Commission, 2012), Denmark is an advanced country when it comes to e-health development.

"The Danish eHealth system has two characteristics, which make the country a frontrunner in the field compared to other EU member states: First, IT applications [such as EHR] in the field of health are already deeply rooted at a local or regional level. This means that mature systems are in place not only for communication between health professionals, but also for patient access and data management, which leads to a certain amount of trust into health technology. Second, Denmark has a long history of financing and developing new IT applications in governance and health." (Doupi et al., 2012, p.39)

Examples for this can be found in the deployment of Electronic Health Records, as the first plan called Action Plan for EHRs from 1996 was developed. It was the basis for subsequent policy papers for e-health, which, as a consequence, guided the present e-health strategy. Nowadays, Denmark is currently shaping a national EHR system “based on shared standards being implemented in all Danish hospitals” (Doupi et al., 2012, p.24). On the other hand, contrarily, there is the case of Lithuania. In 2009 an e-health programme was presented which consists of a gradual development and deployment of EHR systems in the country. “There are Hospital information systems already in place in three big hospitals (...) [but] Currently one of the major problems are the uncoordinated actions of separate healthcare institutions already having invested in their own information systems” (Kiskiene , 2010, p.20).

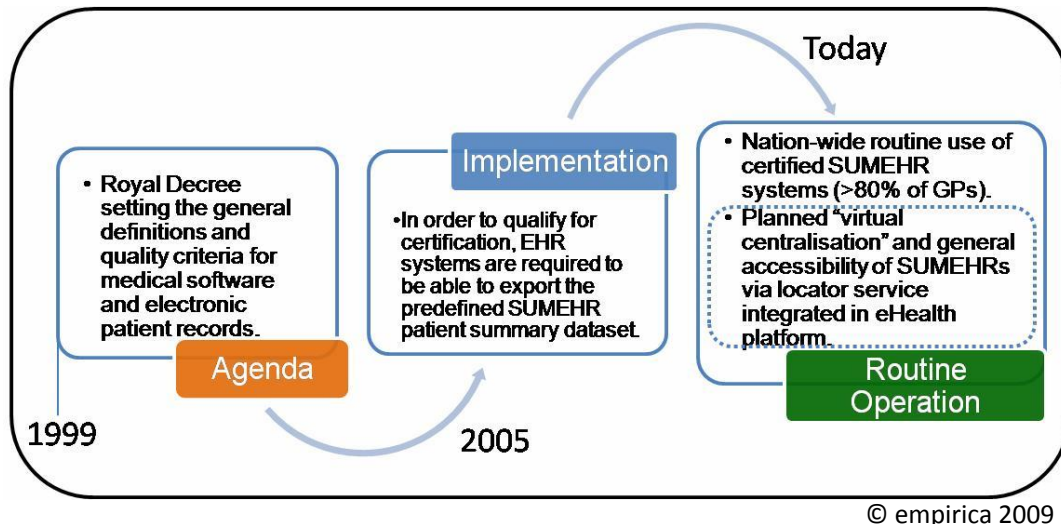
Apart from these countries that have been already started their way to set up a nationwide Electronic Health Record system, other Member States such as Cyprus, Luxembourg, Poland, Portugal and Romania are planning to implement EHRs in the near future. Contrarily, countries as Bulgaria, Greece, Hungary, Latvia, Malta, Slovakia and Slovenia, have no projects planned already to progress in this field.

Apart from the European initiatives, other projects regarding the e-health application of study are being deployed in other nations. As far as American initiatives is concerned, the main significant are the ones that take place in The United States of America and Canada, countries that have already initiated their way towards EHRs.

Regarding other international initiatives, stand out the projects carried out in Australia and New-Zeland regarding health data sharing.

4.4.2. In Belgium

The following illustration provides a schema of patient summary's evolution in Belgium.



© empirica 2009

Figure 4 Patient summary in Belgium

4.4.2.1. Traditional Health Records

"In order to control health expenditure, the Belgian government made a very early choice of a better patient care coordination, organized around the General Practitioner" (Staccini, 2014, p.327). As a consequence, in 1999, the National Institute of Sickness and disablement Insurance, the Belgian social protection system, deployed a paper-based health record called "Dossier Médical Global" (DMG). Lately, its electronic version was launched in 2003: "Dossier Médical Informatisé" (DMI) (Staccini, 2014, p.327).

4.4.2.2. Arrival and current state of EHRs

"The official start of dealing with the contents of electronic medical records was marked by the Law on "Social Affairs" in 1999, empowering the king to define minimal criteria to medical / healthcare software in order to be homologated by the Ministry of Health" (Devlies et al., 2010, p.20).

The Law defined a subsidy or bonus to be paid to healthcare professionals for using a labelled EHR system. Since 2005, "the certification criteria for quality labelled EHR systems for general practitioners require them to be able to export the SUMEHR patient summary" (Devlies et al., 2010, p.20).

The SUMEHR (Summarised Electronic Health Record) patient summary was defined in 2004 as part of the BeHealth Platform. It is a template, structure or format for the arrangement of medical information, providing physicians with the set of a patient relevant medical data, a synthetic picture of a patient's medical status (Huvenne, 2012, p.60). The list of SUMEHR contents can be found in the ANNEX III.

After that, the "Belgian health authorities intend[ed] to make patient summaries nationally available by offering a "virtually centralised" medical record" (Devlies et al., 2010, p.20) through the project launched by the initiative of the 2008 eHealth-platform, which provides a basic service called Reference Directory that is seen as a store of medical records. It consists basically on two layers, the creation of a "metahub" and five "hubs". The "metahub" is the first layer of information and refers to the regional or local network, and the second layer is so-called "hubs", where the available electronic medical record for a given patient can be found (Milieu Ltd and Time.lex, 2013).

The distribution of hospitals within the various "hubs", shown in the figure below, was established in 2010 in the context of telematics protocols of the FPS Health.

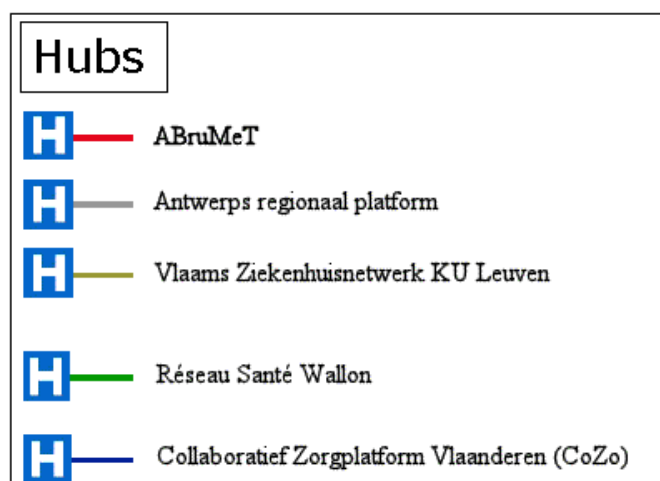


Figure 5 The five established "hubs"

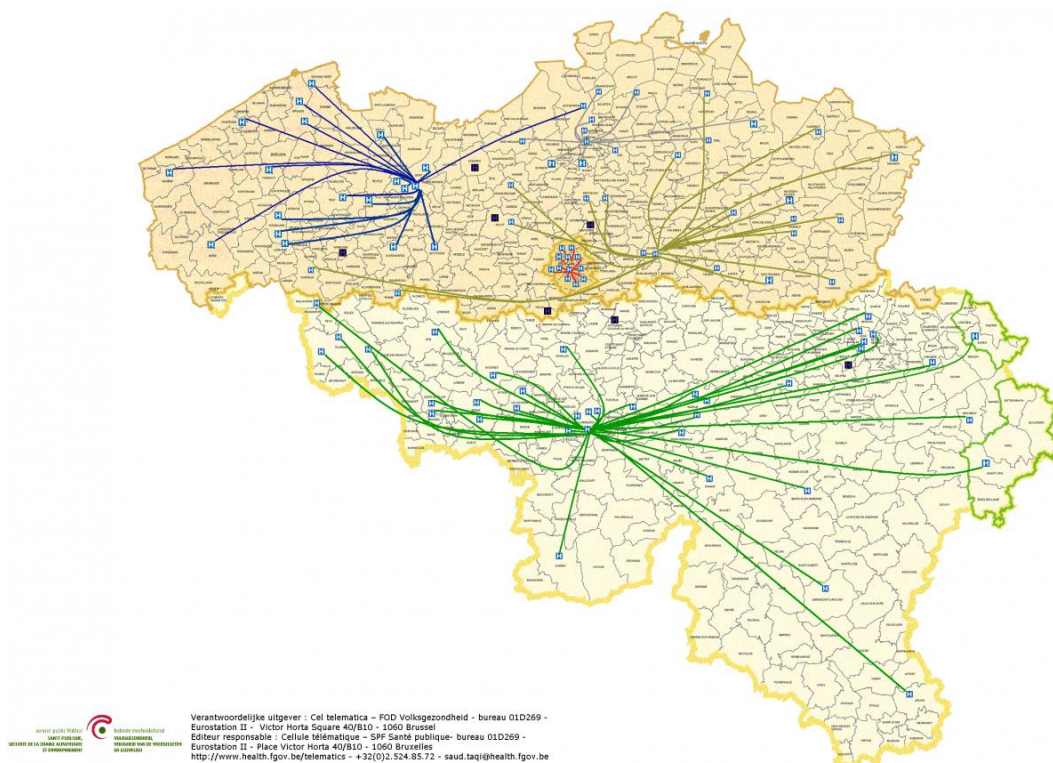


Figure 6 Distribution of the "hubs"²

Huvenne (2012) analysed the current state of EHRs implementation at a national level in Belgium and proposed a model for both e-health and EHRs implementation at a Federal level, based on an information compilation of various authors, organizations and interviewees. It consists on a model based on the following five phases:

1. Preparation and promotion: Relates to the need to prepare the sector for the adoption of EHRs and its related aspects, which will lead to its implementation. Moreover, it also relates to the promotion of the changes that will need to take place within the different levels of the health sector.
2. Selection: Relates to both the selection and integration of existing systems that will answer to the needs of the sector.
3. Adoption: Refers to the moment when healthcare organizations start putting in place the efforts necessary so as to use EHRs to support their healthcare related activities.

²Available at: <https://www.ehealth.fgov.be/fr/prestataires-de-soins/services-en-ligne/hubs-metahub/en-savoir-plus>

4. Exploitation: Refers to the moment from which the consecutive various aspects of EHRs (preparation level and environment and system development) have been accepted as the required answers by users and that their usage is propagated to the predefined user groups.
5. Renewal/Reinvention: Aims at enabling implementation of EHRs to become dynamic.

According to the study, Belgium can be seen as soon leaving the preparation and promotion phase to enter the selection phase. However, at a regional level, the Réseau Santé Wallon (RSW) hub, which was created before the eHealth platform existed incentivised by projects coming from the field and motivated by various field actors such as telematics associations and medical professional syndicates, can be said to have already reached the selection phase and entered the adoption one. The reason why the process of implementing and deploying EHRs, hand in hand with ePrescriptions, at a national level is so slow and the adoption of these systems has taken different rates in the different hubs is mainly related to two factors. On the one hand, the aspects related to security, privacy and confidentiality to both patients and medical professionals are objects of controversy as medical instances are not in agreement. Moreover, political tensions seem to exist between the Regional level hubs and the Federal eHealth-platform on the way to integrate regional and Federal initiatives. On the other hand, the role and the methods used by the 2008 eHealth-platform are highly debated among institutions and medical professionals due to a lack of comprehension of the advantages linked to this service. Due to a low involvement of stakeholders in the processes, there is a lack of acceptance of the infrastructure and info-structure solutions proposed by the governmental institution.

According to the latest study provided by the European Commission “Country Brief: Belgium” in 2010 regarding e-health strategies “there is now a good coverage of certified EHR systems throughout Belgium (>80% of all GPs)” (Deviles et al., 2010, p.20). Further key challenges would be to extend the scope of the accessible data, harmonise the EHRs standards, keeping them updated, as well as encourage health professionals to make increased use of the records. “Especially the take-up in hospitals is still on a lower level than with general practitioners, although this has begun to

change in recent years” (Deviles et al., 2010, p.21). In this way, wider goals could be achieved.

4.4.2.3. Barriers of implementation

The adoption of Electronic Health Records present barriers of implementation important to take into account:

- **Usability:** These barriers of adoption are caused due to the complexity of the usage of such systems (multidisciplinary of screens, options and navigational aid). Perhaps, many practices and hospitals may not have the extra time required to learn how to work with a new system (Meinert, 2005).
- **Structural:** Structural barriers are predominantly related to the structure of a country’s health care system. Consequently, they can significantly vary from country to country. As far as EHRs is concerned, there are multiples systems and multiple vendors, which constitute a barrier to EHRs adoption and particularly to the connectivity with other systems that add significant benefit for the physician. In the case of Belgium, “doctors are independent practitioners who are paid by the patient who is then reimbursed by the health insurers. The fact that there is no direct contract and payment relationship between the health insurer and the doctor constitutes an interesting challenge for implementation of EHRs and interconnectivity.” (Meinert, 2005)
- **Time:** The introduction of electronic records in any practice will slow a physician’s workflow, as it results in additional time being required to select, implement and learn how to use these systems (Meinert, 2005).
- **Privacy, confidentiality and security concerns:** Healthcare providers and patients have voiced concerns around medical privacy with EHR systems. Although paper-based records can get lost or being viewed by unauthorized personnel, electronic records may be exposed to security breaches as threats. "The common privacy concerns with EHRs are unauthorized access to records, tampering with records and the risk of losing information due to a natural disaster" (University Alliance, 2014).

In the case of Belgium, *Legal and regulatory facilitators* is provided in the ANNEX IV aiming at shaping a framework on privacy and confidentiality, liability

and data-protection. More information can be found on “Overview of the national laws on electronic health records in the EU Member States: National Report for Belgium” report.

- **Cost:** Finding the capital to invest in the infrastructure, personnel, training and support required to deploy and maintain an EHR system can be a barrier, as it can lead to result expensive. Furthermore, it is also influential the uncertainty over the long-term return on investment (University Alliance, 2014).
- **People:** Healthcare organization may have to deal with healthcare providers and patients resistance to change. Both sides can get easily discouraged by the challenges and limitations exposed above. Moreover, as it is shown in *Electronic Medical Records: A Practical Guide for Primary Care* where there is provided some point of view of Electronic Health Records implementation in many practices, a significant barrier important to mention is the feeling from both, patients and healthcare providers, of losing interaction between them by the introduction of such technologies.

In the particular case of Belgium, there are also added the barriers of adoption related to security, privacy, confidentiality and politics, as well as the lack of involvement of stakeholders in the project of implementing these systems, which have been mentioned in the previous sub-section.

To sum up, in the short-term the barriers of adoption can have a negative impact on both the productivity and financial performance. The main reason is the increment of physician’s time spent in administrative tasks, what can turn into a reduction of the number of visits to patients per day during the process of implementation. Through a strategic plan for implementing such technologies, which should include a solid project timeline and a plan for communication and training, EHRs can prove their worth. However, the implementation of EHR systems has to be seen as a long-term investment in terms of usability, interoperability, health coordination and financial performance.

5. Conclusion

For the last years, there has been a global trend towards the development, deployment and implementation of Information and Communication Technology (ICT) applications in the field of the healthcare, also known as e-health. The aim of this fact is to increase the productivity of healthcare systems, in terms of efficiency and efficacy, meanwhile delivering a high-quality health care at a lower cost. This latter requirement has been a noteworthy restriction during the recent years due to the global economic and financial crisis.

Electronic Health Record (EHR) systems are a digital collection to store and process health information about individual patients or population aiming, in the first place, at interchanging clinical information among healthcare providers to improve the quality of healthcare services. The imperatives that are driving such improvements are interoperability, usability and health coordination, covering the need of all engaged parties, the stakeholders of the healthcare sector (policy makers, financial institutions or sources, industry and suppliers from the sector, all citizens or patients, healthcare providers and IT solutions providers). As has been seen in the study, despite the difficulties to implement such technologies in the different practices, the benefits that an area, region or country can obtain from the deployment of EHRs systems are numerous and added value.

In Belgium, with the launch of the e-Health Platform in 2008 after diverse initiatives in the field, the Belgian Government presented a path to improve their healthcare system at a national level in the field of e-health. That is through the creation of the national EHRs network with the so-called “hubs” and “metahubs” distributions. However, as has been seen, on the one hand the development of this process is still at an early stage due to problems and disagreements related to privacy, security and confidentiality of the systems as well as politic tensions between the Regional and the Federal level. On the other, there is a lack of involvement of stakeholders in the project of implementing EHRs systems.

It is said that by creating national electronic records systems, broader benefits can be achieved at a healthcare facility, regional, national and even international level in

terms of medical mobility. The exchange of best practices and the latest research findings, interoperability and research and development would be facilitated.

Chapter 2: Impact of EHRs and ePrescriptions in hospital pharmaceutical supply chain

1. Introduction

The objective of this chapter is to analyse how Electronic Health Record (EHR) technologies, by using Electronic Prescriptions, may impact and improve Pharmaceutical Supply Chain in hospitals. To meet this objective, starting with an introduction to hospital logistics, an analysis of pharmaceutical supply chain in hospital is provided. That is, a study of techniques used for inventory management as well as inventory control through the hospital. Then, it is used the Porter's model to identify activities involved in pharmaceutical supply chain that generate value for care, aim of a hospital. Finally, an analysis regarding how the implementation of Electronic Health Records (EHRs), by using Electronic Prescriptions (ePrescriptions), may improve or add value to the logistic chain of a hospital is presented.

2. Hospital Logistics

This section aims at having a general understanding of Hospital Logistics, describing the main activities and the different flows that take place within a hospital.

2.1. Introduction to Hospital Logistics

Hospital Logistics can be defined as a set of design, planning and implementation for the purchase, inventory management and replenishment of goods and services surrounding the provision of medical services to patients (Landry and Beaulieu, 2001). The objective is to maximize output or throughput under the resources constraints, taking into accounts the different actors' requirements for delivery flexibility and reliability and acceptable medical outcome (Di Martinelly, 2008).

In 1994, Chow and Heaver leaded the study "Logistics in the Canadian health care industry", which provides an analysis of the impact of logistics in the structure of a hospital (which can be found in the ANNEX V). They came up to the conclusion that all activities that take place in a healthcare facility have its involvement in logistic costs, which represents a 46% of the hospital's budget.

As logistical costs make up a significant part of hospital's annual budget, many studies have been done in order to optimize logistic activities, aiming at increasing efficiency and flexibility of organizations. Furthermore, lately logistics have gained much attention due to the fact that hospitals are under budget pressure as a consequence of the global crisis.

2.2. Main Logistic Activities in a hospital

According to Chow and Heaver (1994), the running of a hospital can be outlined by a number of core activities where all internal processes therein are held. Different actors with different goals are implied in these activities.

The primary activity is the care and cure of the patients. Therefore, human and material resources, medical tests and clinical processes (diagnoses, interventions and medications) aim at addressing the main activity of the organization. The following

figure indicates the basic activities that take place in a hospital, adding their description below.

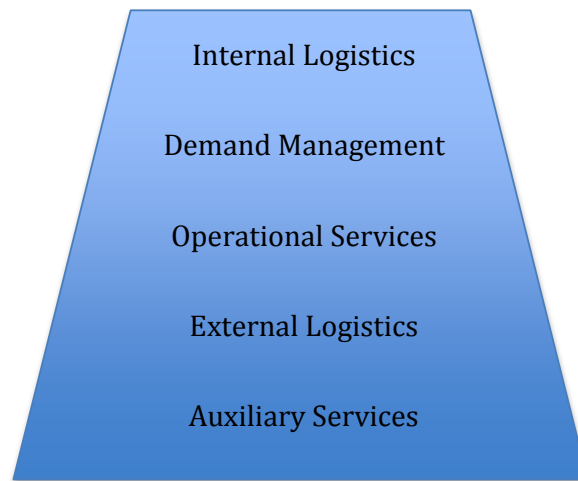


Figure 7: Basic activities taking place in a hospital (Chow and Heaver, 1994)

- Internal Logistics: Groups the activities of purchasing, receiving, storage and distribution of products used on internal processes of the hospital.
- Demand Management: Consist on analysing, planning and assigning the necessary resources in order to acquire the goods and services.
- Operational Services: Includes internal processes and activities that support the patient's stay in the hospital.
- External Logistics: It is associated with activities of medical monitoring of the patient.
- Auxiliary Services: Groups other activities taking place within the hospital, such as catering services, shopping, religious services and others.

Although no one can decouple from the other, Internal Logistics plays a more significant role in controlling processes in order to route the hospital to a substantial improvement of the resources allocated. The review of business practices at healthcare centres aiming at improving the exploitation of these resources, increasing their effectiveness and efficiency, should allow better control of costs to assure the quality of the overall customer services (Massó, 2007).

2.3. Flows in a hospital

The mentioned above logistic activities involve the management and coordination of the different flows of the hospital: physical flows, flow of information and flow of money (Nsamzinshuti, Caroline and Ndiaye, 2014).

As far as the physical flows is concerned, as Hassan (2006) described, there are 7 different physical flows in the hospital:

Flow in the hospital	Service responsible for the flow
Patients	Care providing units
Pharmaceutical flow:	
Drugs	Pharmacy
Sterile medical devices	
Bandages	
Hospitality flows:	
Laundry	Economic service (administration)
Catering	Kitchen (administration)
Waste	Subcontractors (externalized)

Table 1 Flows and the responsible service (Adapted from Hassan, 2006, p. 70)

Not all of the mentioned flows are as important in terms of cost, quality and safety of the care provided. The principal flow of hospitals is the flow of patients, contrarily to other supply chain where goods are the principal flow. In the healthcare sector, without patients, there is no any other flow.

The flow of information is indispensable to ensure a quality delivery of healthcare due to healthcare organizations provide valuable services that rely on large amounts of high quality information (Hughes, Cain and Haque, 2008). Aims at coordinating, synchronizing and monitoring all processes and physical flows that are carried out in a hospital, which are composed of multiple activities by different actors, on different locations, at different times. Therefore, information has to ensure the traceability of the activities and products. It is the result of a meaningful interpretation of data (Nsamzinshuti, Caroline and Ndiaye, 2014).

The flow of money in a hospital is determined based on the money that all activities taking place within the organization generate and their associated cost. The flow of funds of a Belgian hospital financing system is very complex. The 80% of funds come from a fixed prospective budget system based on so-called "justified activities" for services of accommodation, emergency services and nursing activities in day hospitalization, as well as a fee-for-service system to the service provider, which funds medical and medico-technical services and paramedical activities. The remaining part, is received from multiples and different sources. Payments are collected through direct payments of the patient, which afterwards are partly reimbursed to him by his sickness funds to the hospitals, or through the third-party system governed by direct payments of the sickness funds to the hospitals. (Gerken and Merkur, 2010, pp. 102-103)

3. Pharmaceutical Supply Chain in Hospitals

The aim of this section is to study and analyse the supply chain of pharmaceuticals in a hospital. To meet this objective, a review of existing methodologies for the inventory control and management regarding pharmaceutical products is provided.

3.1. Introduction to Pharmaceutical Supply Chain in Hospitals

In a healthcare logistics and supply chain, pharmaceuticals play a crucial role in the healthcare industry due to the importance of their availability at the right time, in the right place, in good conditions to the right customer. Their role is indispensable to deliver healthcare services to patients, hospital's principal objective.

Important to take into account is that pharmaceuticals make up between 15-20% of the costs of a hospital due to the significant costs of the products and their storage and control requirements (Landry and Beaulieu, 2001).

3.2. Pharmaceuticals Management in Hospitals

In this section, a review of the management of pharmaceuticals throughout the hospital supply chain is given. To achieve this objective, it is conducted a study with regards the flow of pharmaceuticals within both, the healthcare sector and the main organization, as well as an overview of pharmaceuticals distribution methodologies.

3.2.1. Triggering pharmaceuticals supply chain

Once a patient enters a hospital, a diagnosis according to patient's symptoms and the results of medical tests required by physicians is made and a treatment plan is prescribed. This is what triggers pharmaceuticals supply chain along the hospital.

There are two ways of prescribing, by using traditional handwritten drug charts or electronic prescriptions (ePrescriptions). As has been mentioned in the first chapter, in this study it is assumed the use of ePrescriptions as part of EHR systems.

3.2.2. Physical Flow of Pharmaceuticals

3.2.2.1. In the Healthcare Sector

As Vila-Parrish and Ivy (2013) described, the conventional hospital inventory system is based in a multiple echelon (or physical location) supply chain. It takes into consideration both, the external and the internal supply chain.

In a three-echelon supply chain, pharmaceuticals arrive to the hospital from vendors, manufacturers and distributors and are stored in the hospital storeroom: the central pharmacy. According to the orders, from there they are transferred to the different clinical departments of the hospital (such as emergency, intensive care, oncology, cardiology or coronary care, the catheterization laboratory or cath lab, and surgery), where pharmaceuticals are distributed to their satellite pharmacies located in the Patient Care Unit, so-called PCU (Landry and Beaulieu, 2013, p. 467). Then, pharmaceuticals can be administered to the corresponding patient. This supply chain is represented as follows:

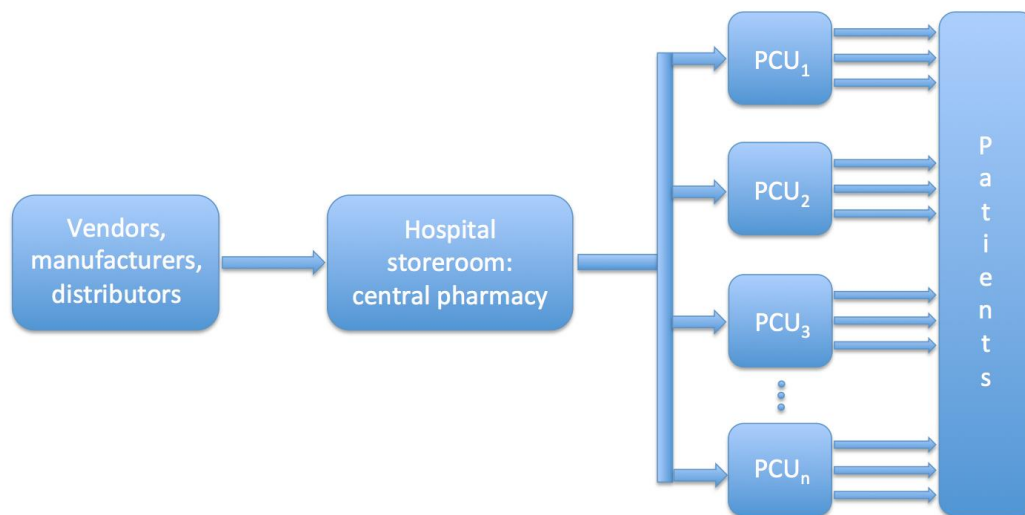


Figure 8 Three-echelon supply chain distribution (adapted from Rivard-Royer et al., 2002)

In some organizations it is also considered a stockless inventory system, distribution so-called two-echelon supply chain. In healthcare context, the term stockless inventory system implies that products are stocked at the distributor or manufacturer. In this case, orders are placed from the hospital's units directly to these upstream supply chain partners. Therefore, this system bypasses the hospital level.

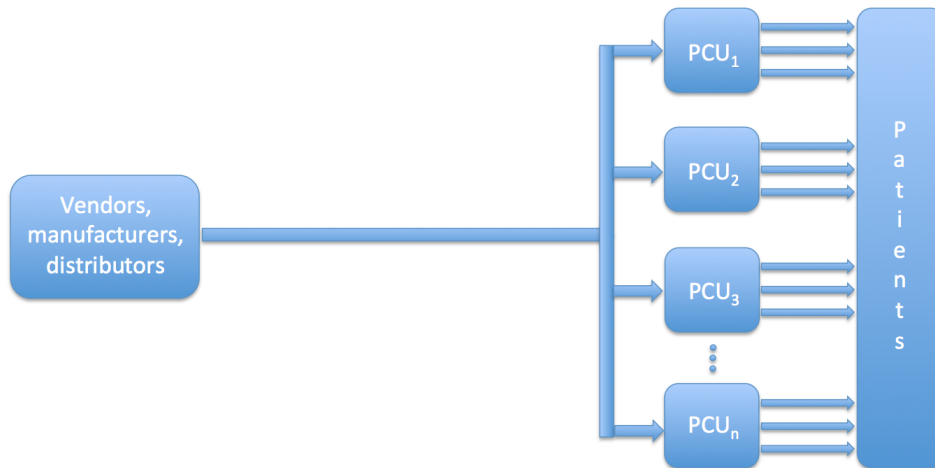


Figure 3 Two-echelon supply chain distribution (adapted form Rivard-Royer, 2002)

Rivard-Royer et al. (2002) proposed a hybrid approach combining the conventional and the stockless inventory system (Vila-Parrish and Ivy, 2013, p. 453), which basically consisted on distributing case quantities, generally by distributors, in a two-echelon supply chain system, and bulk purchases in a three-echelon system.

There have been several studies about these multiple echelon distribution system. Nicholson et al. (2004) and Zhu et al. (2005) compare both of them. The results suggested cost savings without sacrificing customer service for the two-echelon distribution network rather than the three-echelon methodology. However, a hospital cannot run only under two-echelon distribution system because most of the times patients cannot or are unwilling to wait for the order to be filled by outsourced suppliers (Woosley, 2009).

3.2.2.2. Within the hospital

After having a general overview of the healthcare sector supply chain, a flow diagram illustrating the flow of pharmaceuticals is presented. This is a diagram that comprises all basic elements of the system: suppliers, resources, inventories, physical flows and information flows (Lockamy and Mc Cromack, 2004).

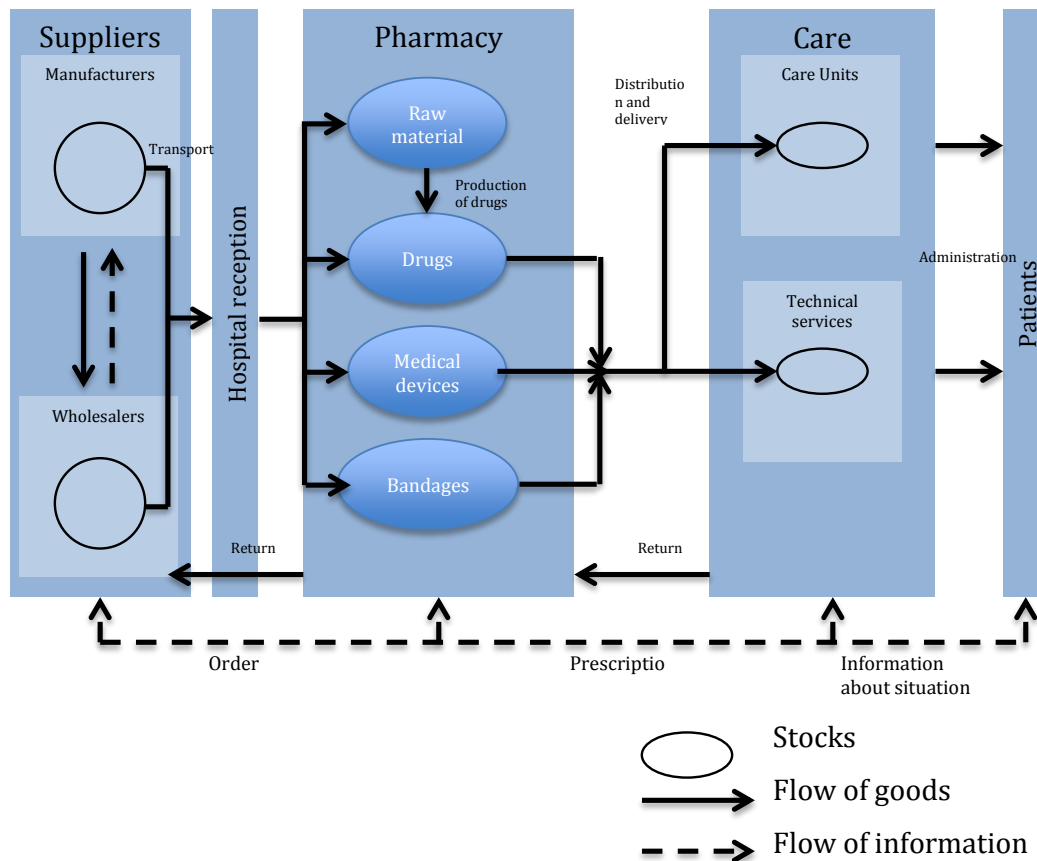


Figure 9 Flow diagram pharmaceuticals (Adapted from Nsamzinshuti et al., 2014)

Actors involved

Different actors with different goals perform the diverse activities involved in the flow of pharmaceuticals. They are described in the study carried out by Nsamzinshuti et al., as follows (Hassan, 2006; Di Martinelly et al., 2009; Baboli and Guinet, 2009; Vila-Parrish et al., 2013):

- External
 - Suppliers: Pharmaceuticals are requested by the Purchasing Department or Material Management Department of the hospital. They are supplied from distributors, manufacturers, wholesalers, vendors.

When it comes to sourcing there is a trend towards centralization of purchases across hospitals.

- Transporters: Transfer of orders to the hospital. They have to assure their proper delivery.
- Internal
 - Prescriber: Prescription of pharmaceuticals is done by physicians in the frame of the treatment they deliver to a patient. It is patient-specific, written and signed by the treating physician. For the choice of the pharmaceuticals, physicians have a formulary containing all products the pharmacy should always have in stock. The formulary is established in Medical Pharmaceutical Committees by agreement between physicians and the pharmacy. In these Committees, it is also decided upon the having in stock the branded product or its generic counterpart. Still, physicians have the possibility to order other products so they have freedom of prescription. (Agentschap Inspectie Welzijn, Volksgezondheid en Gezin, Afdeling Welzijn Gezondheid, 2009).
 - Pharmacists: They are obliged by law to validate prescriptions, which represent the beginning of pharmaceuticals' flow. Pharmacists manage and monitor the pharmaceuticals flow so are responsible of ensuring the quality of this flow. This involves delivering the right drug, at the right moment (time), at the right place (patient), in the right quantity (dose) and for the right use (route) (Baboli and Guinet, 2009; Ebel et al., 2012). Pharmacists are also in charge with assuring the right inventory levels.
 - Preparer: Deliveries are prepared based on prescriptions or inventory management. There are two kinds of preparations. At first, there are those whose preparation is made by the pharmacists, manufactured within the hospital pharmacy from raw materials. Apart from these, there are those that refer to the picking and packing of prescribed or stored pharmaceuticals that have to be routed to the units and patients. Pharmacists can perform this activity, although it is mostly carried out their assistants.

- Handlers: The person (a pharmacy assistant, a nurse or a logistics support) transferring the prepared orders from the hospital's pharmacy to the ultimate point-of-use.
- Administrator: The person who dispense and administer the pharmaceuticals to the appropriate patient or point of care. The nurses perform this activity, although occasionally could be the physician.
- Patient: The person initiating the pharmaceutical flow when in need of pharmaceuticals to cure illness. At the same time, he also represents the latest step in the flow of pharmaceuticals, when their administration is received.

A part of this pharmaceuticals flow is push; triggered by demand provisions, market planning and distribution approach. Demand provisions are mostly based on past consumption. Another part is pull, triggered by the real demand.

In the following sections, it is provided a general overview regarding the supply chain of a hospital's pharmacy, the inventory management and the supply chain within the hospital (distribution system adopted) in terms of pharmaceuticals.

3.2.3. Pharmaceuticals distribution methods

It is not so important the way in which pharmaceuticals are transferred, from their arrival at the hospital until they meet their point-of-use, than their adopted distribution method throughout the hospital.

Before introducing the different distribution methods and according to the literature used to carry out this project (which is based on Rivard-Royer, Landry and Beaulieu, 2002; Landry, Blouin and Beaulieu, 2004; Landry and Beaulieu, 2010; Philippe and Beaulieu, 2010, for this section), it is important to take into account that the management of pharmaceuticals within the hospital supply chain is mainly determined by the criteria or management methodology adopted in the different satellite pharmacies located in the PCUs. Then, in the table below, the distribution methods that have been already adopted, or can be adopted, for pharmaceuticals is presented. They are listed sorted chronologically according to their deployment and implementation.

Method	Description
Requisition	Decentralized-periodic replenishment. Clinical staff conducts regular inventory counts in all the different satellite pharmacies of the hospital. Combined with consumption estimates, requisition forms are forwarded, either manually or electronically, to the Materials Management Department ¹ whether replenishments of pharmaceuticals are needed. Based on this requisition, required supplies are picked or ordered from external vendors and send to the corresponding satellite pharmacies. This way, it is often clinical personnel who are in charge with the supplies distribution across the hospital as well as putting away the delivered products in the storage units.
Exchange carts	Centralized-periodic replenishment. Pharmaceuticals are placed on a cart positioned in a storage area or satellite pharmacies on the PCUs, from where they are taken for

¹ In this project, the hospital department in charge of Inventory Control and Management policies is assumed to be so-called *Materials Management Department*, according to the literature review.

	<p>administration. The cart is exchanged according to a predetermined schedule by an identical, fully stocked replacement cart located in the central store (fixed-time periodic review system) (Landry and Philippe, 2004).</p> <p><u>Added values:</u> This method introduces a key objective that is to transfer responsibility for replenishment from clinical staff to a centralized administrative body, which would perform this task for all of the satellite pharmacies of the hospital. This fact leads to improve management and control of inventory. That is meant in terms of both, allow for greater specialization of functions for the clinical staff, who then are able to better focus on their core mission of patient care, as well as facilitate establishing minimum and maximum thresholds for the various supplies stored and identifying the optimal inventory control (replenishment frequency).</p>
<p>Par level</p>	<p>Centralized-periodic replenishment.</p> <p>Material handlers conduct scheduled rounds at the satellite pharmacies in order to determine pharmaceuticals that need replenishment, which are based on visual evaluation or a more formal inventory count. Normally, a product is identified with the help of scanning a barcoded label on the shelf, bin or packaging, and the quantities counted are entered into a handheld computer. In this way, the data is directly transmitted to the Materials Management Department, which compares the quantities counted with established quotas and generates a requisition list for the products that are running out of inventory (fixed-time periodic review system). Then, the picked and ordered pharmaceuticals are delivered to the satellite pharmacies and put away by material handlers. Some hospitals use a min/max variation of the par level system.</p> <p><u>Added values:</u> In comparison with exchange carts method, this methodology showed improvements in distribution system efficiency by delivering appreciable gains through reductions in stock and storage space in central stores. This is because par level eliminated the need to manage duplicate mobile supply chain. It is also more flexible, in that it can be used with any and all storage equipment in the storage area within the PCUs and enables clinical staff to manage a wider range of products. Furthermore, the system allows the use of portable readers to enter quantities in stock or scan label barcodes.</p> <p><u>Weaknesses:</u> The material handler needs to spend a lot of time in the storage areas to count the pharmaceuticals requiring replenishment and put away delivered products. That means an additional contact between them and clinical staff. However, solutions to the problem have been found: the material handler can work on the storage areas when there is less activity in the hospitals (e.g., at night).</p>

Two-bin/kanban	<p>Centralized-periodic replenishment.</p> <p>Each quota of medical supplies is divided between two compartments. When the first is empty, clinical staff removes its label and affix it to a wall-mounted kanban board. Material handlers conduct scheduled rounds in order to scan the labels on the board. This data is transferred to the Material Management Department in charge with inventory control. They are responsible for replenish these stockouts, either by inventory stored in the central warehouse, or by ordering new purchases from suppliers (hybrid inventory management system, which combines both fixed-order and fixed-interval characteristics). Material handlers are in charge of delivering the orders to the PCUs as well as place them after having rotated the stock.</p> <p><u>Added values:</u> The chance of human error has been reduced since scanning labels does identification of bins to replenish. This system allowed greater control over the quantities to order so quantity per bin is fixed. Moreover, the method forced stock rotation that, consequently, reduced the risk of products expiring. Important to take into consideration is that gains generated by this system did not come at the expense of increased inventory.</p>
User-driven unitary demand capture system	<p>Centralized-perpetual replenishment.</p> <p>This is an automated system. It consists of storing pharmaceuticals in satellite pharmacies in closed cabinets or open bins and record their removals through various means such as pushing bottoms or scanning transponders or barcodes. In this way, the consumption is recorded. Generally, after a scheduled interval of time, the collected data is transferred to the Materials Management Department, which is in charge of enabling replenishment based on this on-hand quantity.</p> <p><u>Added values:</u> The automation of inventory control and demand capture system allows better monitoring of pharmaceuticals kept in stock and facilitates communication with the Materials Management Department, which are provided with real-time information.</p> <p><i>User-driven unitary demand capture system</i> is the first real-time information provider method.</p> <p><u>Weaknesses:</u> The system has sometimes shown non-compliance by users to record consumption, which cause inventory inaccuracies. Klibanov and Eckel (2003). Apart from that, such technologies are expensive.</p>
Weight control bins	<p>Centralized-perpetual replenishment.</p> <p>This system stores the different pharmaceuticals in bins and maintains a perpetual inventory in the satellite pharmacies based on the</p>

	<p>weight of these products. Replenishment is triggered when the bin reaches the preset weight for a pharmaceutical. Communication with Materials Management Department is established in order to generate an order.</p> <p><u>Added value:</u> This system triggers the replenishment process using order point logic (which reduce risk of both compliance and demand issue).</p> <p><u>Weaknesses:</u> The system may present space limitations, which usually has to be modified (wall-mounted system is needed, which might require their reinforcement). As well, it has a limited assortment of bins. Furthermore, the technology can be unreliable in a live environment (technology failure, recalibration, items returned to the wrong bin, monitoring of expiry dates, etc.).</p>
<p>RFID-enabled two-bin/kanban systems</p>	<p>Centralized-perpetual replenishment.</p> <p>This method is the automated two-bin/kanban system. The bin's label is equipped with a passive (no battery) high-frequency RFID transponder and a reader is installed behind each of the replenishment boards where labels from empty bins are affixed. This board is connected to the hospital's information technology network. The moment an RFID label enters the reading range of the antenna, communication is established with the Materials Management system to enable a request to be generated at fixed intervals or according to pre-established replenishment rules. Thus, the system maintains a perpetual inventory of bins.</p> <p><u>Added values:</u> This system eliminates the requirement for clinical staff to collect data through pre-established rounds. It provides real-time information, remote visibility of inventory levels and replenishment needs.</p> <p><u>Weaknesses:</u> Since each item must be conditioned by affixing an RFID transponder to it, this technology can become cost-prohibitive. That is why the use of this system has been limited to small groups of products (e.g., implants) in specialized areas (e.g., operating rooms, cath labs, etc.).</p>

Table 1 Description of distribution methods

The described distribution systems include activities of pharmaceuticals distribution from hospital storeroom or suppliers to satellite pharmacies located at the PUCs. Then, from there, healthcare providers, usually nurses, administer the pharmaceuticals to the ultimate point-of-use with the help of trays.

All of these inventory management methods are based on periodic reviews systems, either both, by using fixed-interval reordering process and/or order point logic. This means that with the help of different models of inventory control, it is possible to determine the different parameters (review period duration, maximum inventory level, order point, reordering quantities and safety stock) that may guarantee a right balance between ordering costs and inventory carrying costs. However, as has been seen, this is a complex task. To ensure proper operation of the supply chain, efforts have to be focused on several aspects such as the track of items through the supply chain as well as requests for orders whether replenishment is needed, the handling of products by clinical staff in order to reduce and eliminate human errors and communication between the different points-of-use where pharmaceuticals are required and the main responsible of inventory management and control.

3.3. Inventory Control

Some of the most prevalent and significant problems facing the healthcare supply chain involve the area of inventory control. It is a very complex task mainly due to the amount of products inventoried, which many are perishables, and the daily changing demand for pharmaceuticals. The availability of pharmaceuticals is a crucial factor in a hospital's ability to provide effective, timely and safe patient outcomes. That is why researches and studies have been carried out in order to improve inventory efficiency (Smith, Nachtmann and Pohl, 2012; Vila-Parrish and Ivy, 2013, pp.447-449).

After having seen the different distribution methods for pharmaceutical products, it is interesting to take into consideration the models that hospitals establish as inventory control strategies or techniques. That is, the criteria followed to replenish inventory from suppliers. Its analysis is under Materials Management Department (or Purchase Department, according the literature reviewed) responsibility. It implies selecting the right type of classification for materials and then applying appropriate techniques or models for inventory control.

3.3.1. Classification systems for materials

Classification systems have been developed and implemented in order to create a simple method for improving inventory costs and service levels. Hospitals often use ABC inventory classification strategy. The ABC analysis, also known as Selective Management principle or Pareto's Law, divides an inventory into three categories. Aims at providing a mechanism for identifying the impact of the different items on the overall inventory cost. It gives a measure of inventory importance to each item. Thus, it helps to determine adequate management and controls per each established category (Reddy, 2008). Hereunder are proposed selective controls procedures to be adopted for ABC classified items.

	A	B	C
Control procedure	High Consumption Value	Moderate Consumption value	Low Consumption Value
Type of control and authority	Very strict control. The controller should have great authority.	Moderate control. Controller may be from the middle management.	Low control. Powers can be delegated to the user departments to determine stock level.
Quantity of safety stock	Very low or practically nil, combined with frequent ordering and/or staggered supplies. Possibility of stockless strategy.	Low. Ordering can be done monthly or quarterly	High. Bulk ordering. Half yearly or annual orders to take advantage of bulk discounts.
Consumption control	Should be done regularly: weekly or daily.	This period can be extended to a fortnight or a month.	This period can be extended to a quarter.
Material planning	Should be accurate. Database should be up-to-date.	Can rely on historical data, past consumptions.	Estimates are sufficient.
Application of value	A concerted attempt should be made at value analysis, waste reduction, obsolete and surplus reduction.	Moderate attempts are sufficient.	Annual reviews are sufficient.
Number of suppliers	High. Centralise control. Require short lead times.	2-4 sources. Shorter lead-time is preferred.	1-2 sources. Annual or half-yearly purchase. Decentralised control.

Table 3 Levels of hospital supply inventory management control in an ABC classification category (Adapted from Reddy, 2008)

Therefore, the ABC analysis helps to rationalise the number of orders by establishing priorities and reduce the average inventory during a specific period, which has an

impact on cost reduction. However, ABC analysis has a significant limitation: it indicates nothing regarding profitability or criticality of the items, so importance is given to an item on the basis of its consumption value. As a consequence, in order to accurately classify materials, other analyses have emerged that can add significant value to inventory management. One of the most common is the one proposed by Gupta et al. (2007), which focuses on the coupling of ABC and VED method. VED analysis is based on the criticality of an item. “V” is for vital items without which a hospital cannot function, “E” is for essential items without which an institution can function but may affect the quality of the services and “D” stands for desirable items that do not hinder hospital functionality (Vila-Parrish and Ivy, 2013).

Information about other types of Selective Controls can be found in the ANNEX VI.

3.3.2. Techniques for Inventory Control

In line with these analyses, hospitals set inventory control strategies or models in order to define some criteria to replenish inventory. This can be a complex task. The major problem is the uncertainty of demand. Demand for pharmaceuticals is based on the patient population in the hospital, which is uncertain and varies through time due to season factors (e.g., flu season) (Vila-Parrish and Ivy, 2013, p. 451).

According to the interview with Mr Bruno, Warehouse Manager at Hospital Logistics, the main supply chain strategy used for replenishment of pharmaceuticals in hospitals is a Min-Max strategy (periodic replenishment model). This strategy allows placing orders to suppliers in variable quantities and variable periods based on historical data. It is used for the whole range of products' references that can be found in the central pharmacy. Its main advantage for the case of study is that it also allows inventory control despite the uncertain demand. Rather, it takes into account possible unforeseen spikes in demand by carrying safety stocks. Mr Bruno pointed out the importance and necessity to keep pharmaceuticals as safety stocks in order to meet the uncertain demand. Their stored quantity may vary frequently (e.g. whether supplier is not reliable, or due to his geographical location, changes on products, peaks in demand, etc.). The main constraint of the strategy is the associated holding costs involved.

Hospitals are currently working on improving and optimising this strategy in terms of effort, stock stored and associated costs. Thus, hospitals are starting to use strategies or models of purchasing that may vary from one product to another. That is mainly due to the broad variety of products (drugs, medical devices and materials) and their classification and criticality in the supply chain and service given by healthcare professionals.

So far, as Mr Bruno has explained, the common one aims at classifying pharmaceuticals into “fast movers”, “middle movers” and “slow movers” and then set an inventory pattern for one of each them:

- Fast movers: Min-Max strategy. Inventory ordered in variable quantities and variable periods.
- Middle movers: Fixed-Time Period Model strategy. Inventory ordered in variable quantities in fixed periods.
- Slow movers: Inventory ordered in bulk or big orders in one time.

Depending upon usage or demand from the different points-of-use of the products required, the orders follow a two-echelon or three-echelon distribution, as an hybrid approach distribution.

During the interview, Mr Bruno emphasized the significance of this classification, which takes into account not only the value of inventory seen as days of stock and volume, but also their economic value, as a combination of both aspects.

3.3.3. Production of pharmaceuticals

Not all pharmaceuticals purchased are directly administered to patients or sent to a point-of-use. Some pharmaceuticals are produced on site from raw materials. The consideration of their production strategy, make-to-order (MTO) or make-to-stock (MTS), is complimentary to the classification and prioritization of pharmaceutical supplies as well as any inventory management strategy (Vila-Parrish and Ivy, 2013, p.450).

4. Value chain analysis

The value chain analysis is applied to identify both, the core activities that take place in an institution as its add value. In this section, firstly it is provided the value chain analysis for the hospital institution. It is given the description of the principal activities that create value for the main hospital activity, the delivery of care. Secondly, the same framework is used to analyse one of the hospital support activities, the pharmaceutical supply chain.

This way, the study provides an overview of the activities that add value to the pharmaceutical supply chain and their link or impact on the delivery of the main hospital service, patient's care. This will allow us to analyse the added value that may create the usage of EHR and ePrescriptions to the pharmaceutical supply chain as well as the main institution.

4.1. Concept of "value" adapted to the hospital

In the healthcare context, the notion of "value" under hospital's perspective is composed of two elements: the quality of care delivered to patients and the productivity and competitiveness of the production system of care of the hospital. The performance of the system is measured by efficiency and effectiveness of activities that use technical, human and financial resources to produce care of quality for the patient (Di Martinelly, Riane, and Guinet, 2009).

The primary activities of the value chain are devoted to care patients. As the model introduced by Michael Porter in 1985, they are divided into 5 sub-categories:

- Admission Logistics (*Inbound Logistics*): processes associated with patient's admission and management of their documents and information.
- Care (*Operations*): processes associated with the management of healthcare delivery (diagnose and treat of the patient).
- Discharge Logistics (*Outbound Logistics*): processes associated with patient's discharge.

- Marketing and sales: processes associated with the financial return of care. That is, invoicing to patient and third party payers, information exchange with state-controlled organizations and price setting activities.
- Service: processes associated with care activities that can add value to them.

The primary activities are supported by the support activities, which provide human, technical and material resources.

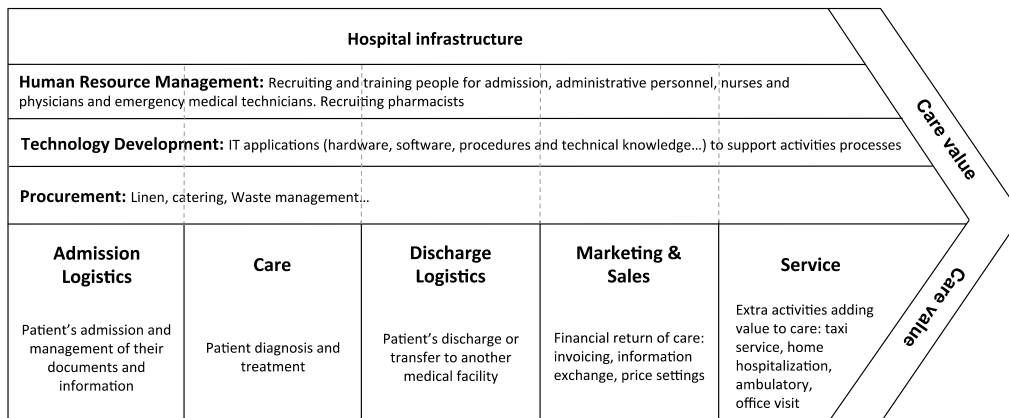


Figure 5 Value chain adapted to hospital (adapted from Di Martinelly, Riane and Guinet, 2009)

4.2. Adapted to pharmaceutical supply chain

The main objective of pharmaceutical supply chain is to make pharmaceuticals available to the patients or points-of-use. Thus, value is based on the ability to coordinate the activities from the pharmaceuticals and their supply chain.

According to Pitta and Laric (2004), which provide a model of the healthcare value chain, it is provided a description of the value chain for pharmaceutical supplies. That is, who and how creates value for the pharmaceutical supply chain.

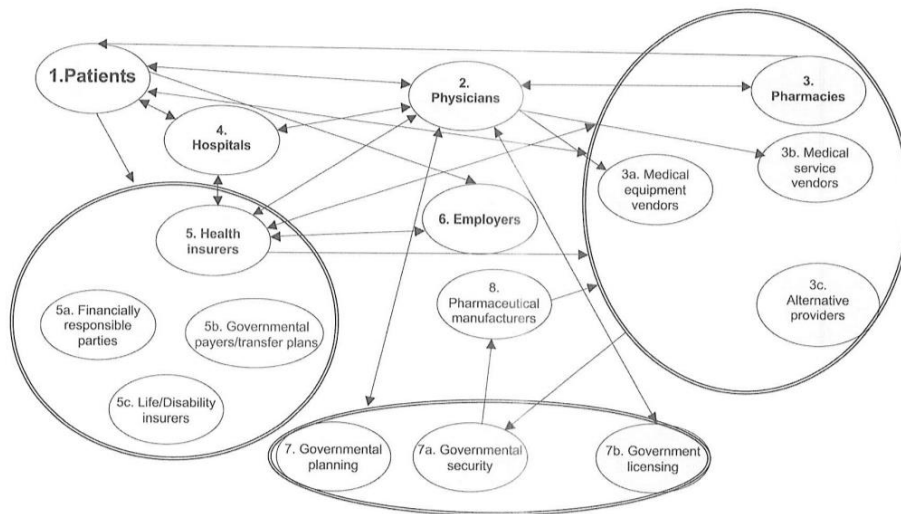


Figure 6 Participants and relationships in the healthcare value chain (Pitta and Laric, 2004)

The first two participants comprising the value chain are the patient and their exchange with the health care provider or physician. Although patients are not part of the pharmaceutical supply chain, as they are its main cause and beneficiary, they can add value to the chain. **Patients** are the initiators of the information flow as they are the first givers of information. In the medical consultation, patients provide value information regarding the matter/s or issue/s that brought them to the hospital, which is necessary to adequately address whatever needs they might have. The research of Pitta and Laric (2004) showed that patients are more willing to share important, if private, information with their healthcare providers when they believe this information is needed for medical purposes and when they trust the confidential nature of the patient-doctor relationship. According to patient's symptoms and information provided, the **health care provider or physician** must contribute to the value chain by first properly diagnosing and then prescribing a treatment plan. To better perform these tasks, physicians need to build confidence with patients in the medical consultation in order to receive all possible information. The more information given, the more valuable information can be extracted, so the more accurate diagnosis can be made. In the majority of treatment plans, there are involved prescriptions. Their prescribed pharmaceuticals trigger pharmaceuticals supply chain. Then, another group enters the value chain, **pharmacists**, which dispense pharmaceuticals, and **other providers of medical equipment and services** - this last group is not part of the

pharmaceutical supply chain but has a crucial role. They provide additional data (battery of diagnostic tests...) required by physicians, which is the basis of the diagnosis and treatment plan prescribed as well as information given by patients. Pharmacists' main added value relies on further investigating the medical history, specifically as it relates to medications, of patients in order to determine any potential risks or interactions that may result from the addition of a new prescribed drug. The next addition to the value chain is the **hospital** and the related services and procedures that may be included in the entire treatment of a patient. Hospitals add value by facilitating the storage and flow of information through the different activities that shape the supply chain of pharmaceuticals. The next member of the healthcare value chain is **health insurers**, which includes both public and private entities responsible for providing financial support to those receiving care. Insurers may request for patients information regarding their diagnosis and treatment plan. May have an effect on them whether certain procedures are not approved because of its high cost. **Employers** are the next participant group. Value is obtained by negotiating better benefits for groups of people as opposed to those offered to individuals. The next addition is **government** as influential party on the system. Finally, **Pharmaceutical manufacturers** are the last participants. Their added value is based on designing, producing and bringing pharmaceuticals to market. To do so, they need information from providers and patients so as to know what the future needs of patients are. That knowledge improves the performance of the value chain.

According to the explanation above, the value chain adapted to pharmaceuticals supply can be summarised as follows:

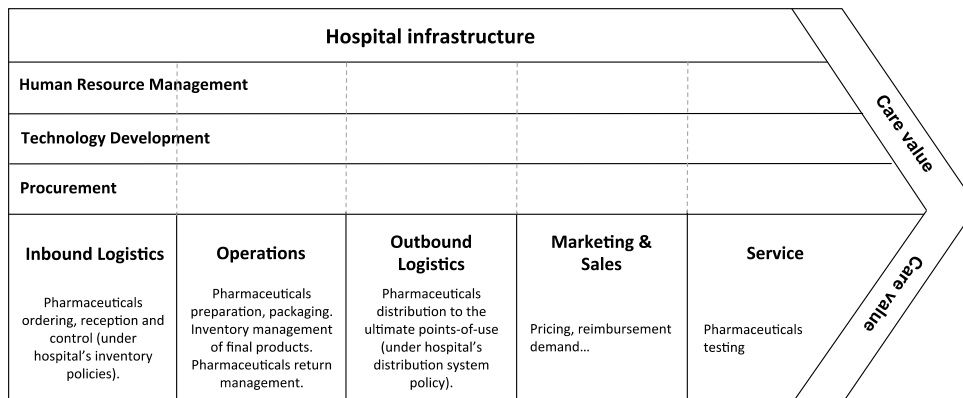


Figure 7 Value chain adapted to pharmaceutical supply chain (adapted from Di Martinelly, Riane and Guinet, 2009)

As for pharmaceutical supply chain support processes is concerned, they are mainly the same as those of the hospital, but less specific.

To conclude this section, it is important to mention that among all the participants and activities that take place in the value chain of pharmaceuticals supply, the information system plays an important role. There is a necessity to process, transfer and convey amounts of quality information across the different members of the chain. A quality flow of information has to be guaranteed. Moreover, the information system has to support a perfect coordination between the patient flow and the pharmaceuticals flow to allow an optimal management.

5. Opportunities to increase value with EHRs and ePrescriptions

With the implementation of Electronic Health Records (EHR) in a hospital, what means the adoption of Electronic Medical Records (EMR) and Electronic Patient Records (EPR), including Electronic Prescribing (ePrescription) for the case of study, there is an opportunity to increase value to the processes and activities that take place along the pharmaceutical supply chain of a hospital. They are presented below.

5.1. In the Pharmaceuticals Management

Improvement or added value to the trigger point of pharmaceuticals: The prescription of a patient's treatment plan

In a hospital, EHRs and ePrescriptions **facilitate tools for decision support** in patient's diagnosis and prescription of a treatment plan, as:

- Can help the physician by generating reminders and alerts (e.g. to detect drug adverse effects) or by suggesting, from the patient data, diagnosis or therapeutic strategy
- During medical consultations, physicians can electronically and **remotely consult the patients' medical history (EHR)**, which are virtually stored and available in the database anytime. This valuable information, along with a rigorous analysis of the information provided by patients, their presented symptoms and the results of analyses required by physicians (if needed), as well as the possibly added **decision support tools** (which can help the physician by generating reminders and alerts (e.g. to detect drug adverse effects or by suggesting diagnosis or therapeutic strategy from the patient's data), may contribute the development of an accurate treatment plan for patients.
- EPrescriptions open up the potential to capture the prescribed treatment plan electronically in a transferable manner to and from other systems and add decision support tools. Then, specifying, its main added value is in:
 - **Enabling test orders to be triggered from within the system**, and for these **test results** to be **posted to the system**.
 - Having the ability to **add decision support tools** to assist the prescriber **in pharmaceutical selection** (such decision support tool may be classified into *active decision support* or *passive decision support*. *Active*

decision support functions provide clinical alerts to the user automatically as part of the workflow of the system, without the user having to actively seek the clinical information. This mechanism is built into the ePrescription system software. On the other hand, *passive decision support* functions are pharmaceutical information reference sources mounted on Internet, an intranet or a local server. This clinical decision support warnings and information may include some or all of the following: sensitive checking, drug interactions, duplicate therapy/drug doubling, precautions/contraindications, dose checking, formulary status and monitoring warnings (Goundrey-Smith, 2013)).

In a study in Scotland, Fowlie et al. (2000) noted a significant reduction in inpatient prescribing errors after the implementation of ePrescriptions. The prescription error rate fell from 7.4%, to 7% one month after implementation and then to 4.7% twelve months after implementation ($p < 0.001$).

[Improvement or added value to the Pharmaceutical Supply Chain](#)

Many of the inefficiencies of existing processes in pharmaceutical supply chain in hospitals surround the way in which prescriptions of the medical consultations (or wards) are filled with pharmaceuticals from the Materials Management Department.

The networked ePrescription system offers a **seamless transmission of prescriptions between the different workstations of the supply chain** (medical consultation - satellite pharmacies - Material Management Department - pharmaceutical administration or point-of-use) for placing orders that need to be administered to patients. Instead of being the clinical staff that is in charge of transcribing and moving handwritten prescriptions in drug charts, the ePrescription system creates an electronic link between the workstations. As a consequence, this flow of information is improved and adds value to the chain as follows:

- **Information is transmitted in a more transferable manner** that is more fast, structured and secure than paper-based documents.

- Providing **real-time display of prescribing information** along the network, what has an impact on the chain based on:
 - The impossibility to lose information along the chain. That is, **prescriptions cannot get lost** (or part thereof), in comparison with paper-based drug charts.

In a study of 317 general practitioners in Yorkshire, 17% said that the loss of chart drugs had led to wrong drugs being given (Smith, 2004).

- A **reduction in pharmaceutical ordering turn-around times**.

One US study has identified a 64% average reduction in medication ordering turn-around time following implementation of an ePrescription system (Koppel et al., 2005).

- **Transcription process, legibility and completeness of prescriptions are improved.** As physicians often do prescriptions in a hurry, handwritten prescriptions may be illegible or incomplete. Consequently, nursing or clinical staff may have doubts about what is written down on drug charts, so that they may have to query prescriptions before they administer any pharmaceutical or place orders to the Material Management Department. With ePrescribing:
 - Legibility is improved since physicians prescribe pharmaceuticals in a computerized manner.

A study assessing the quality of written inpatient prescriptions found that of 4.536 prescriptions 4 to 10 percent were illegible or ambiguous (Jenkins, Cairns and barber, 1993).

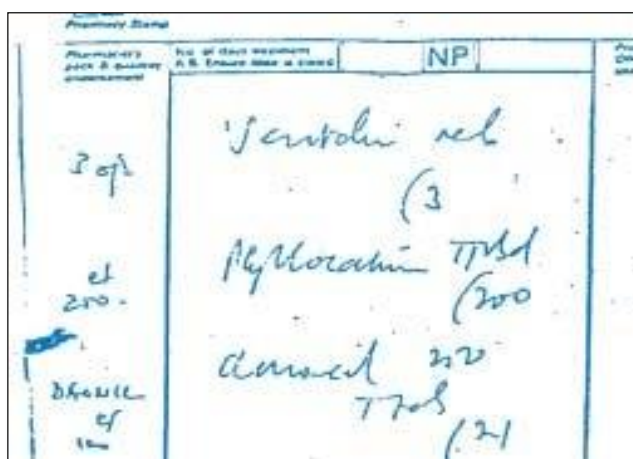


Figure 10 Example of illegibility in handwritten prescriptions

- Completeness is also improved since the ePrescription system cannot consider that a prescription is finished whether specific fields are not filled out.

The use of ePrescriptions at the Wirral Hospitals had increased the number of complete and correct doses on medication charts from 17.7% to approaching 100% (Farrar, 1999).

The effect on legibility and completeness of prescriptions was compared with handwritten prescriptions. A total of 2,180 prescriptions for 267 patients on 5 wards (1,217 before and 963 after computerisation) were assessed against the hospital standard for prescription writing as specified in the British National Formulary. Computerised prescribing significantly ($p < 0.0001$) improved the legibility and completeness of prescriptions compared with hand-written instructions (Smith, 2004).

- Transcription errors, which are commonly found when orders need to be triggered by clinical staff transcribing information from physician's prescription, are avoidable since, as said, physicians prescribe pharmaceuticals in a computerized manner.

Some 11% of errors are as a result of the transcription process. Bates et al. indicated that the rate of non-intercepted errors arising from the transcription process was reduced considerably by 84%, from 1,3events/1000 patient days to 0,2 events/1000 patient days (Bates et al., 1998).

Several studies have analysed the effect of implementing ePrescribing systems assessing the quality of services delivered in medical practices, the main objective of a hospital. There are outlined a couple of examples hereunder:

Shulman et al. (2005) compared the use of handwritten prescriptions with electronic prescribing (without decision support functions) on an intensive care unit at University College Hospital, London. The study found a moderate reduction of medication errors with the ePrescribing system. The medication error rate fall from 6.7% (69 errors on 1.036 prescriptions) for handwritten prescriptions to 4.8% (117 errors on 2.429 prescriptions) for electronic prescribing ($p < 0.04$).

The medication administration error, from 9% prior to implementation, fall to 6% after one month and then to 5.4% twelve months after the implementation ($p < 0.001$). It is interesting to note that medication administration errors involving intravenous drugs and controlled drugs were omitted from these figures due to the complexity of scenarios, which could affect the overall medication administration error rate (Fowlie et al., 2000).

The networked EHR system offers a **seamless storage and transmission of patient information and medical practices (EMR and EPR) between the different workstations of the supply chain** that can make use of this information (medical consultation – central pharmacy – pharmaceutical administration or point-of-use) for consulting, modifying or introducing information regarding patient's treatment plan

prescribed (the function that is carried out depends on the clinical staff that performs them). This opportunity to access to all this information remotely can add value to:

- Enable record **security** (EHRs are likely to be more secure than paper records, although it depends on the design of the system).
- Medical practices since **patient's valuable information can be provided to authorized healthcare professionals in front of any unforeseen circumstance, at any time**, with more structured, legible and complete record contents.
- Pharmacists' activities, which can have more working time available to devote to **near-patient clinical activities**. That is, monitoring new treatments, assessing side effects and providing advice to other healthcare professionals.

The use of EHRs also **facilitates communication and transmission of information between the hospital and health insurers** when they may demand patient's medical information before covering tests or treatment plans ordered by healthcare providers.

5.2. In Inventory Control Strategies

EHRs in a hospital capture patient's medical history, what also can be seen as a capture of medical practices. EPrescribing captures medical prescriptions according to treatment plans prescribed to patients. All this data can be exported and be collected and serve of great use to the Materials Management Department of the hospital to improve and optimize Inventory Control established policies.

Therefore, these records provide valuable information regarding the demand and use of pharmaceutical products in a hospital. This allows gathering information for an accurate study of classification of pharmaceuticals and analysis of their demand, which, as said, is the major problem in determining inventory control strategies or models as it is uncertain, stochastic. As information is collected compactly, new or more accurate statistical models describing demand can be found, as well as Markov chains that can take place.

5.3. In the organization

Both the use of EHR and ePrescription systems as their impact on the pharmaceutical supply chain efficiency brings some benefits to the organization, as they are described below.

Clinical system interoperability

EHRs and ePrescriptions allow a better operability between the different departments and stakeholders of a hospital. These applications open up the potential to be interacted or interfaced with other IT systems of a hospital in an integrated manner, what can benefit medical practices and streamline business processes of a hospital. This is also a key driver for regional, national and even international healthcare IT programs, where information may be transferred to a central spine from which other healthcare providers may retrieve it as the need arises.

Streamlined workflow for healthcare providers, users of the systems

Healthcare professionals of all disciplines have a duty of care towards their patients, which entails an obligation to ensure that patients are treated in a way that fulfils legal and ethical requirements. However, to do so, healthcare professionals may work under operational pressures from the healthcare organization to treat patients as quickly and efficiently as possible and to achieve statistical benchmarks and service level targets (Goundrey-Smith, 2012). Sometimes, these objectives cannot seem to go together. However, there is an opportunity to achieve both objectives whether workflow of the healthcare professionals is streamlined by the appropriate and accurate use of EHRs and ePrescriptions. Nevertheless, it is important to take into account that this may imply less time spent on administrative staff by nurses, while physicians may have to spend more time on the computer.

Security and confidentiality of patient's information

Traditional paper-based drug charts are liable to being lost or viewed by unauthorized users. Contrarily, EHRs and ePrescriptions are a networked closed system whose information access is only permitted to authorised users and only in order to perform functions that are appropriate to their role.

Cost reduction

In comparison to traditional paper-based health records, the introduction of EHR and ePrescription systems will lead to savings by reducing the amount of paper and consumables used (in terms of charts, paper, pens, etc), the wasted staff time due to

inefficient paper-based systems and processes and possible litigation costs when errors are made.

Improvement of the quality of care delivered

As these systems improve the efficiency of both the prescription process as the pharmaceutical supply by automating processes, healthcare professionals have the opportunity to release time and engage in more patient-centered activities, which require intuitive input that only human beings can provide. These tasks may include detailed history taking, medicines review, health education, clinical research, evaluation of resources and technology that could be used to facilitate further service developments, etc. That is, there is a tendency of healthcare providers to move away from product and process-centered work towards patient-centered work. As a result, as has been seen, there is a reduction of pharmaceutical administration error to patients, leading to a better quality of health care delivery.

4.3. Graphical summary

HOSPITAL PHARMACEUTICAL SUPPLY CHAIN

Prescription of a patient's treatment plan

Supply of pharmaceuticals at the point-of-use and medication administration

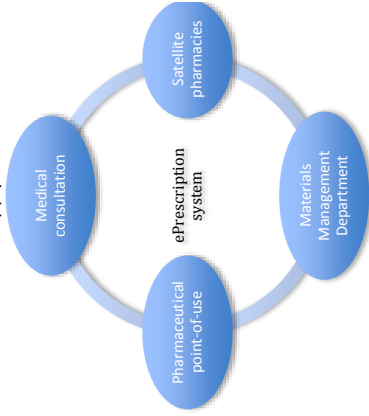
Improvement of prescribing due to:

- EHR provide:
 - **Real time patient's medical history** (EHR), **remotely and anytime**
 - **Decision support tools** (e.g., providing reminders and suggesting diagnosis or therapeutic strategies for patients)
- ePrescription
 - **Enable test orders to be triggered** from within the system **and be posted to the system**
 - **Decision support tools** for pharmaceuticals selection (active / passive decision support)

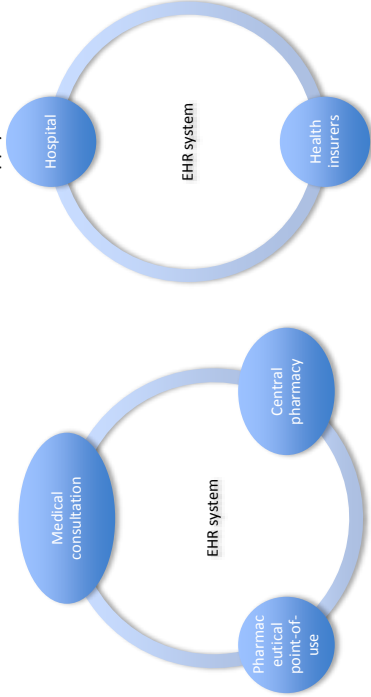
Computerized capture of information with EHR and ePrescription systems improve:

- **Durability**
 - **Legibility**
 - **Completeness**
 - **Standardization**
- of patients' medical information

Seamless transmission of prescriptions between the different stakeholders or workstations of the supply chain:



Seamless storage and transmission of patient information and medical practices between the different stakeholders or workstations of the supply chain:



EHR and ePrescription systems **open up the potential to interface these systems with other IT application** such as RFID or barcode scanning for a better inventory management and traceability **as well as to further research of new or optimised inventory control and replenishment strategies.**



Reduction of prescribing errors



More efficient pharmaceutical supply chain



Reduction in pharmaceutical supply and administration errors

At an organizational level: Clinical system interoperability, streamlined workflow for healthcare providers (users of the systems), security and confidentiality of patient's information, cost reduction and improvement of the quality of care delivered from the hospital.

At a regional, national and international level: Interoperability, usability and health coordination.

Figure 8 Graphical summary of opportunities to increase value with EHRs and ePrescriptions

6. Possible causes of inefficiencies with EHR and ePrescription systems

As has been seen, EHR and ePrescription systems can improve both the supply chain and the hospital efficiency. However, there are some points that may cause inefficiencies to the chain that are important to take into account.

First of all, the way on which these systems are designed plays an important role in their implementation and proper functioning in a hospital, specifically for applications such as EHRs and ePrescriptions where there is a need to present complex information in a way that enables appropriate professional decision-making. For this reason, the easier and usable they are for users to operate, the less dysfunctions and inefficiencies may be caused. In order to gain maximum benefits from these systems, it is essential that system designers take into account the comments, views and aspirations of clinical users.

If they are not easy to operate, errors may occur. Prescribing errors mainly caused by omission of drugs (31%), incorrect selection of drugs (29,4%) and dose regimen errors (18,1%). The prescribing errors were found in 664 medication orders, out of 7.920 orders for 1.038 patients (Abdel-Qader et al., 2010).

Secondly, possible resistance to change by healthcare providers may appear in front of the introduction of new technologies to support medical practices. That is why training and showing the functionalities, advantages and added values of these systems to healthcare providers are crucial to improve their point of views regarding the dissemination of new technologies.

Furthermore, initiatives in case of failure or breakdown of the electrical system of the hospital, as well as damage or loss caused by possible virus, have to be taken into consideration also for these systems. Otherwise, there is no possibility to access to any information.

Important to take into consideration is that there is a necessity to ensure a proper sharing of patient's data in line with appropriate legal requirements, information

governance arrangements and professional standards. Appropriate confidentiality and data security measures have to take place. It is important to take into account that EHR systems must not be used inappropriately or in an unprofessional manner. Furthermore, EHR data should not be used for research purposes without the appropriate patient consent and ethics approvals being secured from the appropriate authority. In any other case, these systems might cause harm to the patient and, as a consequence, to the hospital and the systems' provider as well. For this reason, confidentiality and data security measures should cover, at least, an appropriate use of password or smart card technology for log in the EHR systems, data transfer and encryption, security of hardware devices and premises where equipment is used and training on confidentiality incidents.

It is interesting to take into consideration that the drawbacks or disadvantages these systems may present can be alleviated or eradicated considering the proposed measures.

At last but not least, before closing this section it is important to mention that the cost of acquisition and implementation of these systems in a hospital may be high. The main system and induced costs are related to costs of software and hardware, training, implementation, on-going maintenance and support. The dimension of this investment is variable, so it depends on the size of the hospital, the implementation cycle, the legacy systems involved and whether these systems can be integrated with the new software or not. However, various experts have commented on the costs of EHR implementation. For example, it has been estimated a total cost of \$19 million, approximately, for a 7-year long EHR installation in a 280-bed acute care hospital with 16 satellite clinics, a research institute, and a network of about 400 employed physicians (Menachemi and Brooks, 2006).

7. Conclusion

After the analyse, it is an undeniable fact that Electronic Health Records (EHRs) and Electronic Prescriptions (ePrescriptions) systems can lead to increase efficiency in the pharmaceutical supply chain of a hospital.

First of all, digitalization of information has a fundamental role. In comparison with handwritten prescription and paper-based drug charts, the computerization of information leads to a better durability, legibility, completeness and standardization of the records. As well, it is facilitated an accurate recording, display, transmission and exchange of information, what improves communication of electronic information between different stakeholders of the supply chain according to the IT system.

On the one hand, the ePrescription system offers to a hospital the possibility to electronically capture patient's prescription treatment plan according to patient's symptoms, medical tests analysis and decision pharmaceutical support tools and opens up the potential to exchange these prescriptions between the different workstations and stakeholders of the networked system within the supply chain (medical consultation – satellite pharmacies – Materials Management Department – pharmaceutical points-of-use). On the other hand, the EHR system offers to a hospital the possibility to electronically store all patient information and medical practices, with the opportunity to add support tools, and exchange this valuable information between the different workstations and stakeholders of the networked system within the supply chain (medical consultation – central pharmacy – pharmaceutical points-of-use and Hospital – Health insurers).

As a result, it is not just the flow of information that is improved, but also the quality of information that is stored and transmitted, which consequently may improve the traceability and efficiency of the hospital's physical flow.

The benefits these IT applications can have on the pharmaceutical supply chain can be manifold: from improving pharmaceutical prescribing and dispensing workflow to supporting new ways of working and pharmaceutical management and inventory control in hospitals. This way, EHRs and ePrescriptions have a beneficial impact on the primary activities of the value chain of the pharmaceutical supply chain. They improve

Inbound Logistics activities by facilitating the capture of valuable data, which can serve as a source of patient's data and lead to data extraction and statistical analysis to provide information to develop and/or optimize inventory control strategies and models; Operations and Outbound Logistics activities as they open up the potential to support new ways of working in inventory management and distribution (e.g., unlock the potential to interface these systems with other IT applications such as RFID or barcode scanning for a better traceability of pharmaceuticals); Marketing & Sales activities by improving the flow of information; and Service activities since pharmacists can have more working time available to devote to near-patient clinical activities (for example, in monitoring new treatments, assessing side effects and providing advice to other healthcare professionals).

EHR and ePrescription systems not only have a beneficial impact on the pharmaceutical supply chain, but also on the hospital enterprise. As seen, they allow improving the clinical system intraoperability and the security and confidentiality of patient's information, streamlining workflow for healthcare providers and having a cost reduction. These benefits improve the primary activities of the value chain of a hospital since Admission Logistics; Discharge Logistics and Marketing & Sales activities are mainly streamlined by improving the flow and quality of information and Care activities are improved thanks to streamlining workflow for healthcare providers and hospital's pharmacists.

All these advantages obtained by improving the efficiency of activities within the supply chain and the hospital enterprise can be grouped into one: improvement of the quality of care delivered to patients, which is the main goal of any hospital. By moving away from product and process-centered work towards patient-centered work, as has been seen, there is a reduction of the risk of pharmaceutical administration errors to patients. There is also opened up a possibility for the patient to get more and better involved in its own care.

At a regional, national and international level, the major objective of establishing homologated and standardized EHRs at the different healthcare facilities of the region is to set up a virtual portal for the storage of medical data and information,

electronically and easily accessible, in order to promote their interoperability, usability and health coordination. This way, it is allowed the free movement of patients, healthcare professionals and services across both Belgium, according to the Reference Directory service offered by the 2008 eHealth-Platform, and the Member States of the European Union, according to the Europe 2020 initiative in the healthcare sector.

Chapter 3: Roadmap for implementing EHRs in a hospital

1. Introduction

As has been seen in the first chapter, Huvenne (2012) analysed the current state of e-health and EHRs technologies in Belgium and proposed a model for a nation-wide working implementation for both fields, based on a compilation of information from various authors, organizations and interviewees. As a reminder, the model consists of the following five phases:

1. Preparation and promotion: Relates to the need to prepare the sector for the adoption of EHRs and its related aspects, which will lead to its implementation. Moreover, it also relates to the promotion of the changes that will need to take place within the different levels of the health sector.
2. Selection: Relates to both the selection and integration of existing systems that will answer to the needs of the sector.
3. Adoption: Refers to the moment when healthcare organizations start putting in place the efforts necessary so as to use EHRs to support their healthcare related activities.
4. Exploitation: Refers to the moment from which the consecutive various aspects of EHRs (preparation level and environment and system development) have been accepted as the required answers by users and that their usage is propagated to the predefined user groups.
5. Renewal/Reinvention: Aims at enabling implementation of EHRs to become dynamic.

According to the study, at a national level Belgium can be seen as soon leaving the preparation and promotion phase to enter the selection one, although at a regional level, the Réseau de Santé Wallon (RSW) hub can be said to have already reached the selection phase and entered the adoption one. As was seen before, the reason why the process of implementing and adopting EHRs at a national level, hand in hand with ePrescriptions, has developing slowly is mainly related to two factors. In the first place, because of the aspects related to security, privacy and confidentiality to both patients and medical practices and professionals around these systems, which are not in agreement by the different stakeholders of the sector. Moreover, political tensions

seem to exist between the Regional level hubs and the Federal eHealth-platform on the way to integrate regional and Federal initiatives. In the second place, the slow development of the project is due to the role and the methods used by the 2008 eHealth-platform are highly debated among institutions and medical professionals because of a lack of comprehension of the advantages linked to this service. In the second place, the slow development of the project is due to the role and the methods used by the 2008 eHealth-platform are highly debated among institutions and medical professionals because of a lack of comprehension of the advantages linked to this service. There is a low involvement of stakeholders in the processes, in particular medical professionals that are key users of these systems and who resist to change their ways of working due to a lack of knowledge regarding the impact that these technologies may have to their daily work and the healthcare sector, either at a regional, national or even international level.

Therefore, after having seen in the last chapter the positive impact that EHRs and ePrescriptions may have not only on the pharmaceutical supply chain of a hospital, but also to the healthcare facility contributing to a better treat and care of patients, and in order to streamline the process of implementing and adopting these systems in hospitals, in this third and last chapter we make two proposals. In the first place, we propose to present the study of the impact of EHRs and ePrescriptions to the stakeholders that will be linked, in one way or another, to the process of implementation. This way, all of them will be informed and aware of the main reasons why this action needs to be taken and the advantages that may be obtained. In the particular case of Belgium this step is very important whether we want to get medical professionals more involved in the process and encourage them to give it a proper shoot. After that, we propose a roadmap for implementing EHRs, hand in hand with ePrescriptions, in a hospital. It aims at setting steps or procedure to implement these systems in the healthcare facility coping with the barriers of implementation reviewed in order to make the process productive. This would path the way to move away from the selection phase to the following stages and symbolize the first step to shape hospital's EHR system, which then will allow the organization to join the regional, national and/or international EHRs network.

2. The implementation process of EHR and ePrescription systems

2.1. Preliminary definition

2.1.1. Definition of the objectives

The first step towards the development of any project is the setting of goals and targets. In this case, this involves a thorough analysis of all processes and activities that are currently taking place in a hospital and the needs of the stakeholders users of the IT applications. Then, issues, inefficiencies and dysfunctions as well as opportunities for improvement have to be identified.

Finally, the aim, the purpose and the scope of implementing EHR and ePrescription systems have to be clearly defined.

2.1.2. Study of the economical and financial feasibility

Before starting with the implementation of EHRs and ePrescriptions in the healthcare facility, it is necessary to evaluate whether the implementation of these systems is feasible or not.

At first, to conduct a feasibility study, it is required an analysis of the current technical and operational resources and the ones required by the project (tools, knowledge, skills, experience, etc.). In the second place, it refers to the economic and financial resources that are needed to develop the activities or processes and/or to obtain the basic resources that should be considered (cost of time, cost of acquiring new resources and cost of implementation) in a EHRs implementation process.

This analysis aims at estimating the costs that are involved from the acquisition and development up to the implementation of EHR and ePrescription systems which, according to the estimated benefits that will be obtained, makes it possible to estimate the return of investment (ROI) in order to justify the investment.

2.1.3. Selection of the software provider

In the case the project is feasible, it is possible to proceed with the selection of the provider of the EHR (EMR and EPR) and ePrescription systems.

The first step is to study the different options of providers available on the market (for instance, it would be interesting to take into consideration their previous experience in similar organization and support human and financial resources). Subsequently, technical and economic proposals for the specific needs of the institution should be requested to the providers that may present homologated systems (such as Mediwin, EMR for physicians, OmniPro or the one offered by Cegeka Healthcare) that comply with the law. Once the preliminary solutions have been presented, it is important to involve in decision-making the representative medical, operational and administrative staff from areas of the hospital that will be affected by the implementation of the systems. Their agreement and approval will enrich the solution and decrease possible resistance to change.

One of the important points that should be taken into consideration when choosing the provider of the software is the additional service that offers. At least, some recommended services are:

- License of the software solution and additional components required.
- Due to the amount of software that are usually operating in a hospital for different processes, it is interesting to assess the feasibility of integration of these existing software to the new one. This way, user does not have to use multiple software at once.
- Complementary technological infrastructure.
- Training program for the personnel users and administrators of the system.
- Consultancy and monitoring during the implementation process.
- Maintenance and technical support to the systems and the technological infrastructure involved.

2.1.4. Project planning

Project planning relates to the use of schedules such as Gantt charts to plan and subsequently report progress within the project environment.

After the project scope has been defined, all activities needed to carry out EHRs and ePrescriptions implementation should be listed and grouped into a work breakdown

structure. For an accurate planning, necessary resources and costs for each activity and the organization of the different areas of the project (project plans; workloads and management of teams and individuals) should be included.

Once established and accepted, the plan should become the baseline of the project. The progress of the project should be measured on this alignment throughout its life.

2.2. The process of implementing EMRs and EPRs

2.2.1. Technology infrastructure

The first step to proceed with the implementation of EHR and ePrescription systems is the selection of the data processing equipment required in every area involved in the project.

Some recommendations to assess the vendor's proposals that may be interesting to take into account are outlined hereunder:

- Amount and price of the new equipment: refers to the amount of new equipment needed for the new system and the value of their acquisition.
- Installation requirements: Refers to the power requirements and lighting required for the new equipment.
- Equipment performance: relates to the capabilities and both technical and operational characteristics as well as to the amount of data that can be processed in a specified period of time.
- Support and assistance provider
- Contract maintenance: refers to services for maintenance of equipment in good operation conditions.
- Training: Relates to the offer of training programs to the personnel that will use the equipment in order to ensure a proper operation.
- Other considerations: availability of the equipment (delivery time), availability of compatible equipment that could process data in an emergency, overtime costs, etc.

2.2.2. Implementation of the software

Once the software for the systems and the necessary technological infrastructure have been acquired, it is possible to proceed with the implementation of the software in the hospital. In this project it is presented a progressive dissemination of the use of EHR and ePrescription systems based on three phases:

First phase: Mechanization of patients' admission

This phase aims at creating and updating patient's records with basic information such as name, age and sex in order to obtain general or specific patient's lists. In this way, there is an opportunity to improve both the patient care by facilitating and regulating their access to medical services as the organization of work planning by means of a rational distribution of time and professional activities.

The clinical staff affected at this first stage is mainly the administrative and nursing personal.

Second phase: Deployment of EMRs and ePrescribing at the medical consultations

The objective of this phase is the introduction of Electronic Medical Records at physician's consultations and Electronic Prescribing at both physician's consultations and satellite pharmacies of the hospital. This way, on the one hand it is introduced the digitalization of all patient information; diagnosis and treatment plan (adding medical tests, if needed) shaping patient's personalized records. On the other hand, after that, physicians open an electronic prescription according to the prescribed treatment plan, which is transmitted to the corresponding satellite pharmacy in order to trigger the pharmaceutical administration to the patient.

The clinical staffs affected at this second stage are the administrative personal, nurses and physicians.

Third phase: Dissemination of EMRs and ePrescriptions

The aim of this phase is to integrate to the network other areas that may take advantage of these systems. For instance, implement or interlink the ePrescribing application to the Materials Management Department and the EMRs to the central pharmacy.

Forth phase: Deployment and dissemination of EPRs

The scope of this phase is to integrate patients to the network as well by using EPRs. Healthcare providers should promote these systems and encourage patients to take part in the network.

During the implementation process is very important to conduct **training programs at each phase of the process to every area of the hospital and to the different clinical staff involved** (at the forth phase, it is not necessary to conduct training programs to patients. Providing them with a clear Instructions Manual of how to use EPRs should be enough). This should go hand in hand with a monitoring program aiming at assessing the performance of users of the systems involved in the process and the systems themselves, and thus analyse their productivity.

2.3. Renewal / Updating

At last but not least, keeping the software up-to-date is the last step to guarantee a proper running and performance of the systems.

3. Conclusion

The aim of this part of the thesis was to provide a general guideline on how to disseminate the use of EHRs by implementing EMRs and EPRs in one particular hospital in order to streamline the project of adopting EHRs nationally in Belgium.

The roadmap proposed is based on three stages. At first, there is the preliminary definition phase, which aims at laying the foundations for the project by defining their aim, purpose and scope; studying its economical and financial feasibility; carrying out an accurate selection of the software provider; and finally establishing a baseline for the development of the project. Secondly, there is the process of implementing EMRs and EPRs, phase that include an action plan to provide the hospital with the technology infrastructure needed as well as set the basis for software's implementation and adoption. Finally, the last phase can be seen as a reminder for the update of the system.

The roadmap approach seeks to set a pathway to establish EHRs in hospitals by emphasizing the role to involve the stakeholders of the systems in the planning and project development. Their participation in the decision-making during the first phase plays an important role so enables to contribute to reduce possible future resistance to change of the users of the systems that may appear. Moreover, the importance of conducting training programs is also outlined. This will help to avoid inefficiencies that may arise during the implementation process due to a lack of knowledge of the functioning, operability and usability of the systems. This fact will be key factor to determine the future success of the implementation and adoption of the EHR system in a hospital.

Conclusions

The main objective of this thesis was to analyse the impact of the digitalization of diverse processes and activities that take place in a hospital under the functionality of Electronic Health Record (EHR) systems upon the pharmaceutical supply chain of a hospital.

The first two chapters of the thesis have focused on this aim. In the first one it was introduced the concept and found out the main reason of the increased adoption of Electronic Health Records (EHRs) in many hospitals around the world, which for Belgium, case of study, involved Electronic Medical Record (EMR), Electronic Patient Record (EPR) and Electronic Prescription (ePrescription) systems. For the case of Belgium, it was found that many initiatives have been taken towards the implementation of EHRs at a regional and national level, the last one under the eHealth-platform proposal in 2008. Other initiatives around the adoption of these IT applications have been taken place internationally, such as in America, Australia or even at a European Union level with the Europe 2020 project launched by the European Commission. The main goal of all these initiatives is to promote interoperability, usability and health coordination between healthcare facilities at the different levels in order to improve the quality of care and cure of patients, allowing the free movement of patients, healthcare professionals and services.

In the second chapter it was introduced the concept of hospital logistics, focusing the attention on the *modus operandi* of a hospital pharmaceutical supply chain. Then, an analysis of the management and inventory control for pharmaceuticals in hospitals before the introduction of EHR systems was provided. With the help of Porter's model, there were identified the main activities of the chain that generate value for the primary activity of a hospital: the care of patients. Afterwards, it was identified how the adoption of EHRs, by using ePrescriptions, may improve or add value to the logistic pharmaceutical chain of a hospital. It was concluded that the digitalization of information has a fundamental role since durability; legibility; completeness; and standardization of the records are improved in comparison with hand-written

prescriptions and paper-based drug charts. Furthermore, the use of EHRs not only improves the flow of data and information through the healthcare facility, which consequently may improve the traceability and efficiency of the hospital's physical flow, and between other stakeholders and institutions of the healthcare sector, but also the quality of information that can be stored and exchanged. This is due to the fact that an accurate recording, display, transmission and exchange of data and information are facilitated. As a result, these benefits have a positive impact on the pharmaceutical supply chain by improving pharmaceutical prescribing and dispensing workflow and supporting new ways of working and pharmaceutical management and inventory control policies in hospitals. Finally, in this second chapter was also arrived to the conclusion that the adoption of EHRs usage may have a beneficial impact on the hospital enterprise as well. All together, leads to a move away from product and process-centered towards patient-centered work, that is, an improvement of the quality of care delivered to patients, main concern of any hospital.

As has been seen, logistics play a strategic role within a hospital. Its involvement goes beyond the simple transferring of supplies in response to the needs of patients and clinical staff; it has become a major stakeholder in developing solutions to the various logistics problems faced by a hospital and produce new organizational routines.

Taking into account that the implementation of EHRs in Belgian hospitals is still at an early stage and considering the beneficial impact of EHRs in both the pharmaceutical supply chain and the main hospital enterprise, in the third chapter of this thesis was presented a roadmap to set the baseline to establish an EHR system in a hospital.

To sum up, the adoption of EHRs is a good opportunity to improve business processes taking place within a hospital and at a highest level, adding value at the quality of care delivered to patients as well.

Further research

In this thesis has been seen what the initiative behind the Europe 2020 project launched by the European Commission in the healthcare sector is. It has also been analysed the impact of this project in the pharmaceutical supply chain of a hospital and the main organization, and has been proposed a roadmap for implementation EHRs and ePrescriptions in hospitals trying to cope with barriers of implementation that take place in the current situation of Belgium. However, there is a need to further investigate on a barrier of adoption that is nowadays limiting the adoption of these systems in the country and has not been studied deeply in this project because of its complexity and lack of knowledge and information on the topic. That is, further investigation on the issues and disagreements regarding the privacy, security and confidentiality of these systems, as well as the existing political tensions that seem to exist between the Regional and Federal level of the country, in order to propose an action plan to combat this barrier. It would complement the study of this work.

Moreover, there is a need to elaborate a progress evaluation tool for the roadmap proposed. That is, create a hospital performance measurement to assess the performance of the process of implementation and adoption of EHRs and ePrescriptions in the hospital. After that, it would be necessary to turn this roadmap into reality. That is, to carry out the process of implementing and adopting these systems and feed up the indicators set up with real data.

As a last proposal for further research, how the data and information contained in EHR and ePrescription systems may improve and optimize the existing strategies or models for inventory control in hospitals may be a potential interest of study.

List of acronyms and abbreviations

BCMA	Bar Code Medication Administration
CPOE	Computerized Physician Order Entry
DG SANTE	Director-General for Health and Food Safety
DG INFO	Director-General for Information Society and Media
DMG	Dossier Médical Global
DMI	Dossier Médical Informatisé
EC	European Commission
eHAP	eHealth Action Plan
EHR	Electronic Health Records
eMAR	Electronic Medication Administration Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
ePrescription	Electronic Prescription
FPS Social Security	Federal Public Service Social Security
GP	General Practitioner
HIT	Health Information Technology
ICT	Information and Communication Technology
IT	Information Technology
KCE	Belgian Health Care Knowledge Centre
MTO	Make-to-order
MTS	Make-to-stock
NIHDI	National Institute for Health and Disability Insurance
PCU	Patient Care Unit
PHR	Patient Health Record
RSW	Réseau de Santé Wallon
RFID	Radio Frequency IDentification
RTD	Research and Technological Development

SUMEHR Summarised Electronic Health Record
WHO World Health Organization

ANNEX

Interviews to Mr. Bruno, Warehouse Manager at Hospital Logistics

1st Interview: I am currently looking for information regarding the implementation of Electronic Health Records (EHR) and Electronic Prescriptions (ePrescriptions) in Belgian hospitals. Do you have any experience with these systems? If not, may I have your opinion regarding this topic?

No problem, it's always good to hear new ideas. But unfortunately I don't have any experience with ePrescriptions or Electronic Health records. But yes, I can give you my opinion on this and how I relate to this.

I'm convinced that ePrescriptions can give the right transparency in the chain to decrease stock levels and still give the same high service level. I know this from my years in automotive. There it's standard to work with f.e EDI, I have a lot of experience in "in sequence" deliveries. The more information you get closer to the source where the need is created, the better.

My experience with our customers (f.e UZ leuven, different other bigger hospitals in Belgium) is that hospitals are only now thinking to be more cost effective in general and cost effective with this kind of things. Only now because they are still receiving a big part of there budget from the government. So the need to be more cost effective isn't that high as say in the automotive. (f.e Edi is custom for more than 20 years in the automotive)

But I can imagine a hospital pharmacy creating orders based on ePrescriptions. Very accurate info to base orders on. More accuracy, less "noise" in data, less stock needed (Bullwhip effect?). Nowadays, we deliver our orders based on the kanban principle or two-bin system.

2nd Interview: I am currently working on analysing inventory control and management in hospitals. Do you know the criteria/models/strategies that hospitals follow to replenish inventory? Are they ordering purchases according to Multiperiod Inventory Models (such as Fixed-Order Quantity Model or Fixed-Time Period Model)? Perhaps, they also make orders on Bulk Ordering (with or without time-phase delivery)?

I will try to explain it, as you noticed it's a complex process.

We are owners of the stock. The main strategy that we use is min-max (variable quantity and period) strategy to create the orders to our suppliers. This is based on historical data of the last 3 months. Then we increase minimum stock when f.e supplier isn't reliable, supplier geographical location, peaks in demand, product changes, etc.

Of course we take into account moq. And in other companies I used eoq. I like eoq as it's a robust formula. If you are 50% off it's still a good order qty. A difference that I always see is that I look at the stock in days and volume. As I need to monitor this for capacity in my warehouse. But my CEO looks at the stock in euros. It just needs to be a combination of the two.

We do this for all of our articles. This is something that I tried to persuade my colleague (I'm not responsible for the actual calculation). I'm like the idea that I got from a book I have read.

The idea is that you use different strategies for fast, middle and slow movers.

- Fast movers: variable qty and variable period
- Middle movers: variable qty and fixed period
- Slow movers: frame orders. Big orders in one time. Less effort and management.

I don't know if you can read Dutch. The book that I mentioned is a great practical book. You can download it, here is the link: www.durlinger.nl/files/boeken/Effectief-voorraadbeheer.pdf

ANNEX I: 2004 e-Health Action Plan: Overview of actions

Action	Time	Responsibility
NB. Within each of the issues facing the e-Health sector (addressing common challenges, pilot actions, and working together and monitoring practices), we list the actions to be taken <i>sequentially</i> .		

Issue 1: Addressing common challenges		
<p>The Communication on patient mobility is presented as part of an overall strategy on health care together with the present communication and that on the open method of coordination.</p> <p>Work is already underway to improve information on patient mobility and mobility of health professionals at European level, and is being taken forward in particular through the health systems working party under the information strand of the public health programme.</p>	2004	Commission
By mid 2005, the Commission should produce a summary of European best practices as guidance for Member States.	Mid-2005	Commission
By end 2005, each Member State is to develop a national or regional roadmap for e-Health. This should focus on deploying e-Health systems, setting targets for interoperability and the use of electronic health records, and address issues such as the reimbursement of e-Health services.	End 2005	Member States
By end 2006, Member States, in collaboration with the European Commission, should identify a common approach to patient identifiers. This should take account of best practices and developments in areas such as the European Health Insurance Card and identity management for European citizens.	End 2006	Member States, Commission
By end 2006, Member States, in collaboration with the European Commission, should identify and outline interoperability standards for health data messages	End 2006	Member States, Commission

and electronic health records, taking into account best practices and relevant standardisation efforts.		
By end 2006, a collaborative approach should be undertaken among Member States to supporting and boosting investment in e-Health.	End 2006	Member States
By end 2007, Member States should adopt conformity testing and accreditation schemes following successful best practices.	End 2007	Member States
During the period 2004-2008, Member States should support deployment of health information networks for e- Health based on fixed and wireless broadband and mobile infrastructures and Grid technologies.	2004-2008	Member States
<p>By end 2009, the European Commission, in collaboration with Member States, should undertake activities to:</p> <p>Set a baseline for a standardised European qualification for e-Health services in clinical and administrative settings.</p> <p>Provide framework for greater legal certainty of e-Health products and services liability within the context of existing product liability legislation.</p> <p>Improve information for patients, health insurance schemes and providers regarding the rules applying to the assumption of the costs of e-Health services.</p> <p>Promote e-Health with a view to reducing occupational accidents and illnesses as well as supporting preventive actions in the face of the emergence of new workplace risks.</p>	End 2009	Commission, Member States
Issue 2: Pilot actions: accelerating beneficial implementation		
By end 2005, a European Union public health portal will give access to European level public health information. Health portals shall offer dedicated information on safety at work and health risks in the	End 2005	Commission

workplace. By end 2005, there will be a strengthening of early warning, detection, and surveillance of health threats through enhanced information and communication technologies tools.		
Promoting the use of cards in the health care sector. Adoption of implementation of an electronic health insurance card by 2008.	2008	Commission, Member States
By end 2008, the majority of European health organisations and health regions (communities, counties, districts) should be able to provide online services such as teleconsultation (second medical opinion), e-prescription, e-referral, telemonitoring and telecare.	End 2008	Member States
Issue 3: Working together and monitoring practices		
In 2004, a high-level e-Health forum should be established, the role of which will be to support the Commission services. It should involve all necessary stakeholders, including at national, regional, or local hospital authority levels, thereby enhancing the understanding of the Commission services with regard to the current and planned status of development of e-Health in Member States. Its task should be to follow up the various roadmaps, and to identify further actions including a strong focus on users and access for all to e-Health, as well as to develop a strong evidence basis for the case for e-Health. The work of the e-Health forum will also be closely associated with the implementation of the Community Public Health Programme.	2004	Commission
By the start of 2005, Member States, in collaboration with the European Commission, should agree on an overall approach to benchmarking in order to assess the quantitative, including economic, and qualitative impacts of e-Health.	Start 2005	Member States, Commission
By the end of 2005, the European Commission, with	End 2005	Member States

contributions from Member States, should establish an effective way of disseminating best practices and supporting actions within the European e-Health area.		
An assessment of e-Health developments should be completed ahead of the second part of the World Summit to be held in Tunis in 2005.	2005	Commission, Member States
During the period 2004-2008, Member States with the support of the European Commission will organise special events such as high level conferences in order to disseminate best practices.	2004- 2008	Member States, Commission
During the period 2004-2010, every two years, the European Commission will publish a study on the state of the art in deployment, examples of best practices, and the associated benefits of e-Health.	2004 - 2010	Commission

Table 4 Overview of the actions in the 2004 e-Health Action Plan (Liikanen, 2004, pp. 23-26)

ANNEX II: Organization of the Health system in Belgium

In 2010, The European Observatory on Health Systems and Policies has, in collaboration with the KCE (Belgian Health Care Knowledge Centre), published its latest version of a series of reports entitled “Health In Transition” for Belgium. As this publication provides a detailed description of Belgian health system and of reform and policy initiatives in progress or under development in the country, is going to serve as a main basis for this section.

So as to give some perspective to the organizational structure of the Belgian health sector, it is useful to first note the **general political structure of Belgium**.

“Belgium is a federal state with a parliamentary democracy. There are three levels of government – the federal government, the federated entities (three regions [based on territory: the Flemish, the Walloon and the Brussels-Capital regions] and three communities [based on language and culture: Flemish, French and German communities) and the local governments (provinces and municipalities).” (Gerken and Merkur, 2010, p.29)

Due to the fact that there are both French and Dutch speaking individuals living in the Brussels-Capital region, three institutions were created so as to enable community specific policies to be conducted in the region: the French Community Commission (COCOF), the Flemish Community Commission (VGC) and the Joint Community Commission (GGC-COCOM).

There is a “repartition of competences between these three levels of power (federal, federated and local authorities)” (Gerken and Merkur, 2010, p.40).

As far as the **Health system in Belgium** is concerned, its responsibilities for healthcare policy are shared between the federal state and the communities. The three regions handle territorial matters while the health care responsibilities of the provinces and municipalities are limited, based on general advisory functions.

“The federal level is responsible for the regulation and financing of

compulsory health insurance; the determination of accreditation criteria (that is, minimum standards for the running of hospital services); the financing of hospital budgets and heavy medical equipment (...); legislation covering different professional qualifications; and the registration of pharmaceuticals and their price control. At the level of federated entities (regions and communities), governments are responsible for health promotion and prevention; maternity and child health services; different aspects of elderly care, home care, coordination and collaboration in primary health care and palliative care; the implementation of accreditation standards and the determination of additional accreditation criteria; and the financing of hospital investment. To facilitate cooperation between the federal level and governments of regions and communities, interministerial conferences are regularly organized.” (Gerken and Merkur, 2010, p.48)

The figure below shows a general schema of Belgian Health system organization at the federal level and the level of federates entities, with the most important departments, agency and advisory bodies.

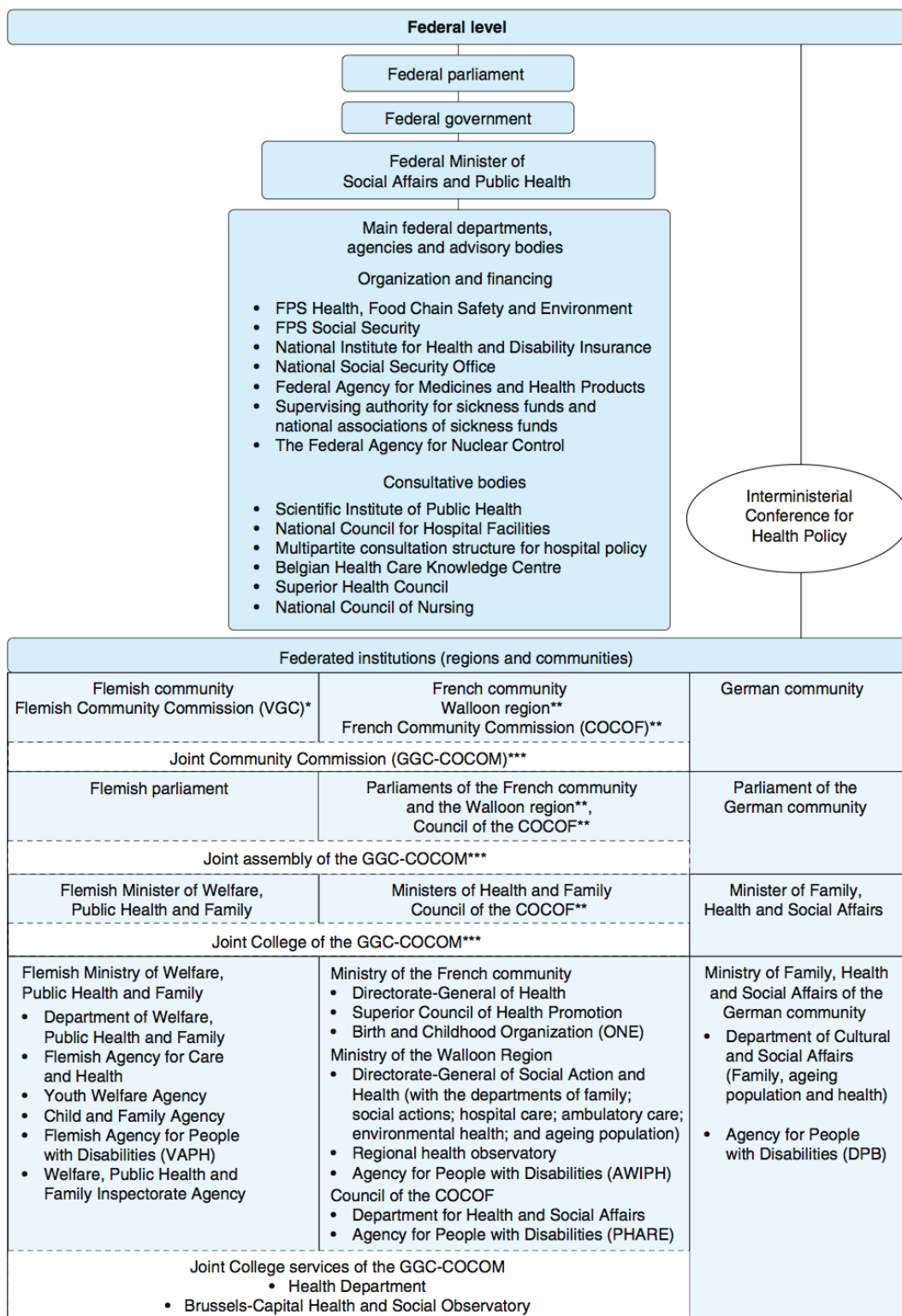


Table 5 Organization of the Belgian healthcare system (Gerken and Merkur, 2010, p.25)

Below, it is defined the overall objective of each entity represented in the above scheme.

FEDERAL LEVEL

“At the federal level, the parliament is the legislative body. The federal government and the Minister of Social Affairs and Public Health are the executive bodies” (Gerken and Merkur, 2010, p.56). The main federal departments, agencies and advisory bodies are described as follows.

Entities of organization and financing activities:

The FPS Health, Food Chain Safety and Environment

It consists of four departments:

- Health Care Facilities Organization: it is “in charge of the organization, planning rules, recognition criteria, evaluation of the quality of medical and nursing practices in health care facilities, registration of data and financing of inpatient health care facilities, as well as the implementation of patients’ rights” (Gerken and Merkur, 2010, p.58).
- Primary Health Care and Crisis Management: its responsibilities include “the recognition and planning of activities for health care professionals, and designing a policy for the prevention and monitoring of health crisis, including crisis scenarios, emergency plans and organization of relief” (Gerken and Merkur, 2010, p.59). Apart from that, the department is responsible for the organization of emergency medical assistance, as well.
- Animal, Plant and Foodstuffs: it is “responsible for policies, notification, standardization and inspection in the domains of food, food chain safety, alcohol, tobacco, cosmetics and pesticides” (Gerken and Merkur, 2010, p.59).
- Environment: department “responsible for matters concerning climate change, biodiversity and genetically modified organisms, marine environment, chemical substances, electromagnetic fields, product’s inspection and environmental rights” (Gerken and Merkur, 2010, p.59).

The FPS Social Security

This entity “sits at the crossroads of all legislation that contributes to the social security of citizens”. It ensures that everybody “appropriately enjoys social rights and aims to ensure the viability of a system of support and solidarity that is as efficient as it is fair” (Gerken and Merkur, 2010, p.59).

National Institute for Health and Disability Insurance (NIHDI)

The NIHDI has a series of important tasks due to it is “responsible for the general organization and financial management of the compulsory health care and benefits insurance” (Gerken and Merkur, 2010, p.60). It is composed of five departments:

- Health Care Department: it is “charged with the administrative and financial management of compulsory health insurance” (Gerken and Merkur, 2010, p.60).
- Department for Medical Evaluation and Inspection: it aims to inform “the health care providers about the correct application of the health care and benefits insurance regulation, more specifically to prevent administrative errors” (Gerken and Merkur, 2010, p.60).
- Benefits Department: it is in charge of “determining criteria and guidelines concerning benefits in case of incapacity for work, and in case of maternity, paternity or adoption leave” (Gerken and Merkur, 2010, p.60).
- Department for Administrative Inspection: it is “responsible for monitoring legal and other regulations of the sickness funds (...) also in charge of sanctioning non-adherence to the rules” (Gerken and Merkur, 2010, p.60).
- General Support Departments: it offers “strategic” support to the other departments of the NIHDI (human resources management, ICT support, etc.).

National Social Security Office (NSSO)

The mission of the NSSO is the “central institution in the social security system for private sector employees and most civil servants” (Gerken and Merkur, 2010, p.59).

The Federal Agency for Medicines and Health Products

It aims to ensure the quality, safety and effectiveness of pharmaceuticals for humans and animals.

Sickness funds

The overall purpose of this entity is to provide insurance to the sickness funds as well as being in charge of medical auditing. "Sickness funds are private non-profit-making organizations with a public interest mission" (Gerken and Merkur, 2010, p.64). They are active members of both the executive and the advisory committees of the NIHDI, from whom receive their financial resources.

The Supervising Authority for Sickness Funds and National Associations of Sickness Funds

"General control over the sickness funds and the national associations of sickness funds" (Gerken and Merkur, 2010, p.64) is exercised by this entity. This way, it is ensured that the services and activities established by the sickness funds and their associations are in agreement with the Sickness Funds Act and, moreover, that administrative, accounting and financial regulation is respected. Apart from that, it aims to evaluate the management performance of the sickness funds.

The Federal Agency for Nuclear Control

Its purpose is to "ensure that the population and the environment are effectively protected against the dangers of ionizing radiation." (Gerken and Merkur, 2010, p.64)

Consultative bodies:

Scientific Institute of Public Health (IPH)

The mission of the IPH is to provide the federal and federated government with knowledge, based on scientific evidence, of health promotion and disease prevention. Its main activities "consists of four operational directions: communicable and infectious diseases; food, medicines and consumer safety; public health and surveillance; and expertise, service provision and customer relations." (Gerken and Merkur, 2010, p.65)

National Council for Hospital Facilities

This entity “plays an important role in the formation of Belgian health care policy by advising the Minister of Social Affairs and Public Health on issues related to hospital planning, accreditation and financing” (Gerkens and Merkur, 2010, p.65).

Multipartite consultation structure for hospital policy

“The goal of this consultative structure is to build bridges between the NIHDI (providing insurance for inpatient care) and the FPS Health, Food Chain Safety and Environment (responsible for the organization and quality regulation of inpatient care) to improve administration in the hospital sector.” (Gerkens and Merkur, 2010, p.65)

Belgian Health Care Knowledge Centre (KCE)

The KCE provides scientific support to health care decision-makers. Working together with all main stakeholders in the health care sector, the entity

“is active in producing recommendations and carrying out research in the following areas: the analysis of clinical practice and the development of guidelines for Good Clinical Practice (Good Clinical Practice); the assessment of medical technology and medicine (health technology assessment (HTA)); and the study of health care organization and financing (Health Services Research, including research on equity and patient behaviour).” (Gerkens and Merkur, 2010, p.66)

Superior Health Council

It aims to link government policy and scientific community in public health field. “It deals mostly with the following areas: mental health (...), physical and chemical environment (...), nutrition (...), and biological problems” (Gerkens and Merkur, 2010, p.65).

National Council of Nursing

The mission of this entity is to provide advice and recommendations to the Minister of Social Affairs and Public Health on “all matters relating to the art of nursing and particularly on the practice of nursing and required qualifications” (Gerkens and

Merkur, 2010, p.67).

FEDERATED LEVEL

Flemish Community

For the Flemish community, “the Flemish Agency for Care and Health of the Flemish Ministry of Welfare, Public Health and Family is responsible for the development, implementation and evaluation of policies concerning regional health and care responsibilities.” (Gerken and Merkur, 2010, p.67)

French Community

For the French community, “public health policies are administered by the Directorate-General of Health within the Ministry of the French Community” (Gerken and Merkur, 2010, p.68). Moreover, the Birth and Childhood Organization Office (ONE) and the Superior Council of Health Promotion are agencies involved in public health policy in the French community as well.

However, some of the community’s responsibilities were transferred to the Walloon region. For example, a “regional Health Observatory was also set up in the Walloon region to improve health in the region and to contribute to health information” (Gerken and Merkur, 2010, p.68).

German-speaking Community

For the German-speaking community, it is the Department of Cultural and Social Affairs of the Ministry of the German-speaking Community that “is responsible for matters related to public health and health promotion.” (Gerken and Merkur, 2010, p.69)

ANNEX III: List of SUMEHR contents

SUMEHR contents	
Date of creation	
Author	
Patient identification	
Patient presentation	* Family name
	* Forenames
	* Sex
	* Birth date
	* Usual language
Contact person	
Risks	* Allergies
	* Adverse drug reactions
	* Social factors
	* Other factors
Relevant personal antecedents	* Standardisation: IBUI and ICPC-2 and ICD10
	* Begin date
	* Text
Relevant medications	* CNK (Code National(e) Kode) or other Id (if no available CNK)
	* Administration information
	* Instructions for patient
	* Begin date
	* End date
	* Text
Vaccination status	* Administrated <ul style="list-style-type: none"> • CNK and/or ATC (Anatomical Therapeutic Chemical-code) • Date
	* To be administrated <ul style="list-style-type: none"> • CNK and/or ATC • Date

Table 6 List of SUMEHR contents (Devlies et al., 2010, pp.39-40)

ANNEX IV: Legal and regulatory facilitators

Legislation on medical Records

In Belgium, over 225 medical record related Royal Decrees have been issued, between January 1st 1999 and October 31st 2008. 25 of these were specifically dedicated to the “electronic medical record”. The official start of dealing with the contents of electronic medical records was marked by the Law on “Social Affairs” in 1999⁴, empowering the king to define minimal (quality/functional) criteria to medical / healthcare software in order to be homologated by the Ministry of Health. This law article applies to medical records as well as to nursing records. Another important piece of legislation regarding eHealth was the Royal Decree (KB/AR) of May 3rd, 1999, which created the commission for „Norms related to telematics in support of the healthcare sector.“ A decree of the same date also defined the minimal content of a Hospital Medical Record, and was completed by the Royal Decree (KB/AR) of April 16th, 2002.

Legislation on ID Cards

Legislation which helped prepare national identification registers and cards includes the law of 25th March 2003 on the legal framework of electronic ID cards. It modified the law of 8th August 1983 (organising a national registry of physical persons) and the law of 19th July 1991 (on population registers and identity cards). Additional specifications on the topic were provided by the Ministerial Decree of 26th March

⁴ Law on “Social Affairs” of January 25th, 1999 RD (KB/AR), adding an Article 45 to the KB/AR 78. In addition, the Royal Decree (KB/AR) of 3rd May 1999 defined the minimal content of a Hospital Medical Record, and was completed by the Royal Decree (KB/AR) of 16th April 2002. Such a record is to contain the following information: Identity of the patient; Personal Health History; Family Health History; Actual Diseases or Problems or Health Issues; Data about / from previous patient contacts and hospitalisations; Results of clinical, imaging, lab, functional and histo-pathological test; Reports / advices from consulted health care professionals; Provisional and/or final diagnosis for the actual stay; Treatment. For surgical treatments (16 April 2002): the intervention’s and anaesthetist’s report; Evolution of the affection; If applicable the report of the autopsy; Copy of the discharge letter; Specific data regarding the use of “blood products”.

2003 on the format of electronic ID cards, the Royal Decree of 1st September 2004 on the generalisation of electronic ID cards, and the Royal decree of 18th October 2006 on the eID document for Belgian children under 12.⁵ Furthermore, the legislation on the electronic signature from 17th March 2003 defined certain legal aspects of information society services.

There is no specific law regarding telemedicine services. In this field, so far the general legal rules regarding care provision and privacy protection apply.

Patient rights

Patient rights, which are here mainly described in relation to medical records, are derived from two Belgian legislative sources: the Privacy Legislation (Law of 8th December 1992, published 18th March 1993, enacted regarding the processing of personal data by the Royal Decree of 13th February 2001, published on the same day⁶) and the law on patient rights⁷. Patient rights legislation has been adopted since 22nd August 2002, (publication 26th September 2002)⁸.

⁵ European Communities 2007

⁶ On 11th December 1998, the Privacy Act was adapted to the European Directive 95/46/EC. The transposition of this directive into Belgian law led to fundamental changes in the Privacy Act, making a new implementing decree necessary. This Royal Decree lays down:

- the conditions authorizing the further processing of personal data for historical, statistical or scientific purposes;
 - the conditions for processing sensitive data;
 - the way in which a person whose data are processed may exercise his rights (access, rectification, deletion of his data);
 - the way in which the automatic processing of personal data has to be notified.”
- Commission for the protection of privacy,
<http://www.privacycommission.be/en/legislation/national>

⁷ Centre for Biomedical Ethics and Law of the Catholic University of Leuven

⁸ In Belgium, there is a difference between the date of adoption of a law and the date of the publication of the law. A law applies at earliest when published in the official Journal. But usually, when indicating a specific the date of adoption is used.

Opting-in model for medical records

Patient rights legislation with relevance to the creation of electronic patient records in Belgium prescribes the opting-in model. This means that by law explicit consent is required (except in emergency medicine). However, the forms in which consent can be given are not clearly defined. It does not always have to be in written form. Consent can be implicit if the treating physician can reasonably derive consent from the behaviour of the patient (e.g. patients presenting themselves for a diagnosis and/or treatment). The collection of the data has to be fully in line with the privacy protection legislation of natural persons.

Data Access rights for patients

Citizens have a right to be informed of the information contained in their medical records. The information provided has to be clear. However, the patients can also exert their right "not to know" and the physician in charge can invoke "therapeutic exception rules" if he/she thinks that providing the information is detrimental for the patient. Both, patient or treating physician, can decide to involve a trustworthy "go-between" or a custodian. In that case, therapeutic exception can be waved in favour of the custodian. Personal notes made by the physician remain personal and do not have to be communicated, though the legal definition of "personal notes" is not clear.

Generally, the patient has read-only access to his/her patient record. However, according to patient rights legislation patients can demand that "documents" be attached to their medical record, but neither is the sort of document specified, nor is there any provision for patients making any additions themselves. Likewise, the patient cannot directly delete data, but he/she can demand deletion of data, hide certain types of information and bar certain healthcare providers from access to the healthcare record. According to privacy legislation, a citizen can either demand the correction, removal or forbid the use of personal data that is incorrect, incomplete, not fit for the purpose or unlawfully collected or kept (e.g. after expiry of the recording period). These rights are not mentioned in the legislation on patient rights. The patient keeps the right to withdraw his/her consent. Emergency medicine is in the first instance governed by the penal code (art 422bis) where life threatening situations are

dealt with, often in a context without recurrence to consent or preferences of the patient and with insufficient time to contact a third party on his behalf.

Data Access for patient representatives

A third party, for example parents or other family members or any other person related to the patient, cannot gain access to personal data without consent of the data subject, unless they have legal custody on the data subject (e.g. in case of minors or mentally handicapped persons). According to patient rights legislation, a citizen can consent and even demand that a trustworthy person has access to his medical personal data on this behalf. In the case of therapeutic exception, the treating physician can even propose this initiative himself.

Secondary data use

Secondary use of (patient) data is possible, provided that the rules in the Belgian legislation (which is an instantiation of the EU data protection directive) are followed. If personal health data are concerned, explicit patient consent is required in all cases where it can be obtained.

(Good guidelines are available at the website of the Belgian Data Registrar⁹. There are recommendations that whenever possible totally anonymous data should be used, if not, encoded (i.e. de-identified) data should be used. In a very last instance and under strict conditions, personal data can be used.)

⁹ Commission for the protection of privacy

ANNEX V: Impact of logistics on the cost structure of a hospital

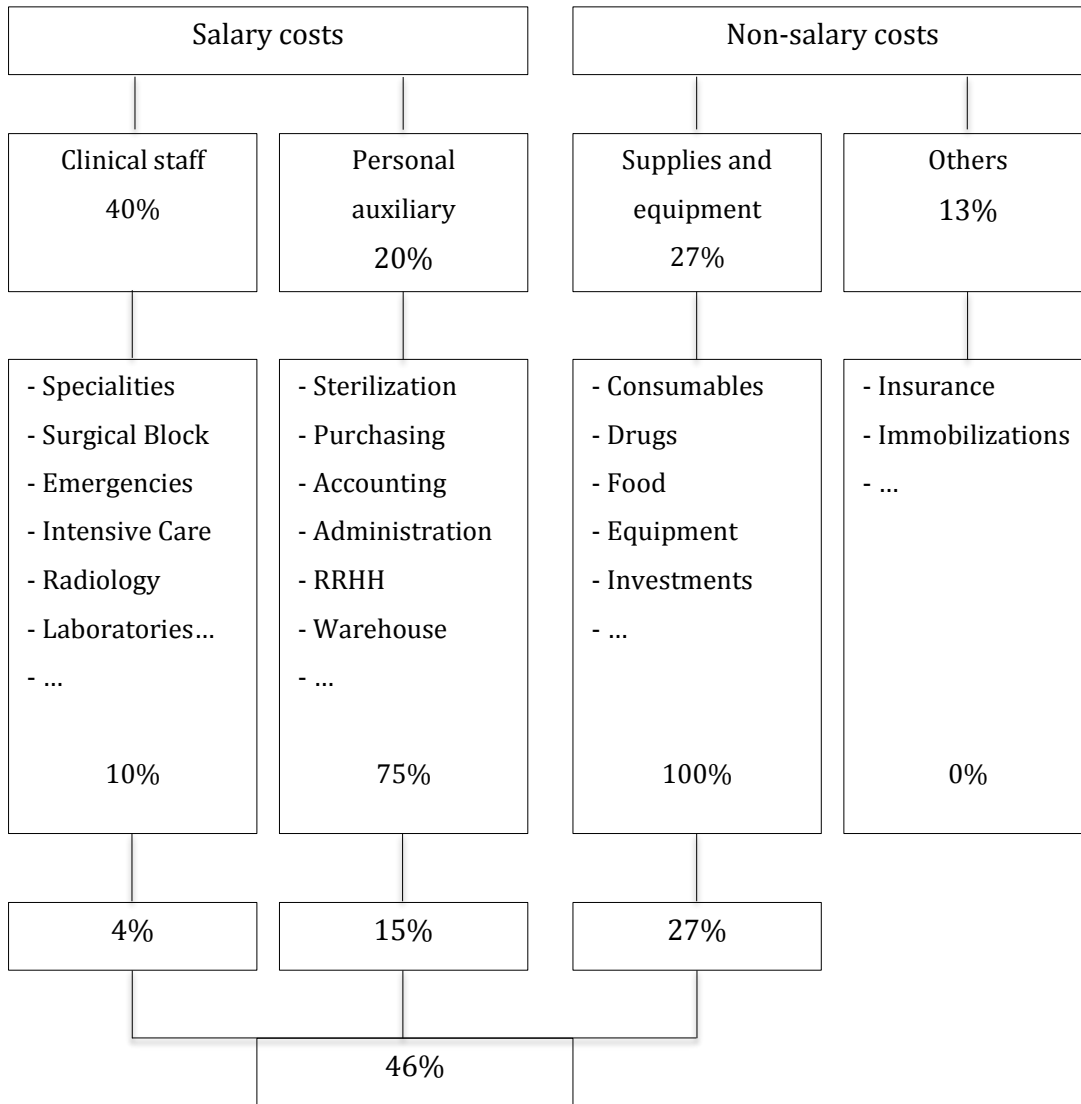


Figure 9 Impact of logistics on the costs structure of a hospital (Adapted from Chow and Heaver, 1994)

ANNEX VI: Classification systems for materials

The following table presents different types of selective controls, their basis and their use.

Type of Control	Basis	Main Use
ABC	Value of consumption of item	Control inventory value
HML	Unit price of item	Control purchases
XYZ	Value of items in store	Review inventories
VED	Criticality of item	Inventory control of spares
FSN	Consumption pattern of item	Control obsolescence
SDE	Problems of procurement	Lead time analysis and purchasing strategies
GOLF	Source of supply	Procurement strategies
SOS	Nature of supply	Procurement and holding strategies for seasonal items

Table 4 Types of Selective Controls (Reddy, 2008)

Bibliography

Abdel-Qader, D. H., Harper, L., Cantrill, J. A., & Tully, M. P. (2010). Pharmacists' interventions in prescribing errors at hospital discharge. *Drug safety*, 33(11), 1027-1044.

Al-Qatawneh, L., & Hafeez, K. (2011, January). Healthcare logistics cost optimization using a multi-criteria inventory classification. In *Proceedings of the 2011 International Conference on Industrial Engineering and operations management, Kuala Lumpur*.

Andoulsi, I., & Wilson, P. (2013). Understanding Liability in eHealth: Towards Greater Clarity at European Union Level. In *eHealth: Legal, Ethical and Governance Challenges* (pp. 165-180). Springer Berlin Heidelberg.

Chow, G., & Heaver, T. D. (1994). Logistics in the Canadian health care industry. *Canadian Logistics Journal*, 1(1), 29-73.

Cuggia, M., Avillach, P., & Daniel, C. (2014). Representation of Patient Data in Health Information Systems and Electronic Health Records. In *Medical Informatics, e-Health* (pp. 65-89). Springer Paris.

Daniel, C., Albuisson, E., Dart, T., Avillach, P., Cuggia, M., & Guo, Y. (2014). Translational Bioinformatics and Clinical Research Informatics. In *Medical Informatics, e-Health* (pp. 429-461). Springer Paris.

Devlies, J., Walossek, U., Artmann, J., & Giest, S. (2010). Country Brief: Belgium.

Di Martinelly, C. (2008). *Proposition of a framework to reengineer and evaluate the hospital supply chain* (Doctoral dissertation, INSA de Lyon).

Di Martinelly, C., Riane, F., & Guinet, A. (2009). A Porter-SCOR modelling approach for the hospital supply chain. *International Journal of Logistics Systems and Management*, 5(3), 436-456.

Doupi, P., Renko, E., Giest, S., & Dumortier, J. (2010). Country Brief: Denmark. *Health (San Francisco)*, (October).

Elia, *Questions about the risk of shortage in Belgium*. Accessed April 2015 at: <http://www.elia.be/en/about-elia/questions-about-the-risk-of-shortage-in-Belgium>

European Commission. (2012). eHealth Action Plan 2012-2020: Frequently Asked Questions.

European Commission, Information Society and Media Directorate General, *Report on the Public Consultation on the eHealth Action Plan (eHAP) 2012-2020*, 2011.

Farrar, K. (1999). Accountability, prescribing and hospital pharmacy in an electronic, automated age. *Pharm J*, 263, 496-501.

Fowlie, F., Bennie, M., Jardine, G., Bicknell, S., Toner, D., & Caldwell, M. (2000). Evaluation of an electronic prescribing and administration system in a British hospital. *Pharmaceutical Journal*, 265, R16-R16.

Freeman, R. E. (2010). *Strategic management: A stakeholder approach*. Cambridge University Press.

Fundación Salud 2000. (2009). Los pacientes y su papel en el Sistema Nacional de Salud.

Gerkens, S., & Merkur, S. (2010). Belgium: Health system review. *Health Systems in Transition*, 12(5), 1-266.

GUINET, A., & BABOLI, A. (2009). Logistique hospitalière: Besoins de gestion des flux pharmaceutiques. *Techniques de l'ingénieur. L'Entreprise industrielle*, (AG5430).

Gupta, R., Gupta, K. K., Jain, B. R., & Garg, R. K. (2007). ABC and VED analysis in medical stores inventory control. *Medical Journal Armed Forces India*, 63(4), 325-327.

Hassan, T. (2006). *Logistique hospitalière: organisation de la chaîne logistique pharmaceutique aval et optimisation des flux de consommables et des matériels à usage unique* (Doctoral dissertation, INSA de Lyon).

Healthcare Belgium. Member Companies. Accessed December 2014 at: <http://www.healthcarebelgium.com>

Hughes, R. G., Cain, C., & Haque, S. (2008). Organizational workflow and its impact on work quality.

HUVENNE (Anthony), *Implementing a disruptive Innovation in the Health Sector: the Case of Electronic Health Records in Belgium*, Université Libre de Bruxelles, Faculty Solvay Brussels School of Economics and Management, Section Management Science, Master thesis, Director: Professor PEETERS (Carine), 2012, pp. 20-23.

Kierkegaard, P. (2011). Electronic health record: Wiring Europe's healthcare. *Computer Law & Security Review*, 27(5), 503-515.

Kiskiène, A., Giest, S., & Dumortier, J. (2010). Country Brief: Lithuania.

Klibanov, O. M., & Eckel, S. F. (2003). Effects of automated dispensing on inventory control, billing, workload, and potential for medication errors. *American journal of health-system pharmacy*, 60(6), 569-572.

Kofler, S. (2011). The EU and eHealth: Good for Patients, Good for Medicine, Good for the Economy, in *EU Insight*, Catalogue No: IQ-AB-11-02-EN-C, No. 50.

Koppel, R., Metlay, J. P., Cohen, A., Abaluck, B., Localio, A. R., Kimmel, S. E., & Strom, B. L. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Jama*, 293(10), 1197-1203.

Landry, S., & Beaulieu, M. (2001). La logistique hospitalière: un remède aux maux du secteur de la santé?. *Gestion*, 26(4), 34-41.

Landry, S., & Beaulieu, M. (2010). Achieving lean healthcare by combining the two-bin kanban replenishment system with RFID technology. *International Journal of Health Management and Information*, 1(1), 85-98.

Landry, S., & Beaulieu, M. (2013). The challenges of hospital supply chain management, from central stores to nursing units. In *Handbook of Healthcare Operations Management* (pp. 465-482). Springer New York.

Landry, S., Blouin, J. P., & Beaulieu, M. (2004). Réapprovisionnement des unités de soins: Portrait de six hôpitaux québécois et français. *Logistique Manag (Special issue)*, 13-20.

Landry S, Philippe R (2004) How logistics can service health care. *Supply Chain Forum* 5(2): 24–30

Liikanen, E. (2004). e-Health - making healthcare better for European citizens: an action plan for a European e-Health Area. 15/10/2014, de EUR-Lex Sitio web: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2004:0356:FIN>

Massó, B. O. (2007). *Logística hospitalaria-2ª edición*. Marge Books.

Meinert, D. B. (2005). Resistance to Electronic Medical Records(EMRs): A Barrier to Improved Quality of Care. *Informing Science: International Journal of an Emerging*

Transdiscipline, 2, 493-504.

Menachemi, N., & Brooks, R. G. (2006). Reviewing the benefits and costs of electronic health records and associated patient safety technologies. *Journal of Medical Systems*, 30(3), 159-168.

Milieu Ltd and Time.lex. (2013). Overview of the national laws on electronic health records in the EU Member States: National Report for Belgium. 2/12/2014, de Milieu Ltd and Time.lex. Available at: http://ec.europa.eu/health/ehealth/docs/laws_belgium_en.pdf

NDIA YE, A., 2012. Logistics, Quality and Supply Chain Management course, Brussels: s.n.

Pagliari, C., Sloan, D., Gregor, P., Sullivan, F., Detmer, D., Kahan, J. P., ... & MacGillivray, S. (2005). What is eHealth (4): a scoping exercise to map the field. *Journal of medical Internet research*, 7(1).

Philippe R, Beaulieu M (2010) Supply chain processes in ORs can be improved using industrial

Reddy, VV. (2008). Hospital Materials Management. In *Managing a modern hospital* (pp. 126-145). SAGE Publications India.

Rivard-Royer, H., Landry, S., & Beaulieu, M. (2002). Hybrid stockless: A case study: Lessons for health-care supply chain integration. *International Journal of Operations & Production Management*, 22(4), 412-424.

Ryu, S. (2012). Telemedicine: Opportunities and Developments in Member States: Report on the Second Global Survey on eHealth 2009 (Global Observatory for eHealth Series, Volume 2). *Healthcare informatics research*, 18(2), 153-155.

Shulman, R., Singer, M., Goldstone, J., & Bellingan, G. (2005). Medication errors: a prospective cohort study of hand-written and computerised physician order entry in the intensive care unit. *Critical Care*, 9(5), R516.

Skolnik, N. S. (2011). A View from the Top: Reflections of Leaders in the Electronic Health Record Industry. In *Electronic Medical Records* (pp. 123-145). Humana Press.

Smith, B. K., Nachtmann, H., & Pohl, E. A. (2012). Improving Healthcare Supply Chain Processes Via Data Standardization. *Engineering Management Journal*, 24(1).

Staccini, P., Daniel, C., Dart, T., & Bouhaddou, O. (2014). Sharing Data and Medical Records. In *Medical Informatics, e-Health* (pp. 315-348). Springer Paris.

Stroetmann, K. A., Artmann, J., Stroetmann, V. N., & Whitehouse, D. (2011). European countries on their journey towards national eHealth infrastructures. *European commission DG information society and media ICT for health unit*.

Tang, P. C., Ash, J. S., Bates, D. W., Overhage, J. M., & Sands, D. Z. (2006). Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. *Journal of the American Medical Informatics Association*, 13(2), 121-126.

Thakur, R., Hsu, S. H., & Fontenot, G. (2012). Innovation in healthcare: Issues and future trends. *Journal of Business Research*, 65(4), 562-569.

University Alliance. (2014). Common Barriers Faced During EHR Implementation. 6/12/2014, de University Alliance. Available at: <http://www.usfhealthonline.com/resources/healthcare/common-barriers-faced-during-ehr-implementation/#.VOyxJVrnmfQ>

Venot, A., Burgun, A., & Quantin, C. (2013). *Medical Informatics, e-Health: Fundamentals and Applications*. Springer Science & Business Media.

Vila-Parrish, A. R., & Ivy, J. S. (2013). Managing Supply Critical to Patient Care: An Introduction to Hospital Inventory Management for Pharmaceuticals. In *Handbook of Healthcare Operations Management* (pp. 447-463). Springer New York.

Williams, L. (2013). Patient 'follow up' as a pedagogical technique for medical students. *Res Medica*, 21(1), 82-84.

Woosley, J. M. (2009). *Improving healthcare supply chains and decision making in the management of pharmaceuticals* (Doctoral dissertation, Louisiana State University).

World Health Organization. (2012). *National eHealth strategy toolkit*. International Telecommunication Union.

