Care-Paths: Searching the Way to Implement Pathways

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Abstract

Clinical Pathways are structured, multidisplinary plans of care designed to support the implementation of clinical guidelines and protocols. The goal of Care-paths project (IST-1-507017) is to set up an intelligent operational environment for making Clinical Governance effective, to support Health Professionals, Clinicians and Care Operators, in continually improving the quality of services and safeguarding high standards of care. To enable such improvements, CARE-PATHS leans upon the concept of Clinical Pathways. In order to demonstrate the completion of the objectives, the project is conducting one pilot phase in two different scenarios: La Azienda ospedaliera di Parma and the Hospital universitario la Fe de Valencia. Both scenarios deals with the implementations of two clinical pathways, the urgency procedure of an Acute myocardial infarction and the cardiac insufficiency in the context of a Home Hospitalization Unit respectively. This paper explain the main artifacts of the project produced until now: the tools and the IT system that support the execution of pathways.

1.   Introduction

The CARE-PATHS project[1] deals with the implementation of an intelligent set of IT tools for making Clinical Governance effective, to support Health Professionals, Clinicians and Care Operators, in continually improving the quality of their services and safeguarding high standards of care. The main characteristic of such a system is to integrate multidisciplinary knowledge in a very well structured way, to provide proper distribution channels of it via a decision support system and to assess in an intelligent way the progress of a specific patient group towards a predefined therapeutic policy, thus to estimate the variance. The CARE-PATHS promote the integration of various health care records standards, and is be able to collect information from databases holding these information in a secure way, both from the technological but from ethical and legal point of view. For the above, the CARE-PATHS system integrates different modules combining various technologies into a homogeneous system, that enable the doctors to use it a tool for the application of the clinical pathways methodology[2].

The CARE-PATHS as a WEB based and distributed architecture, promotes the use of Internet and advanced telecommunication techniques, along with embedded intelligence.   Furthermore, it promotes the use of knowledge based techniques, at a distributed manner, into the everyday and routine operations in the medical sector, so that the medical users (doctors, nurses) but also the administrative staff (especially managers) to be provided with information that will enable them to analyse the efficiency of the applied methodology, from both the scientific but also the administrative point of view. This way, the applied therapeutic methodology regarding the clinical pathways, could be revisited and start a cycle for optimal results.

2.   Methods

The consortium that have implemented the project advocated in using a user-centred design (UCD) process[3]. This participatory design process generates each design through explicit elicitation and modelling of users' goals, beliefs, and behaviours, and ensures the resulting personalized system delivers genuine value to the end user. Hence, the user have the ability to constantly participate in the process of the system design and specification. In that case, the system design have evolved smoothly and efficiently in a way that both the user and the technical sides of the consortium had the same common view over the system architecture and the functionality to be supported.

Furthermore, the above process have lead to two clearly defined software development iterations. These iterations evolved during the implementation phase and have ensured the efficiency of the software development process. During the initial iterations, the user's requirements were clarified and taken under consideration by the technical partners of the consortium so as to develop the software components more efficiently. Furthermore, once the first prototype was implemented, the users were presented with it in order to provide their

comments regarding the user-friendliness and the functionality that should be supported. Consequently, the Iterative Methodology of software development was adopted so as to ensure the similarity of the proposed and the implemented architecture.

The main development method that was followed during the implementation phase was Rapid Application Development (RAD). Rapid Application Development is an approach to building and maintaining computer-based systems which combines effective use of tools and techniques, prototyping and tight project delivery timescales. A method that has been followed and constitutes a RAD method is Dynamic Systems Development Method (DSDM)[4]. DSDM is a vendor-independent RAD method that recognises that, for every organization that needs a RAD tool to improve their development capability, there is an organization that needs to change the development process. DSDM provides a framework of controls for building and maintaining systems which meet tight time constraints and provide a recipe for repeatable RAD success. The method not only addresses the developer's view of RAD but also that of all the other parties who are interested in effective system development, including the users, project managers and quality assurance personnel.

The CARE-PATHS system has been developed in structured way and it has been broken down into well defined components and their functionality has been clearly identifiable. The implementation has been as much as loosely tight among the components so to promote technical partners of the consortium to work in an independent way.

A promising approach for addressing these architectural requirements is to rely on a "Service oriented Architecture" (SoA)[5]. A service can be considered to be an autonomous application that offers a specific functionality to other applications whenever invoked. A feature inherent to a service is the definition of "terms of agreements" (also called "Contracts") for other services and thus implement security restrictions. In fact, integrity and confidentiality of data and information exchanges on the internet has been enforced; in particular, data cannot flow freely, and CARE-PATHS must allow the enforcement of data flow restrictions.

Using a SoA in CARE-PATHS has also provided the specific advanced features :

Modularity: The more modular as possible to be adaptable to the greatest number of configurations/pilots (either from scratch or by mapping components onto existing systems);

Modules Independency: a faster implementation and future effortless integration will be possible if the modules are defined in an "loosely coupled" way;

Modules Evolutivity / Flexibility: Modules should be

replaced by a newer version without having negative impact on the framework's availability;

Interoperability between modules and external information systems both internal to the healthcare institution and external knowledge repositories
.

3. Results

The goal of CARE-PATHS is to set up an intelligent operational environment for making Clinical Governance efficient to support Health Professionals, Clinicians and Care Operators, in continually improving the quality of services and safeguarding high standards of care. The IT approach adopted by CARE-PATHS has been to exploit emerging technologies in medical knowledge management and semantic web for enabling the methodology of "Clinical Pathways" to function, to be effective and to succeed. The output of the project has been a set of intelligent tools for supporting Health Professionals in putting Clinical Pathways in practice in the everyday treatment of individual patients, monitoring and managing their variances and authoring conceptual clinical pathways for selected group of pathologies in specific contexts.
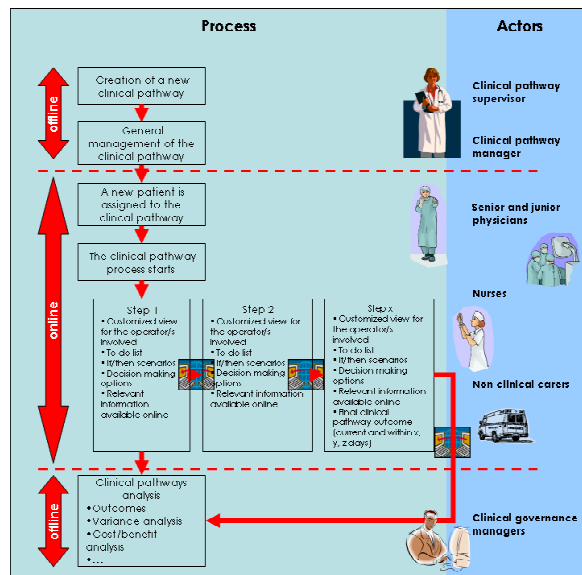

Figure 1. Care-paths processes

The mail goal of our architecture is to allow the implementation of a platform that can combine several services for the efficient provision and support of clinical pathways management. The collection and synchronization of services that are assigned to realize a specific functionality and open to be integrated under the platform has provided to the system the ability to be easily integrated and customized according to the specific

needs of the individual medical installations.

The monolithic approach and the traditional design of the system architecture were not selected due to the need to maintain an open and modular architecture that could be easily adjusted in various user organizations. Our research revealed that the medical organizations nowadays have already selected and use systems that facilitate their everyday practice. Thus, an off-the-self solution with minimum degree of customization is not a system that could be adjusted and used in such organizations without the investment of an important amount of resources.

The architectural model and the system concept can be depicted in the following schema: (see figure 2)
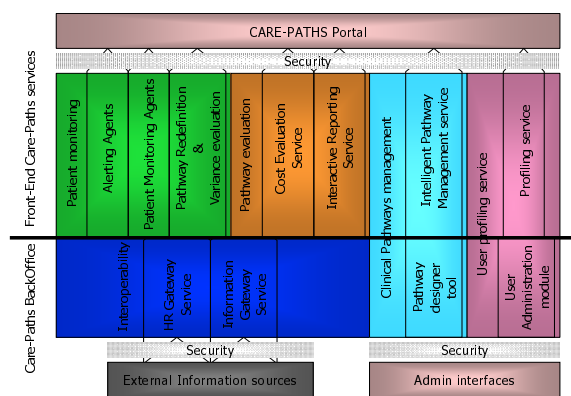

Figure 2 Care-paths modules

As it is depicted in the schema the CARE-PATHS system can be divided in two main sub-systems. The CARE-PATHS Back-Office which includes the administration applications and the information provision services and the Front-End services which realise the framework for the support and follow-up of clinical pathways.

In order for the system to enable the clinical pathways management it provides the **Clinical Pathways Management** tool. Its functionality is two-fold. Primarily it is responsible for the definition and storing of the clinical pathway templates into the system with help from various clinical guidelines and external medical knowledge. The **Pathway designer tool** provides an intuitive interface that will enable the user to graphically review the pathway and easily insert the variances and expected goals. Secondly it manages the most important aspects of clinical pathways implementation in the system. These include choosing the right clinical pathway to be applied to each patient, applying the selected pathway to each patient and participating along with the Patient Monitoring service in pathways redefinition. This module can also activate the **Information Gateway**

service in order to retrieve information related to a patient condition and specific clinical pathway step.

The **User Profiling service** manages the profiles of the CARE-PATHS users and provides the appropriate interfaces according to their needs. For the definition of the user profiles and the administration of the roles and the users the **User administration module** is being used. The **User Profiling Service** is responsible to dynamically provide the profile of the users to the modules that requested this information. The profile consists of information regarding user preferences, characteristics and special needs and requirements that affect both the interfaces and the services that this user utilises.

For the efficient creation of the clinical pathways and for the manipulation of the patient related information the **Interoperability services** plays a great role. During the clinical pathways definition the **Information Gateway Service** is activated in order to retrieve the most appropriate information related to the ongoing process from external sources and services. Moreover, the patient specific information that is stored and maintained in the health record of the medical organisation is collected with the use of the Health Record (HR) Gateway service.

For the moment a clinical pathway is assigned to a patient, the **Patient Monitoring services** are responsible for the continuous monitoring of the patient's pathway course throughout its implementation. The actual monitoring of the clinical pathway is realised with the **Patient Monitoring Agents** that are responsible to record any activity that was performed by a patient related to a specific pathway and to a specific step. If there is a discrepancy in follow up of a pathway the **Alerting agent** is responsible to send alert messages to the responsible actors and to keep track of the activities that followed the specific alert. Another important service offered for the efficient patient monitoring is the evaluation of the variances from the implementation of clinical pathways. The purpose of the **Pathway redefinition and variance evaluation service** is to suggest a list of recommended activities to be implemented in a specific patient's pathway, a modification of the indicators threshold, or an option to apply another pathway to this patient.

The **Pathway evaluation services** are responsible for providing statistical data about the consolidated implementation of clinical pathways as well as for identifying possible ways to make cost-effective decisions for the improvement and optimization of resources management of the clinical pathways. The **Cost Evaluation service** is responsible for evaluating the cost of each clinical pathway implemented, comparing this cost with the objective set initially for this clinical pathway in order to identify possible ways to make cost-effective decisions for the improvement and optimization of resources management. Moreover the **Interactive**

reporting service provides to managers different levels of the healthcare structure statistical data about the consolidated implementation of clinical pathways and relevant financial aspects.

Finally the system is accessed via intuitive user interfaces that collect the output of the several services and they provides the consolidated information to the end user. Special attention is given to interfaces related to patient monitoring and alerting information. Due to the fact that the system deals will patient related and sensitive data the **security and confidentiality layer** provides the necessary measures in order to reassure the safe and trusted manipulation of the patient and clinical pathways data taking into account the current installation of the organisation's environment.

4.   Discussion and conclusions

Clinical pathways are being applied in different medical domains. However the application is really difficult without an appropriate information & communications environment. Without a tool that support the physicians in using efficiently the big amount of collected data, activities to perform, results, etc. is difficult the follow-up of the ongoing process. Care-paths has been created to support the professional in this complex procedure: the design of the path, the execution and the evaluation of the different parameters that could lead to an improvement of the pathway.

The design & construction of this tool has been hard. Different teams of medical staff have different perceptions of how should be the support that a tool must provide to implement a pathway, so the establishment of the different requirements have been difficult. The design of the model of the pathways have suffered several refinements to assure that they provide the execution of the different pathways templates. The apparently simple and well documented procedures for the attendance of the acute myocardial infarction and the cardiac insufficiency hides a very complicated decision making in the mind of the professionals and it have been really difficult to transfer their knowledge to the computers domain.

Anyway, after the completion of the two pilots ,we are confident that the "reengineering" process that the two units have been experienced will guide them to be more effective in the care process improving the quality of services and safeguarding high standards of care.

Acknowledgements

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