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Med*intel*: Decision Support for General Practitioners: A Case Study

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Abstract. Short consultations and a large and growing amount of available medical information make searching for suitable information difficult for general practitioners. Thus information is often not searched for or not found, diminishing the quality of care. We propose a system that offers decision support by combining medical information sources with data from the electronic patient record. A first evaluation shows that a system like Medintel can be a useful supportive tool and can increase the quality of care provided by general practitioners.

Keywords. Information handling, general practitioner, decision support, electronic patient record

1. Introduction

General practitioners need information, both patient data as well as general medical information, in order to successfully execute their tasks [1]. *Patient data* concerns the medical condition and history of the patient. The general practitioner may also consult *medical information*. Medical information can greatly influence the decisions made by general practitioners and, consequently, on the quality and costs of medical care [1, 2].

General practitioners express increasing difficulties in searching for and using medical information and patient data [1]. Many questions general practitioners have during consultations remain unanswered because the physician cannot find or does not search for the answer, possibly diminishing the quality of care [1, 2].

Our research focuses on designing a software system with which medical information and patient data can be *intelligently* combined and used by the general practitioner. Unique features of this system, when compared to other proposed knowledge systems, are the integration of different sources of data during both the diagnostic and therapeutic phases of medical decision making.

This paper is organised as follows. Section 2 provides some preliminaries related to the information provisioning to general practitioners and the results gained from a survey of general practitioners. Section 3 details the requirements for the information system we developed. A prototype application was implemented, based upon the design described in Section 4. In Section 5 we present the result of a first evaluation of

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the prototype, aimed at verifying the requirements with general practitioners. We end our paper with the conclusions in Section 6.

2. Preliminaries

Medical information sources can be roughly classified into three categories: guidelines, reference texts and scientific literature. *Guidelines* show physicians decision criteria and suitable actions given specific patient characteristics. *Reference texts* give physicians extended background information on general subjects. *Scientific literature* is the collection of medical research publications. In addition to a review of the literature on information behaviour by clinicians during patient visits, we carried out a survey to establish the information requirements of general practitioners. From questionnaires we sent out to 20 physicians, we learnt that during consultations, guidelines are the preferred source of information (mentioned by 11 out of 13 respondents). Reference works are the second most used type of information sources (10 out of 13). Scientific literature is hardly ever used by the general practitioners we surveyed (3 out of 13), mostly because the information is deemed too specific and searching for the correct literature takes too much resources. Details of this survey can be found in [3].

The sources are used for both *diagnostic* as well as *therapeutic* decision making. The usage of these sources is considered positive, since it increases the physicians' certainty and may thus increase the quality of care provided. All general practitioners agree that combining the information from these sources and the patient data from the electronic patient record in order to find the information that best suits the specific patient situation is very difficult. Also, once information has been found it is often found time-consuming to put this information into the electronic patient record. The general practitioners agreed that in the majority of cases they can execute their tasks without using any source. They do require information when it comes to rare or complex situations. Knowledge systems could be of help to physicians dealing with multiple information sources efficiently.

A survey of existing and researched knowledge systems for general practitioners revealed three types of systems [3]. First, systems like *PubMed, QuickClinical, MELISA* and *OnSSA* enable physicians to search through collections of medical literature using various query optimisation techniques. Next, clinical decision support systems like *DXplain* show the user possible diagnoses based on entered symptoms. Finally, knowledge systems integrated into the electronic patient record, like *HepaTopix/PsychTopix*, *MINDscape*, *STEPPS*, *Infobuttons*, and *Mira* have varying methods for accessing sources from or based on the contents of the patient record.

Many of the mentioned knowledge systems use a representation of medical knowledge in order to recognise relations between patient data and medical information. *Classification systems* like *ICD*, *ICPC* and *LOINC* provide codes for medical terms without relating the associated concepts [4–6]. *Taxonomies* (like *MeSH*) are collections of terms of which the associated concepts are structured using parent-child relations [4]. *Thesauri* like *SNOMED CT*, *UMLS* and *MED* take this approach one step further by facilitating several of these hierarchal structures, and other relation types between concepts (for example, chemical compound A is the working substance of medication B) [4]. Finally, an *ontology* is a controlled vocabulary which is expressed in a formal language. Because of this, statements in these collections are always meaningful. A good example of this is the *OpenGALEN* ontology [7].

3. Requirements for a Knowledge System for General Practitioners

From our preliminary research we found that general practitioners most often require medical information in rare or complex clinical cases where possibly many patient attributes need to be overseen. If one combines this fact with the enormous amount of information and very little time during consultations, the image of a system which assists the physician by *reasoning with him* comes into view. This notion was also brought forward by the physicians themselves in the questionnaires they returned: they wished for diagnostic assistance and a provision of possible treatment steps given an established diagnosis and certain patient parameters. Another wish was better interaction between information sources and the electronic patient record.

In order to facilitate these wishes, the answers given in the questionnaires show that an information system could be of use, when it meets the following criteria. First, it needs to be able to *interpret* information sources. Second, it needs to be able to filter these sources based on the content of the electronic patient record, so only information relevant to the situation is shown. Third, it needs to be able to combine this information and the patient data in order to assist the user during diagnostic and therapeutic decision making. Finally, it needs to be able to capture relevant information from the decision support process in the electronic record, in order to ensure the record is complete. None of the researched systems conform to the above criteria. Notably, the combination of support for all three types of information (guidelines, reference texts, and scientific literature) for both diagnostic and therapeutic decision support is lacking.

4. Med*intel*: Decision Support for the General Practitioner

Medintel is designed as an extension to the electronic patient record which enables the general practitioner to combine patient data and general medical information for decision support purposes. Med*intel* accepts entry of symptoms and reads patient data from the record which results in the display of a differential diagnosis, based on the specific patient characteristics. The differential diagnosis can be made more accurate by executing one of the proposed additional examinations which are also shown. After the user agrees on one of the presented diagnoses, a treatment plan is presented. The physician can select steps from this plan and, where needed, change the suggested parameters for these steps (e.g., medication dosage). The presented plan is merely a *suggestion*: the user is free to choose other steps. In this case Med*intel* can provide soundness checks on the input (e.g., whether a medication conflicts with one the patient already takes or an overdose is expected based on patient age and comorbidities). After confirmation, all data the user has entered is stored into the electronic patient record.

Med*intel* is designed to realise these functionalities, using the architecture depicted in Figure 1. The Med*intel* / EPR Interface takes the relevant data from the patient record and stores the relevant data entered during the interaction with the Med*intel* module back into the patient record. The controller takes care of the logic of both the diagnostic and therapeutic decisions, using the thesaurus interface to link concepts and the search engine to provide relevant guidelines, documentation, literature and external sources. These sources are served by their own specific components, as they have their own logic and structure in order to be used as part of the decision support process. They are combined in an intelligent information source interface, linking them to (outside) sources.

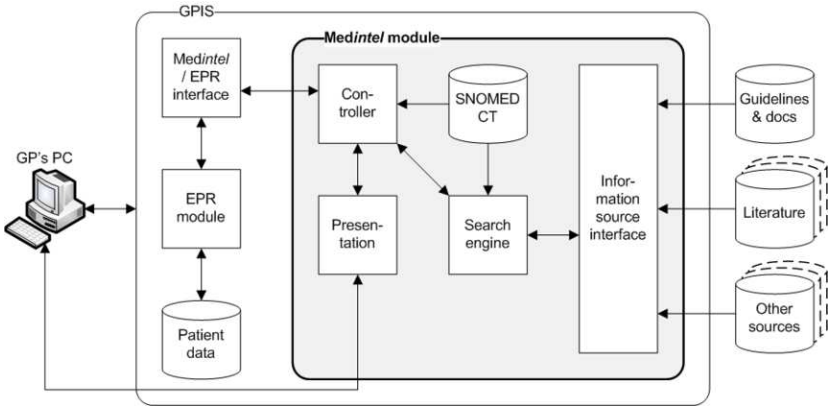

Figure 1. High level software architecture of Med*intel*.

Medintel's reasoning is based upon content from guidelines. Guidelines provide information about possible diagnoses given certain symptoms and patient parameters as well as treatment propositions. The most important Dutch guidelines (the NHG-Standaarden) are only available in plain-text. Thus, these need to be converted into a computer interpretable information structure. The Guideline Elements Model (GEM) is chosen for this, since it supports a broad range of knowledge elements, is easily extendable (it is based on XML), and its mark-up can be easily read and understood by domain professionals [8]. Furthermore, the plain text from the guidelines needs to be annotated with statements about the applicability to certain disorders and patient attributes. Also, medical concepts mentioned need to be hyperlinked for swift navigation. For coding of the concepts present in the guidelines, SNOMED CT is used.

Med*intel* is placed as a module inside the general practitioners' information system (GPIS) in the same way as the electronic patient record (EPR) module. The linking interface can be tailored to various existing GPISs and EPRs. The Med*intel* module interfaces to a centralised storage for guidelines and documentation and various other sources available on diverse locations. The proposed architecture enables easy extensibility of information sources and system logic, since only as much instances of Med*intel* need to be updated as there are GPIS instances, the guidelines are centralised and other sources can be interfaced. Finally, the patients' level of privacy is maintained, since communication between Med*intel* and the EPR stays within the GPIS. The design requires no additional patient data to traverse the network.

5. Evaluation

In order to test whether the requirements, as expressed by the general practitioners, are actually met by the Med*intel* design, we constructed a very limited prototype. The prototype contains medical guidelines and relevant background documents regarding thyroid conditions. It provides diagnostic support for four specific disorders of the thyroid gland and presents a treatment plan for hypothyroidism. A qualitative evaluation was conducted with two physicians, during which they were asked to execute a set of tasks with respect to diagnosis, treatment planning and information search for a specific patient using the system. The opinion of the user was discussed in

terms of usefulness of functionalities, the correctness of their implementation, the ease of use and whether the functionalities fit in with the consultation routine.

The evaluation result was positive: according to the physicians, the use of Med*intel* fits in their consultation routine. The list of possible additional examinations was especially welcome. The interface was found easy to use. In general, it can be said that the system lived up to the expectations these general practitioners have of a system which combines consultation assistance with information supply.

6. Conclusion

The large amount of available information makes searching for patient specific information difficult for general practitioners, given the short amount of time they have during consultations. Our research mainly focussed on the development of a prototype of a system that supports the physician in his information needs. When designing our system, we uncovered key user requirements which are not met by existing knowledge systems. A limited evaluation was carried out to validate these key design decisions.

At this moment, our system gives the general practitioner decision support and information provisioning whilst keeping the interaction streamlined with the process of a consultation. The general practitioner can thus focus more on the patient and the system gives him the possibility to quickly find suitable information from the sources which otherwise might not occur because it would be too time consuming. This may very well have a positive effect on the quality of care since with better information diagnoses can be more precisely identified and therapies better tailored to the patient, especially when dealing with rare disorders. Also, the checks the system can perform on the chosen treatment steps could lower the number of medical errors.

The results encourage further research. Evaluations with larger numbers of participants and more implemented guidelines will need to be carried out. Although further research needs to be performed, our evaluation indicates that a system like Med*intel* can be a useful supportive tool and can increase the quality of care.

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