HYGIA: Design and Application of New Techniques of Artificial Intelligence for the Acquisition and Use of Represented Medical Knowledge as Care Pathways

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Abstract

Clinical practice guidelines (CPG) represent standard sets of recommendations for the clinical handling of patient affections of a concrete pathology. They reflect the best scientific evidence available for such pathology. Its adoption by health-care professionals has a direct impact in the quality of the assistance, fostering the standardization of the interventions. In spite of the interest of their application and use, the adherence of professionals to CPG has been observed below the desirable level. Two are the main reasons: 1) the difficulty to adapt standard CPGs to the particularities of each health care center and 2) the little synchrony between CPGs and the particularities of work practices that often reflect the specifics of work places. Both factors influence negatively in the viewpoint of doctors and other health care professionals, making them reluctant to use CPGs in the clinical decision making. Regardless of the reason, this poor adherence lowers the quality of the health service provided. In order to solve this, more operative versions of CPGs have set out: Care Pathways (CPs). These are operative versions of the CPGs that detail the steps to follow for the care of a disease in a certain segment of patients and concrete healthcare context. Therefore, CPs constitute a fundamental instrument for the effective application and use of the CPGs in clinical frameworks.

In this project we propose the use of Intelligent Systems in the processes of acquiring, formalizing, adapting, using and assessing knowledge models that describe CPs. Here, CPs are generated from electronic protocols, that represent versions of the CPGs when they are made specific to particular healthcare circumstances. The CPs obtained could be used by intelligent computer science distributed systems to facilitate the decision making that allows the e-care in the context of a new Information Society. The project is located in the convergence of diverse technologies developed by several work groups and the European and national R+D projects PROTOCURE I, PROTOCURE II, K4CARE, HeCaSe, PalliaSys, AgentCities Working Group on Health Care Applications, AgentLink III Technical Forum Group on Applications of Agents in Health Care.

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1 Objectives

HYGIA (TIN2006-15453) is a three-year R+D Project partially funded by the Spanish “Ministerio de Ciencia e Innovación” that started in October 2006. The objectives of the project are summarized in table 1.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
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<tbody>
<tr>
<td>O1.</td>
<td>Design and implementation of a set of tools to automate, as far as possible, the knowledge acquisition from textual CPG documents.</td>
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<tr>
<td>O3.</td>
<td>Proposal of a methodological framework for the development of CPs from electronic protocols and other additional resources, such as the data stored in hospital databases.</td>
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<tr>
<td>O4.</td>
<td>Construction and utilization of new inductive learning algorithms for the generation of healthcare knowledge from data of medical interventions stored in hospital databases, and using ontologies providing the semantics of the medical domain of the guideline.</td>
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<tr>
<td>O5.</td>
<td>Utilization of these knowledge structures or clinical pathways for decision support by medical professionals and quality control by hospital managers by means of a multi-agent system (MAS) that interprets this knowledge within the institutional context in which the medical activity is carried out.</td>
</tr>
<tr>
<td>O6.</td>
<td>Identification and evaluation of the adherence degree by healthcare professionals to multi-pathology CPs resulting from the technologies integrated in the project, applied to a programme for chronic patient care.</td>
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Table 1. Objectives of the HYGIA Project.

The four institutions participating in the project are Universitat Rovira i Virgili (URV), Universidad de Santiago de Compostela (USC), Universitat Jaume I (UJI), and Fundació Clínic per a la Recerca Biomèdica del Hospital Clínic de Barcelona (HCB). In order to achieve the above mentioned objectives, these institutions provide the means that are enumerated in table 2.

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<tr>
<th>Institution</th>
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<tr>
<td>USC</td>
<td>Has assigned three researchers of the Project Team to revise the PNL and EI methodologies and tools in order to select the most relevant techniques to extract information from CPG texts. Two more researchers, including a research assistant with a temporary contract, have worked with the Team in the design and implementation of tools to automatically extract concepts and relationships from the CPG texts, using the selected PNL tools and public available repositories, such as the UMLS, and the development, verification and validation of resulting algorithms to generate electronic GPCs from texts.</td>
</tr>
<tr>
<td>UJI</td>
<td>Has allocated two full-time faculty members, both belonging to the Knowledge Engineering research group, to attain the general objective O2. The research work related to O2 includes mainly the study of the alternatives for the representation of electronic CPGs and protocols, and a case study about the development of operational versions of CPGs for an individual disease.</td>
</tr>
<tr>
<td>UJI</td>
<td>Personnel listed in the previous item has also tackled objective O3. Among the research tasks within O3 we can cite a case study about the development of operational versions of CPGs for multiple diseases, i.e. at the CP level, which includes an analysis of the process of integration of the required CPG fragments.</td>
</tr>
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</table>
M4. URV has assigned four researchers of the Research Group on Artificial Intelligence to work in the definition of the language to represent healthcare procedural knowledge [1, 2], the definition of the data structure model to provide data about healthcare treatments in a standard way [3], and the development and testing of several algorithms [4,5] to induce healthcare procedural knowledge structures from the data provided by HCB and SAGESSA [6]. There is also an URV PhD student working in the use of background knowledge which is represented as cost functions and partial orders to improve the knowledge structures obtained [7,8] as a previous step to the introduction of background knowledge as ontologies. All the works have been supervised by the URV members with medical background.

M5. The design and implementation of the MAS has been addressed by means of the coordination of four members of the URV team and a new researcher contracted for the project.

M6. HCB brings its accumulated experience in the area of integrated care and new modalities of health care provision using ICT to the identification of adherence indicators and to mechanisms to assess the level of accomplishment of such adherence. This has involved health professionals that are part of the integrated care team under the coordination of their supervisor (head nurse). The areas of expertise that have been covered are the ones corresponding to the initial selection of pathologies (chronic obstructive pulmonary disease, congestive heart failure and diabetes). The overall coordination is being carried out by research personnel from HCB's Information Systems Directorate.

Table 2. Means to achieve the objectives of the HYGIA Project.

The means described in table 2 have been used to reach the six objectives of the HYGIA project according to the work plan described in the proposal. Table 3 summarizes the actions performed during the first, second, and third year of the project for each one of the objectives. Observe that the project is currently at the beginning of the third year. The chronogram here is an updated version of the one appeared in the proposal.

2 Level of Success Achieved in the Project

2.1 Achievements on NLP technologies

Task USC-T1.2 (design and implementation of tools for the acquisition of ontology concepts) was successfully achieved during the first year of the project. Later, the USC team worked in further versions to increase the performance (recall and precision) of the developed techniques and to implement new algorithms to improve the disambiguation of GPC guidelines.

Task USC-T1.3 (design and implementation of tools for the automatic generation of ontology relationships) was carried out during 2008, although comparing the obtained results and the PROforma formalism (finally selected to be used in the codification of medical guidelines in HYGIA), some adjustments of the techniques during 2009 will be made, aiming to automatically acquire more types of knowledge. A journal paper will come out of this task, during 2009.

Task USC-T2.2 (design and implementation of tools to generate electronic CPGs) is being carried out.
Task USC-T2.4 includes verification and validation of the algorithms and techniques. It has been made in parallel with the other tasks. The validation part is the most critical one, as no gold standard exists and we need it manually.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actions</th>
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<tr>
<td>2007</td>
<td>O1 Several PNL and EI techniques, algorithms and tools were analyzed and the most relevant to extract knowledge from GPC texts were selected. Tools and algorithms to acquire clinical entities from texts were started.</td>
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<tr>
<td></td>
<td>O2 An analysis of the alternatives for the representation of electronic CPGs, protocols and CPs was carried out. The case study about obtaining CPs, under a “CP oriented” perspective, was started [29]. The CP chosen deals with stable COPD+HF patients.</td>
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<td></td>
<td>O3 The study of the problem of integration of different CP fragments was started.</td>
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<tr>
<td></td>
<td>O4 During the first year the URV team defined SDA (the formal language to represent procedural knowledge in medicine) and published the representation model [1, 2]. SDA Lab v1.0, a platform to manage such sort of knowledge, was also started [9]. Initial bilateral contacts between URV and HCB were set up to determine the data structures to be used as input of the learning process. Partial data was extracted from HCB databases. A first version of the learning algorithm was obtained [6].</td>
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<tr>
<td></td>
<td>O5 During 2007 URV studied several agent-oriented software engineering methodologies, and selected one of them for the project. The task was completed, and reported in [12], [13], [14] and [15]. The PROforma formalism was finally selected to be used in the codification of medical guidelines in HYGIA. A preliminary design of the MAS for the follow-up of guidelines was proposed.</td>
</tr>
<tr>
<td>2008</td>
<td>O1 Several publicly available information resources were revised and the most relevant ones for our work were selected. Algorithms to acquire clinical entities from texts were finished. New algorithms to acquire modifiers and relationships from texts were implemented. Some verification and validation texts were made, in order to detect gaps and correct them. A preliminary design of tools oriented to automatically transform the acquired knowledge into PROforma components was carried out.</td>
</tr>
<tr>
<td></td>
<td>O2 The case study about obtaining CPs (stable COPD+HF patients) continued.</td>
</tr>
<tr>
<td></td>
<td>O3 The study of the problem of integration of different CP fragments continued, devising methodologies for the integration using CPG tools. The application of formal methods to the development of CPs was started, with strategies for the analysis of the integration of CP fragments using model checking.</td>
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<tr>
<td></td>
<td>O4 The SDA Data Model was defined [3]. This model formalizes the sort of inputs the learning algorithms are able to process. Subsequent versions of the SDA Lab v1.7 were implemented [10]. New algorithms to learn SDA structures were developed and tested, but still not published [11].</td>
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<td></td>
<td>O5 A renewed version of the design of the MAS was obtained. The final design was a conveniently modified subset of the HeCaSe2 MAS, especially designed for the automatic coordination of all the medical staff following PROforma codification. The designed system was implemented and reported in [15, 16, 17, 18]. In particular, [16] includes a state-of-the-art analysis and comparison of the main existing guideline execution systems.</td>
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</table>
|      | O6 The indicators for COPD and CHF have been defined and are being validated by the integrated care team. The ones corresponding to diabetes are still under development. A proposal for inclusion of new ones has been recently communicated to the team in order to cover new services expected to be operative by mid-2009. This is currently under evaluation for inclusion. The indicators selected are aligned with the institutional program and are planned to be used in the evaluation exercise of four services piloted under a EU
2009 funded project [19].

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<tr>
<td>O1</td>
<td>The implementation of algorithms to automatically transform the acquired knowledge into components of an electronic guideline will be carried out. Final verification, validations and publications of the results reached with the implemented algorithms will be made.</td>
</tr>
<tr>
<td>O2</td>
<td>The case study about obtaining CPs (stable COPD+HF patients) is to be completed.</td>
</tr>
<tr>
<td>O3</td>
<td>A comprehensive methodology for the development of CPs, comprising the utilization of CPG tools and formal methods, and the integration of other knowledge sources, is expected to be completed by the end of the project.</td>
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<tr>
<td>O4</td>
<td>Final tests and publications of the ML algorithms. Exploitation with the data of HCB.</td>
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<tr>
<td>O5</td>
<td>The incorporation of the adherence algorithms in the MAS has to be addressed to June 2009. The test of the MAS with real medical data will be performed between July 2009 and the end of the project, as initially planned.</td>
</tr>
<tr>
<td>O6</td>
<td>Completion of definition phase of indicators. Validation of the final set in the proposed testing scenarios.</td>
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Table 3. Chronogram to achieve the objectives of the HYGIA Project.

2.2 Achievements on KE methodologies

This part deals with the objectives O2 and O3 in table 1, which are structured into two main sets of tasks, namely T1 – Development of electronic protocols from CPGs and T2 – Elaboration from electronic CPs from electronic protocols. The achievements of these sets of tasks are listed below.

**Task UJI-T1.1**, analysis of the alternatives for the representation of electronic CPGs, protocols and CPs, was completely and satisfactorily fulfilled during the first months of the project. As a result, SAGE and PROforma were deemed the most adequate candidates according to the needs of the HYGIA project.

**Task UJI-T1.2**, analysis of the requirements for the definition of constraints to apply to electronic CPGs for obtaining electronic protocols, has been postponed due to a reformulation of the research goals of related tasks, namely UJI-T1.3 and UJI-T2.2 (see explanation below). The task is expected to be reconsidered by the end of UJI-T2.2, i.e. during year 2009.

**Tasks UJI-T1.3** and **UJI-T2.2**, about obtaining protocols from CPGs and CPs from protocols, have been reformulated into an integrated task due to a change in research orientation. This new orientation stems from a perspective “CP oriented”, rather than the original “CPG oriented” one, and was devised in collaboration with the medical experts during the process of knowledge acquisition of a CP for the prevention of exacerbations in stable COPD and HF patients. In this context, progress has been made in the definition of reusable CP fragments.

**Task UJI-T2.1**, analysis of the problem of integration of different protocols, has also been affected by the changes mentioned in the previous item, shifting from the integration of protocols to the integration of CP fragments. In this case, progress has been made in methodological guidelines for the integration of electronic CP fragments using CPG tools.

**Tasks UJI-T1.4** and **UJI-T2.3**, about the application of formal methods to the development of both protocols and CPs and also influenced by the changes in UJI-T1.3 and UJI-T2.2 tasks, will be tackled jointly during year 2009. To date, progress has been made in strategies for the application of formal methods to the integration of CP fragments.
Concerning the integration tasks requiring UJI collaboration, namely HCB-I1 and UJI-I2, they are both pending, waiting for the required input of the corresponding partners (HCB and URV, respectively).

### 2.3 Achievements on ML algorithms

This section is directly related to objective O4 in table 1. In the project proposal, we identified three tasks addressing the achievement of that objective. Task URV-T1.1 was about the selection of the representation language to model medical treatments. Task URV-T1.2 was about the determination of the data structures to be used for the generation of models of medical treatment, and Task URV-T1.3 was about the design, implementation and testing of the machine learning (ML) algorithms. We also identified an integration task that was closely related to the construction of the ML algorithms: Task HCB-I4 about the preparation of the necessary data for inductive learning.

**Task URV-T1.1** was fully and successfully achieved during the first year of the project [2]. The URV team is working in further versions to include respectively Boolean variables and multi-valued variables, though these developments are out of the current project, but a continuation of it.

**Task URV-T1.2** suffered from unexpected delays. The work expected for 2007 had to be shifted to 2008 [3]. Now the task is finished, however due to final considerations of the new data in HCB, some minor adjustments of the data model during 2009 are possible.

**Task URV-T1.3** run on time and the results are as good as expected. A journal paper will come out of this task, during 2009.

**Task HCB-I4** was proved to be critical, personnel from URV was assigned to support the work of HCB. The exportation of data was already done. The preprocessing of such data is requiring more effort than initially planned. At the moment there’s an URV part-time researcher working with the data. The work in 2009 is expected intensive, as far as this task is concerned. A Master Thesis is expected out of this work.

### 2.4 Achievements on the definition of adherence

Objective O6 relates to a crucial challenge daily observed in the domain of healthcare provision: On one side, our understanding of diseases has allowed a high normalization of professional work and this is reflected in clinical guidelines. On the other, although ICT solutions have definitely penetrated the healthcare sector, they still seem not to sufficiently support current work practices. The reduction of the individuals’ variability in applying treatments requires adopting mechanisms that generate information about such behaviors. This means first representing the knowledge and, secondly, collecting an analyzing the way professionals adhere to the normalized practice.

**Tasks HCB-T1**: Development of electronic CPGs from textual CPGs. With subtasks: Selection of adequate textual CPGs (completed); Filtering of textual CPGs, to discard issues not relevant and incorporating particularities of the participating institutions (the CPGs for the three pathologies considered were selected and their contents were filtered and marked for the inclusion in the programs targeting the segment of chronic patients that are treated in the integrated care program of HCB); Development of the electronic CPGs (it was suspended following the discussions among all the partners - It was assessed that its level of complexity and associated effort was too high and it was not clear that the intended outcomes could be achieved. In turn the focus was set on the development of the textual care paths and move from them to their electronic versions).
Tasks HCB-T2: Development of protocols and electronic patterns of care (CPs or PoCs) from textual CPGs. With subtasks: Development of general protocols (the general protocols for each one of the three conditions have been elaborated as well as those reflecting a mix of pathologies (COPD+CHF, COPD+CHF+Diabetes). Problems have been raised (as already expected) in the area of professional interventions linked to comorbidities. This has required extending the initial group of experts to consultants from the required specialties); Historical Patient data analysis to determine comorbidities (we produced an anonymous historical set of the integrated care programs database. This database was provided to the researchers of URV together with the description of the structure and flows of patients and data for the different processes represented); Development of electronic CPs integrating the management of comorbidities (this task is about to start, as soon as the required clarifications described in HCB-T2.1 concerning comorbidities are solved. The only work carried out has been the contribution to the selection of the tool for representation).

Tasks HCB-T3: Adherence indicators: definition and monitoring methodology. With subtasks: Definition of adherence indicators (it is currently finishing -indicators for the single conditions and check points for adherence have been defined but doubts on how to handle them in the context of more than one pathology are being clarified), and Definition of a monitoring system for adherence indicators (this task runs almost in parallel to the previous one. It is at its end at present).

Tasks HCB-T4: Integration of CP in existing chronic programs. Data collection. With all the subtasks to be executed during year 2009.

Task HCB-T5: Impact assessment on current processes and clinical outcomes. To be executed during year 2009.

Task HCB-I1: UJI’s supervision of CPGs modeling from the textual versions. This task has been reformulated. Modeling will be carried out on the care paths and not on the set of guidelines as initially planned. Trials in segments of the care paths have been done and upon resolution of the definitions of the segments corresponding to the comorbidities the entire paths will be modeled.

Task HCB-I4: Preparation of the necessary data for the inductive learning. A first set of anonymous data have been prepared together with the information of the data structure and data flow.

2.5 Achievements on the integration of components

Objective O5 in table 1 is related to tasks URV-T2.1 (study and selection of the agent-oriented software engineering to be used in the design), URV-T2.2 (design of the MAS to help follow PAs), URV-T2.3 (implementation of MAS), URV-T2.4 (design of algorithms to measure health service quality), URV-T2.5 (use of the algorithms in the MAS), URV-T2.6 (use the MAS with real data), URV-I5 (integration of indicators of adhesion in the MAS), HCB-I6 (practice of the MAS with real data).

Task URV-T2.1 was completed on time and the results of the study were published in [12, 13, 14].

Task URV-T2.2 used the results of task URV-T2.1 to generate a first design of the MAS. This design was discarded after deep changes in the interpretation of clinical pathways (from an initial general pathway for each disease to specific pathways for disease admission, assessment, follow-up and discharge). This affected the way that these pathways had to be implemented, and therefore the general design of the system.

Task URV-T2.3 is fully developed except for the incorporation of the algorithms to calculate adherence to clinical pathways. This part is expected to be concluded in 2009.
Tasks URV-T2.4, URV-T2.5 and URV-I5 were initially planned for 2008 and first quarter of 2009, but some delays in the definition of the adherence indicators caused that their implementation and incorporation in the MAS had to be postponed. Tasks URV-T2.6 and HCB-I6 are about the general behavior of the MAS when it is confronted to real data. This part belongs to the last year of the project, just started.

3 Indicators to Help Evaluation

HIGIA is a coordinated Project integrated by four subprojects:
- TIN2006-15453-c04-04: Multi-pathology clinical pathways to assist chronic patients: development and evaluation of adherence by professionals.

3.1 Indicators for TIN2006-15453-c04-01

The work of subproject TIN2006-15453-c04-01 revolves around the elaboration of machine learning algorithms to induce procedural knowledge, and the development of a MAS to perform the tasks of CP execution and adherence analysis. The algorithms to develop procedural knowledge have been implemented, tested and published in [4, 5, 6]. Regarding the MAS, it has been implemented and it is able to execute CPs in PROforma it is also ready to integrate the quality functions to evaluate adherence ratios once these are fully defined by the medical partners in the project. Technology objectives of this project are, therefore, almost completely fulfilled though URV continues working to improve the algorithms developed [11].

Considering existing bibliography, the machine learning approach to generate CPs is quite innovative, and the results obtained till the moment are highly promising and envisions a fruitful research line that URV will continue in the future. Developing a MAS for the interpretation of CPs is not as innovative, but the original parts have been published in [12-18]. The application of these results and the final products in health care systems is been addressed during the last months at the level of Catalonia by means of preliminary meetings. The subproject has been the launch platform for two PhD Theses [15, 30], two Master Thesis and one Diploma Project.

Coordination with other groups of the project mainly happened during the development of the MAS where technological and medical partners provided comments and ideas to improve the system, apart of reaching a common agreement on the language to represent CPs, which is very important to the system implementation.

The subproject has published a couple of Springer Lecture Notes in Artificial Intelligence, related to the topic of KM of procedural knowledge in medicine. D. Riaño has also organized three international workshops in this same topic that served to foster dissemination of the subproject results. The workshops were also the means to know other European groups with related to the subproject interests.
3.2 Indicators for TIN2006-15453-c04-02

The techniques developed in the project are useful to automatically extract concepts and relationships from GPC documents, which can be automatically translated into components in a computerized GPC, simplifying the knowledge acquisition in the development of a knowledge-intensive system. Moreover, our techniques can be used to automatically mark-up a GPC document with UMLS codes. So, in a future, these GPCs can be easily indexed by electronic libraries, such as now research publications are. In general, these publications are indexed by terminologies as EMTREE or MeSH. As a result of the project (not included in the initial proposal), we have adapted our techniques to map the terminology EMTREE (used to index EMBASE) onto the UMLS, providing the inter-operability required for efficient searching GPCs. The tools developed in the project implement a method for automatically generating knowledge representations from natural language documents. Several research groups have already exploited the automatic processing of medical documents, but often limited to extract data from clinical reports or to mine concepts and relationships from journal papers and abstracts. Our techniques include a richer acquisition of knowledge: medical entities, relationships and medical actions. So, new potentials of using publicly available terminology and ontology resources to produce useful semantic structures were opened in the project. Existing medical NLP systems normally use some terminology to map natural language onto concepts in the terminology but they do not use the same terminology to code modifiers nor relationships between concepts or between these modifiers. In the project, we have exploited the UMLS for generating mappings from natural language onto concepts, modifiers, relationships and medical actions, based on terminology, syntactic and semantic information. Finally, reusing our techniques, we have developed a method to automatically map an external terminology (such as, EMTREE) to the UMLS. All this work has been disseminated with the scientific papers [20-23] and presented in the conferences CAEPIA 2007, EUROCAST 2009, and IWINAC 2009. As far as human resources is concerned a PhD thesis has been finished [24] and two more started [25, 26] in the topic, and also a MsC thesis [27] and a Diploma project [28].

This subproject and their members has fostered the collaboration with the Departamento de IA at UNED (research group of Prof. José Mira), the Department of AI at UPM (research group of Prof. Asunción Gómez Pérez) and with the research groups participating in this project.

3.3 Indicators for TIN2006-15453-c04-03

The project proposal includes a set of measurable objectives specified in terms of milestones. The initial milestones can be reformulated according to the changes in orientation of UJI-T1.3 and UJI-T2.2 tasks: (1) a selection of languages for the representation of CPGs, protocols and CPs, (2) strategies for the integration of different CP fragments, (3) a case study of development of CPs, (4) resulting CPs in electronic format, and (4) methodological guidelines for the elaboration of CPs. All these milestones are expected to be completed by the end of the project. The case study of development of CPs chosen implies in itself a high degree of innovation, because the management of stable COPD+HF patients is a topic of research in the medical domain. Consequently, the development of electronic CPs for this topic is highly relevant and innovative. An oral communication has been presented in the 2008 Tromso Telemedicine and eHealth Conference [29], about the development of electronic CPs under the so called “CP oriented”
perspective. Another publications are under preparation, about the methodological guidelines for
the integration of electronic CP fragments using CPG (and other) tools.
Advances in ICT tools associated to the management of stable COPD+HF patients would have a
very positive impact in the population of patients with these problems.
In the framework of the project, a master thesis student is being supervised by UJI team.
The topics under study in the HYGIA coordinated project are highly diversified and consequently
the whole set of objectives would be difficult to achieve without the participation and competences
of the different members of the consortium.
Although different European institutions have stated an interest in this project, no international
collaborations have been initiated directly related to it.
Project development evolves as expected, although different delays have been identified in
particular tasks. The main delay, related to the integration task HCB-I1, is planned to be solved in
short and hence it is not expected to become critical.

3.4 Indicators for TIN2006-15453-c04-04

The subproject TIN2006-15453-c04-04 aims at identifying and assessing the level of adherence to
multi-pathology patterns of care (CP) by healthcare professionals when these CP are applied to a
program of care for chronic patients. Regarding the specific objectives of this subproject, the
development of multi-pathology patterns has proved not to be, due to the need to address the
inconsistencies that are when single-disease protocols are combined. We are at present closing this
phase. Indicators of adherence have been worked out almost in parallel to the definition of
patterns of care. They are base on the selection of items that depict the progress of the condition
or conditions plus the overall patient status and correlate them with the interventions carried out
and their timed sequence. Upon completion of the previous phases, and following the technical
development by the corresponding partners, CPs and the mechanism to assess adherence will be
tested in real cases during 2009.
The growing interest in alternative non-institutional services to care provision in the segment of
chronic patients is hampered by the difficulties in defining viable models. The current focus is set
in proving that they are operationally feasible in a context of multiple providers and institutions. In
this scenario, ensuring that the professionals adhere to the CP has a paramount importance. Up to
now, a trusted solution does not exist and this makes the project relevant.
A knowledge-acquisition framework to facilitate the development and reengineering of care plans
in electronic format. Part of this work appears in [29].
Regarding the relevance of project outcomes, finding out a viable and sustainable scenario for this
type of services has significant socio-economic impact. Our current format of services for chronic
patients will not be sustainable any longer in the short run. Therefore, intervention of professional
should be strongly guided by evidence and adherence to patterns of care (or guidelines, in general) is
a cornerstone in this process.
In a more specific case, HCB is preparing the commercialization of a set of software applications
based on its experience in chronic patient management (Linkcare products). Should the results of
the coordinated project be successful, an additional module could be included in this software.
In the context of the project, a pre-doc student is being trained in the use of the tools to
electronically represent the patterns of care.
The coordination has allowed the HCB project team to gain accessibility to tools and methods of
representation that previously were unfamiliar to us.
The Normare project complements the main research line in chronic patients that started in year 2000 at HCB. Therefore, collaboration with running European projects and the teams in the Consortium is an open possibility. At this moment, HCB coordinates the CIP-PSP project NEXES that aims at evaluating 4 integrated care service programs (home hospitalization, frail patients, wellness and rehabilitation and support to discharge and transfer across levels) in 5000 patients. The interventions of professionals during the field phase of the pilots will be coached through peer-reviews and quality teams to ensure adherence to the protocols defined for patterns of care. The options offered by HYGIA will be discussed during the elaboration of the Nexes pilot handbook for professionals and depending on the maturity of the HYGIA outcomes, the possibility to integrate the approach in Nexes will be considered. The project has experienced some difficulties in the task of developing the multi-pathology patterns for chronic patients. Actually this was partially expected since these difficulties have been pointed out previously as an outstanding problem in the management of these patients. HCB has counted on the experience of the professionals that are part of the integrated care program. However, formalizing their interventions has proved to be a long process. As a result, this delay has partially influenced the elaboration of the indicators that are to reflect the level of adherence of professionals.

4 References

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