He@lthCo-op: a web-based system to support distributed healthcare co-operative work

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Abstract

Healthcare is characterized by close collaboration and information sharing among many distinct actors, who co-operate for the patient care in different temporal moments, also at a distance. In this context, availability to caregivers of all relevant patient health data and of specific healthcare co-operative work supporting tools is fundamental for best patient treatment. We designed and implemented He@lthCo-op, a web-based modular system supporting co-operative work and patient information secure sharing among healthcare personnel also from remotely located sites. He@lthCo-op enables easily gathering, storing, and accessing patient clinical and personal data anytime and from anywhere an Internet connection is available.

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1. Introduction

The management of data related to patient health care is a complex process. An information system designed to perform this activity must be able to collect, organize, and maintain every different type of information associated to a patient, i.e. administrative, personal, and medical data. The main requirements are efficacy and efficiency in data management and processing, information protection according to specific rules for security and privacy [1–4] (e.g. those defined in the Health Insurance Portability

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and Accountability Act — HIPAA [5]), and friendly use for the healthcare personnel. To these aims, since several years the main clinical centers are attempting to adopt an efficient electronic medical record for their patients. More recently, organization changes of healthcare institutions and increasing people mobility are pushing towards the adoption of a comprehensive patient electronic health record (EHR), virtually accessible wherever the patient health care requires it [6–9]. In fact, healthcare organizations are shifting towards offering integrated care and integrated healthcare networks with many clinical departments in several sites. This requires a single information system easily and efficiently interconnecting different and geographically distributed healthcare sites [10–12]. On the other hand, increasingly high people mobility makes important to access the patient health record from whatever healthcare site where the patient can ask for assistance [13]. These new requirements and the development of information and communication infrastructures have recently led to use web-based distributed technologies in healthcare information systems. Internet technologies can provide easy and secure access to EHRs from outside the clinical site where the information system is installed or the data reside, and are very adequate to work in a scenario constituted of a fleet of highly heterogeneous performance and multi generational hardware and software platforms [14], as the healthcare arena is. Moreover, these technologies allow supporting even simple telemedicine services recognized useful for a better patient treatment and follow up [15–17]. Nevertheless, at present only few clinical centers have adopted a web-based information system that handles patient EHRs. Moreover, most of the available EHR systems focus on data management and does not adequately support the co-operative work of healthcare providers, especially when the co-operating healthcare actors are remotely located.

A healthcare information system must run in a multi-user environment characterized by the presence of different types of users, i.e. healthcare administrative personnel, technicians, nurses, physicians, and the patients themselves. These healthcare actors need to share heterogeneous multimodal medical data, documents, information, and knowledge [18]; they work simultaneously or in different temporal moments, at the same location or in separate places even geographically distant; they co-operate for the clinical effectiveness, continuity of care, and ultimately for the best patient health care; and they discipline their performance through a continuous feedback from patients, colleagues, and managers [19–22]. Thus, a system supporting healthcare actors in their co-operative work must be able to provide them with all the patient medical data they need, wherever they are located [19,20]. Since the interaction among the involved healthcare co-operating people may happen both in different physical spaces and temporal moments, a good implementation choice is a database-oriented web-based solution. This approach guarantees high flexibility and easy deploying to the final user, allowing good performances and service availability. Moreover, today diffusion and use of Internet and its related navigational instruments also among most of all typical healthcare subjects make a web-based system very easy to use and characterized by a friendly user interface [23]. Therefore, we evaluated the feasibility and usability of a web-based system supporting healthcare co-operative work. For this goal, first we analyzed some emblematic healthcare co-operative work flows, then we defined the requirements and designed a modular system supporting the analyzed co-operative healthcare activities, and finally we implemented a prototype version of the main component modules of such a system.

2. Healthcare co-operative work support

In healthcare, co-operative work consists of predefined, sometime optional, partially compulsory actions to be kept coordinated in time and implemented usually by several distinct people — also located in
different sites distributed at a distance — responsible of specific actions and all engaged in common tasks or goals. Software tools effectively helping co-operative work are generally welcome. Nevertheless, as much as the complexity and uncertainty of the co-operative work workflow increase, not so many software tools are available. Management of patient health care and filling of a departmental medical record, which covers the entire hospital stay of a patient, are paradigmatic cases. In fact, the complex diagnosis-oriented logical analysis to which the medical data must be submitted, the necessarily time-oriented collection of patient healthcare data, the sometime evolving strategies that guide the clinical data collection, the changing balance between wished data and how much it is costly or risky for the patient health to have them, the intrinsically unpredictable sequence of the care process phases, the not negligible number of responsible people covering partially superimposed but specific roles (i.e. physicians, nurses, technicians, paramedical and administrative personnel), all these elements make the patient health care management and health record filling examples of extremely complex co-operative works [19,20] (Fig. 1).

A system supporting the multifaceted healthcare co-operative work must be able not only to provide healthcare actors with easy and fast access to all the patient medical data they need wherever they are located but also to guide each different healthcare actor in the specific tasks he/she has to perform, providing decision support and performed operation checking methods. Besides, it must provide a complete, fast, and simple channel permitting a bi-directional communication between all involved healthcare actors and allowing the co-operating subjects to share the numerous heterogeneous data, documents, and information they need; to exchange knowledge and decisions; and to coordinate their work. A co-operative work support system should also contain knowledge of the work processes, be organizationally aware, and help in specifying, executing, monitoring, and coordinating flow of work cases within a distributed environment. Finally, it should be flexible and adapt to different work situations and changes, giving support in overcoming the working complexities and difficulties that may arise [19–21,24,25].
3. Workflow analysis

We analyzed a representative co-operative scenario of patient health care, its main phases, the actors involved, the data used and generated. As sketched out in Fig. 2, the first phase involves a patient and doctor encounter. This is the typical medical visit during which the visiting doctor evaluates the patient clinical data and conditions, can ask for diagnostic or checking medical tests, and gives prescriptions. According to the visit outcomes, the patient can autonomously take care of his/her follow up in accordance with the received therapeutic prescriptions, or can require clinical treatment. This involves the interaction and co-operation of physicians, nurses, and the patient. When medical tests are requested, they involve technicians and/or specialized doctors. Analysis and reporting of the performed medical tests imply differential evaluation of a lot of information besides the test results, including patient clinical history and data. In presence of complex or unusual cases, second opinion is a good practice for a better diagnosis and patient treatment.

Fig. 2. Main information flow and actors of the main typical phases in patient’s health care, which starts from the encounter between patient and visiting doctor.
These outlined phases are emblematic of patient health care. Thus, although each particular hospital, institution or clinic implements a specific workflow, analysis of the main workflow steps of these healthcare phases can be generalized. Based on direct observations, interviews with workflow actors, and guidelines, our analysis focused on medical test reporting, and patient clinical treatment and follow up.

3.1. Medical reporting

The medical reporting workflow is summarized in Fig. 3. A referring doctor with an adequate specialization analyzes the result of a medical test and all the available patient information considered useful for a better diagnosis. When these data do not make him/her confident in formulating a clear and reliable referral, he/she can ask for the opinion of another specialized doctor, in case nominally chosen among the reference doctors for the specific medical test or hypothesized pathology. On the basis of the information received, the doctor consulted for second opinion analyzes the case. When needed, he/she interacts with the first referring doctor by discussing the available evidences with him/her and exchanging opinions before giving a personal evaluation. If with the support of the second opinion specialist a clear and convincing diagnosis is reached, the first referring doctor formulates a final referral, otherwise he/she can ask for another opinion.

Fundamental elements in the medical reporting process are availability and transmission to the referring doctor of as many patient data as possible that can help in making a correct referral. In fact, generally the referring doctor does not know the patient and neither his/her clinical history. In this process, only referring doctors are directly involved but also other actors are important. In fact, the referring doctors work together interacting and cooperating to provide the patient visiting doctor, who required the referred medical test, with the information useful to define the best treatment for the patient.

3.2. Clinical treatment and follow up

In Fig. 4 the main steps of patient clinical treatment and follow up are outlined. When a patient is admitted in hospital a doctor visits him/her, evaluates the patient condition, and prescribes a therapy. Nurses take care of the patient giving to him/her the prescribed pharmacological therapies at the time and in the doses specified by the doctor, monitoring his/her vital parameters, and recording all observations in the patient clinical log. When a doctor visiting the hospitalized patient evaluates that he/she does not require further clinical treatment, the patient is discharged and goes home where he/she continues the follow up according to the received referrals and prescriptions. During hospitalization, besides the patient, physicians and nurses are the involved co-operating actors. In the follow up outside the hospital, instead, interaction is between the patient and his/her visiting doctor.

In all the considered healthcare phases, we observed that the data flow does not have a predefined direction and goes from any actor to another. In fact, the information flow is from doctors to nurses and patient when a diagnosis is formulated and a therapy prescribed. Nevertheless, it goes from the patient to doctors or nurses, or from doctors to doctors, or from nurses to doctors and back to nurses when the treatment is given, its effects observed and evaluated, and in case a new treatment is defined (Fig. 1). Each information is reported in the patient clinical log and health record, and shared among the involved actors. These last can interact and co-operate in real time (synchronous co-operation) or at different moments (asynchronous co-operation). The common element of all actions is the need of information sharing and
Fig. 3. Main workflow of medical test reporting.
continuous communication among all the co-operating actors. In this scenario it is clear the central role that a system providing all required and useful information, and supporting the co-operative work, can have.
4. System design

According to the information collected and the modeling developed during the workflow analysis, we defined the requirements and designed a system supporting healthcare co-operative work. Because many different actors, sites, and activities may concur or not during healthcare work, we designed a fully modular system in which data can be collected from different sites, stored in a distributed way, and accessed according to a co-operative model. This is in accordance with the requirement that in healthcare patient data not only need to be shared and accessed by different actors from different sites but also they are generated in different places [8,11]. For this reason we decided to use distributed database technologies, giving the chance not to store all data in a single central repository only but to keep them in the local repository of the place where they are generated or used more frequently. Therefore, we designed system backend databases with a flexible and modular structure able to link other distributed databases containing patient data and healthcare actor information. The standardization recommendations of Health Level 7, version 3, Reference Information Model (HL7 RIM), and of European Committee for Standardisation, Technical Committee 251 (CEN/TC251) ENV 13606, were considered, as well as the OpenEHR initiative [26–30]. Special attention was given to the common management of the identifications of all co-operating actors (i.e. physicians, nurses, technicians, and patients). A unique table “Person” containing all actor identifications is shared by all linked databases and it is used in all modules of the system (Fig. 5). This allows a unified and compact management of such data and the immediate availability of all distributed system services to the actors qualified for their use. Univocal patient identification was obtained using a Master Patient Index composed of multiple elements, including patient name, surname, and age. This allows integration of different patient data also generated in distinct healthcare sites.

The system, which provides the different healthcare actors with the access to the distributed databases and services, has been designed as a modular centralized architecture with a single application program residing on a central server. This has the advantage that the events are always handled from the client processes in the same order serialized by the server [19]. Each module of the system has been designed to support either a particular healthcare activity or site — e.g. a module for the medical visits, one for the management of medical tests, another for the medical reporting process, one for the management of patient clinical logs, other different modules for each clinical department or lab (Fig. 6). Besides, in each module we considered specific views and functionalities for each different type of actor [31].

By using distributed system technology, we planned to install the central system on a web server connected to distributed client platforms through an intranet/Internet network using the common TCP/IP web protocol. Thus, the system can be deployed to each healthcare site where a network connection is available (e.g. emergency rooms, operating theatres, wards, nurseries, and also outpatient clinics and offsite healthcare centers as well). Furthermore, in this way the user interface is provided inside a common web browser, without needing to install additional hardware or software on the client computers. This enables high portability and direct deployment of the system services and functionalities to all users also outside a single healthcare institute, with the mandatory implementation of the security and privacy protections required for medical data. A direct consequence is the possibility to extend easily the system with telecare modules, which can for instance support the follow up of a patient at his/her home [15,16]. Moreover, the use of intuitive web interfaces eases those personnel with limited informatics knowledge in the rapid utilization of new software applications, like the different modules of our system are [14].
5. System implementation

We implemented a prototype version, named He@lthCo-op, of the designed system. The He@lthCo-op core engine, based on a relational database developed with a MS-SQL Server data base management system (DBMS), manages main patient data and information for access security and user identification. Microsoft ActiveX Data Object (ADO) technology was used to access the system database from the developed web-based services and user interfaces. The chosen system DBMS does not imply any future constraint. In fact, thanks to the modular characteristics of the implemented system and the employed web technologies, it can be easily replaced with a different DBMS (e.g. MySQL, Oracle, Informix), without demanding source code modification. Moreover, the used ADO technology requires no restrictions on the DBMS of the remote distributed databases our system can connect.

The He@lthCo-op prototype was developed using Microsoft Active Server Page technology, with Javascript language for scripting and Hyper Text Markup Language 4.01 for formatting the graphic user interface (GUI) implemented as web pages. The use of web server-side technologies, with the centralization on the server of data archiving and processing operations, lowers costs and makes faster and easier both managing and maintaining the system, and deploying the developed functionalities and GUIs.
Fig. 6. Communication schema of the He@lthCo-op system connecting distributed data repositories and healthcare sites, and providing specific supporting software modules for each different healthcare activity or site.

to all remote clients [14,23,32]. This facilitates the use of He@lthCo-op on the variety of multigenerational and heterogeneous performance informatics platforms generally present in any healthcare context [14]. Besides, the He@lthCo-op simple and intuitive GUIs provide each healthcare actor with easy information visualization for a clear and better understanding. Moreover, each actor working-task related to patient information collecting and sharing is guided, and data-entry checking procedures control as much as possible correctness and completeness of the data entered in the system.

The implemented He@lthCo-op prototype includes the medical visit and medical reporting modules, and a module supporting nursing activities, to be used during patient clinical treatment. Additional modules, such as those related to other clinical departments and labs, can be added to the system at any time without modifying the existing parts.

The medical visit module is designed to help a physician in performing a patient anamnesis and collecting the relative data, reporting a diagnosis, and/or prescribing a pharmacological therapy (Fig. 7). All these tasks are guided step by step. To support them, in this module we implemented the standard controlled vocabulary of the World Health Organization’s International Classification of Diseases — Ninth Revision — Clinical Modification (ICD-9-CM) [33] and a knowledge base of medicines. The last
contains the names of all available drugs, their packaging type, active ingredients, dosage, and usage guidelines. Use of standard vocabularies and knowledge bases limits data entry errors, uniform clinical information shared among co-operating actors, avoids less understandable personalized compilations of healthcare reports, and enables better results of subsequent information searching in patient EHRs, ultimately improving patient care.

In the medical reporting module, we implemented a complete support to the whole referral generation process, including referral management, second opinion, and the chance for any referring doctor to share and consult all patient clinical data at any time (Fig. 8). All intermediate and final referrals created during the reporting and second opinion steps are stored for certification purposes, being the intermediate referrals for internal use only. Furthermore, the doctors who asked for the referred medical tests can see the progress status of the requested tests. The system notifies them as soon as test results and referrals are available and makes such information accessible to those actors who have the privileges to access it.

In the implemented clinical treatment module, the patient clinical log (Fig. 9) and the graphical representations of the collected patient vital parameters (Fig. 10) immediately show the evolution of patient clinical state and treatments to doctors and nurses.
Specific tables clearly list all details of current and interrupted pharmacological therapies for each patient (Fig. 11), providing support to doctor decisions and nurse activities according to the evolving patient condition. The same data for all patients in a ward are also used to schedule and coordinate nurse work in relation to doctor prescriptions and patient health state, specifically highlighting what each nurse have to do and when, which patients need specific treatments, which drugs to give, in which dose, when, and how frequently.

In all modules, the system memorizes who inserts, modifies, or deletes whatever datum and the time when the operation is performed. Thus, each entry is clearly connected to the specific person responsible for it. This non-repudiation policy is one of the implemented requirements for health information integrity, security, and confidentiality [1–5]. Each user has a unique identifier and can access and modify the different data only according to the owned authorization privileges on each specific type of data. Besides identity tracking, we utilized unique identifiers also for authentication control and validation of system section access on the basis of user role and function. To terminate an electronic session after a predetermined time of inactivity, automatic logoff was implemented. Furthermore, to guard against unauthorized access to electronic health information transmitted over the network, transmission security protocols together with encryption and decryption mechanisms were applied. The implemented security measures provide state of the art reasonable confidentiality and integrity for the healthcare data without limiting their availability to authorized healthcare actors or reducing system flexibility.
The implemented system was tested successfully either in a local and a wide area network, or using common TCP/IP Internet connections, demonstrating its usability not only in a clinical intranet but also outside it. Thus, He@lthCo-op allows the realization of an integrated multi-site system with access and availability independent from the user physical location. Clinical pilot projects including several healthcare actors with different roles (i.e., physicians, nurses, technicians, and patients) and from distinct remotely located healthcare sites are under development. Preliminary results are encouraging and show the efficacy of He@lthCo-op either in assisting patient health information gathering and access, or in supporting specific co-operative healthcare activities through its web-based friendly interfaces and tools easy deployable through Internet. They also prove good acceptance of the system by the different testing healthcare actors considered, and the easiness of its use also for people with limited informatics abilities.

6. Discussion

In health care, availability to care givers of all relevant patient health data is fundamental for the best patient treatment. To this aim, since several years many efforts have been made to develop efficient patient EHRs [6–11]. However, health care is also a field characterized by close collaboration and high information sharing among all healthcare actors [19–22]. Nevertheless, so far not as much attention has been paid to the co-operative aspect of health care work and to develop adequate tools to support healthcare providers in their specific collaborative activities and interactions. In fact, complexity of the co-operative healthcare workflow — regarding a virtual team of several people with different roles and from many sites, who perform heterogeneous activities that need to be kept coordinated in time and executed sequentially or in parallel — requires to use not generic but specifically implemented computer supported co-operative work systems. Therefore, we developed He@lthCo-op, a multi-user work system expressly supporting
Fig. 10. An example screenshot of the He@lthCo-op clinical treatment module showing the histogram panel for monitoring patient vital parameters.

Ubiquitous collection, organized storage, fast and easy retrieval of patient data are necessary requirements for supporting co-operative healthcare work. In addition, He@lthCo-op makes available in real time the data generated or modified by any healthcare actor also to all other users having the privileges to access them. As an example, every medical inspection note taken by a doctor, or every observation made by a nurse, does not remain just stored in the system but they are orderly collected within the patient health record and become immediately accessible to other users. Thus, physicians can monitor always in real time the patient clinical state in order to better understand his/her actual health condition and take rapidly opportune decisions about the best therapy to adopt. Besides, He@lthCo-op includes specifically developed modules that support the main physician and nurse activities, guiding them in patient health
fig. 11. An example screenshot of the He@lthCo-op clinical treatment module showing the patient pharmacological therapy table. Current and interrupted therapies are clearly listed with all details. hh: hours, dd: days.

record filling, checking as best as possible correctness and completeness of input data, and providing comprehensive views of patient medical data orderly organized according to the particular needs of each healthcare role. Support to physicians is provided in managing anamneses and medical examinations, and in assisting their decisional activities in diagnostic medical test prescription, pharmacological therapy assignment, and diagnosis formulation. Moreover, special attention is given to support the reporting of patient medical tests. A specific He@lthCo-op module enables a fast and easy communication channel among the healthcare actors involved in the medical reporting process and provides coordination of their activities. Besides, it provides referral management and second opinion support, including the chance for any referring doctor to consult all patient medical data at any time. Support to nurses in their clinical work is provided through a particular module that clearly shows evolution of patient clinical state and treatments, and helps scheduling nurse activities by coordinating them accordingly to doctor prescriptions and patient conditions.

The workflow analysis He@lthCo-op is based on and the friendly web interface it presents allow a smooth introduction of our prototype in the healthcare working environment, aiding the different healthcare actors in executing their tasks without altering their work practices. Besides, the technologies used to implement He@lthCo-op enable both its interoperability with existing heterogeneous legacy systems, and its flexibility with regard to diverse healthcare organizations and activities, with various amount and types of actors and processes involved. Differently from other systems [9,11,34], we used distributed database technologies and designed our prototype in order not to store all patient data in a single central repository only but to keep them in the local repository of the place where they are generated or used more frequently. This ensures faster data access without limiting data sharing. Moreover, use of web technologies and implementation of the security and confidentiality protections required for medical data allow remote secure use of He@lthCo-op, ensuring either patient data distributed collection, storing, and access, or specific work support to all distantly located co-operating actors. Besides, the used web
technologies require final users only a network connection and a web browser, without demanding any additional hardware or software, for exploiting He@lthCo-op. Thus, our system can be employed also in small general practitioner offices or at patient house. This enables both to directly support also general practitioners as members of the virtual team co-operating for the patient healthcare, and to create a permanent contact between doctor and patient also after discharge from a clinical structure. In this context, our system can easily support continuous high quality care and patient communication with healthcare professionals through inexpensive web-based interactive tools and transmission of multimedia information. Moreover, providing remote secure access to the updated personal healthcare record, He@lthCo-op supports patient empowerment. Several papers have reported the value for empowered patients to have access to their own patient information over the Internet [9,34–36]. In Cimino et al. [36] a study is reported in which both patients and their caring doctors believe that access to personal health record enhances the patient’s understanding of their conditions and improve their communication with physicians. The patient can use the He@lthCo-op system either as a consultation schedule for therapies to follow and a reminder of medical examinations to take, or as a personal healthcare record. In the first case, the patient can easily and quickly consult his/her health record at home through Internet for viewing all information required to continue a therapy during follow up period. As personal healthcare record, He@lthCo-op could help in the co-operative care of patient health among several healthcare providers, contributing to avoid unnecessary tests, providing comparison with data from earlier examinations, reducing the number of ineffective treatments, increasing patient’s compliance with clinical care processes, reducing length of stay within hospitals, and providing a lifelong health record across healthcare institutional boundaries [9].

About the hinge of our project, i.e. communication and continuous information sharing among different healthcare actors and support to their co-operative work, future developments can concern the implementation of other specific healthcare modules and supporting tools. For instance, to increase the sense of proximity that joins patients to their caring doctors and nurses during follow up at home, streaming systems for real time voice and image transmission (e.g. using simple web cams and microphones) can be utilized. Moreover, a virtual blackboard can be created, where physicians and nurses may leave messages for other healthcare actors (e.g. to communicate to the following shift-worker any notes about hospitalized patients) and better coordinate their work. In the present version of our system this is partially realized by inserting notes into patient clinical logs. Besides, e-mail or SMS (short message system) communications can be usefully introduced to send specific advices to patients during follow up period after their hospital discharge, or when results and referrals of taken medical tests are ready for remote access through the He@lthCo-op system. Regarding specific co-operative work support, future developments can refer to the inclusion in He@lthCo-op of additional well established and agreed references (e.g. healthcare protocols, best practice guidelines, regulations) to better guide healthcare actor’s activities, support the decisions they have to take, and automatically advise if differences from standard practice occur.

7. Conclusions

At any time and anywhere an intranet/Internet connection is available, the developed He@lthCo-op prototype provides an easy and fast communication and information sharing channel among healthcare actors, and gives them easy access to all patient data they need. Besides, differently from other systems, it specifically supports the complex healthcare co-operative work by guiding the distinct healthcare actors
in the particular tasks they have to perform, and by helping in monitoring and coordinating their activities. Specifically developed He@lthCo-op modules support the main physicians and nurse activities, including medical visits, medical test reporting, and patient clinical treatment and follow up. Moreover, they guide the healthcare actors in patient health record filling; they provide them comprehensive views of patient medical data organized according to the particular needs of each healthcare role; and they aid in organizing the healthcare activities in accordance to the actions of all involved subjects, the available information, and the patient conditions. Current clinical pilot projects are showing good acceptance and usability of the He@lthCo-op system that enables all offsite healthcare actors to efficiently interact and co-operate for the best patient care as it normally happens during onsite clinical activities.

8. Summary

Healthcare is characterized by close collaboration and information sharing among many distinct actors — i.e. physicians, nurses, technicians, and patients — who co-operate for the patient care in different temporal moments, also at a distance. In this context, availability to care givers of all relevant patient health data and of specific healthcare co-operative work supporting tools is fundamental for best patient treatment. After analyzing healthcare information and work flows, we designed and implemented He@lthCo-op, a web-based modular system supporting co-operative work and patient information secure sharing among healthcare personnel also from different remotely located sites. Focus objective of He@lthCo-op is providing — in a collaborative work support context — a ubiquitous, easy to use, and effective platform for gathering, storing, and accessing all patient clinical and personal data anytime and anywhere required for a proper health care. Current implementation includes tools and interfaces for the medical test reporting, and patient clinical treatment and follow up modules, supporting physician and nurse co-operative work. Preliminary results of clinical pilot projects show good acceptance of the He@lthCo-op system by the different testing healthcare actors, and effectiveness of the system in supporting co-operative healthcare activities and patient data secure sharing through friendly interfaces and tools easy deployable through intranet/Internet networks to the heterogeneous and multigenerational computer platforms present in the healthcare scenario.

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References


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