Practice-Oriented Implementation of Medical Guidelines

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ABSTRACT

A survey conducted to determine the information needs of physicians revealed that medical guidelines are regarded as a vital instrument of quality management. Since many physicians lack adequate guideline knowledge, we advocate a process-oriented approach towards the implementation of medical guidelines. We argue that a successful implementation requires the embedding of guideline content into medical and clinical information systems. Thereby, physicians would more likely consider guideline information since they were readily available as part of their familiar information systems. Furthermore, relevant data stored in information systems can be used to tailor the presentation of guideline content to the physicians' actual needs. Additionally, the proposed integration of guidelines within information systems facilitates a guideline-compliant medical documentation. This paper investigates and discusses various integration methods to recommend a holistic approach for the deployment of medical guidelines in clinical information systems.

1. INTRODUCTION

As quality management has become an urgent issue within the healthcare market, the demand for additional information is increasing. Subsequently, new sources of information have arisen from this need (e.g. professional journals, medical knowledge data bases, discussion forums, etc.). Physicians, who have to catch up on aspects of quality assurance and management, are facing a vast amount of information with different levels of usefulness, significance and quality. In addition to simply providing information, the challenge is to make this information available appropriately. Only then, information regarding the process of quality management will become useful and in turn be used by physicians.

During a survey we asked about 2500 German physicians about their information demands and their handling of information [1]. It turned out, that physicians are interested in medical guidelines, which are elaborated and detailed documents on quality issues. The Institute of Medicine defines guidelines as "systematically developed statements to assist practitioner and patients decisions about appropriate health care for specific clinical circumstances" [2]. Several studies [3-5] report that despite physicians regarding medical guidelines as important, they often lack adequate guideline knowledge that would enable them to improve the quality of treatment.

We conducted interviews with physicians in order to learn about their difficulties when trying to implement guidelines into their daily practice. Based on the results of our survey, on the analysis of international Web portals providing guideline information, on the examination of different solution approaches towards the implementation of guidelines and adapted from the statements of the interviewed physicians, we developed a concept and a prototype for a work-process oriented implementation of medical guidelines [6]. Although, the system meets the requirements of physicians with respect to their information needs, it is restricted to address issues of information supply and advanced training. It doesn't support, however, the documentation of a patient's treatment according to medical guidelines and it doesn't provide pro-active information supply without explicit request from the physician.

This paper reports on current approaches of computer-based implementations of medical guidelines. We stress the importance of identifying workable and effective paradigms for guideline use, before developing formal models and designing applications. This is followed by a brief introduction of our prototype of a work-process oriented application of medical guidelines. After that, we discuss several possibilities to integrate our solution within clinical information systems. Finally, we briefly expose our future work.

2. COMPUTER-BASED IMPLEMENTATION OF MEDICAL GUIDELINES

Having recognizing that physicians don't automatically familiarize themselves with written medical guidelines and apply them appropriately, the provision of guideline information at the point of care is of growing interest. Possible applications focus not only on precisely tailored information supply but also on clinical decision support and reminder functions.

A well-structured formal model is a precondition for guidelines to become machine-interpretable and to integrate them into information systems. In our review, we considered several existing approaches [7-8]. Some of them require the modelling of detailed workflows, others, e.g. the SAGE guideline model [9-10] provide decision support based on existing clinical workflows. In contrast to the other approaches, the SAGE guideline model takes infrastructural standards such as Health Level Seven's Version 3 (HL7 v3) Reference Information Model (RIM) [11] and part of the SNOMED Clinical Terms [12] into account. The Fraunhofer Institute for Applied Information Technology currently works on a similar approach that is based on the Guideline Interchange Format (GLIF) [13-14] and also supports HL7 messaging standards to communicate with the patient's record repository [15].

It will depend on the integration strategy whether a guideline model including its own workflow description or being based on existing workflows would be useful. If physicians would like to document treatment processes closely according to specific medical guidelines, a guideline model extended with control flow specifications should be chosen. Otherwise, many physicians and hospitals define their own workflows (e.g. by clinical protocols or pathways); that's why the guideline model should not control the host systems' workflow management. Therefore, the identification of settings and applications in which medical guidelines can be most helpful, least obtrusive and demanding to workflow constraints is essential for developing a guideline model. Actually, there is little agreement on the most effective applications for computer-based guidelines. Consequently, it is not clear which functional requirements, and thus what conceptual guideline models offer the most likely chances of success. This problem is reflected by the variety of modelling approaches. In [16], Wears and Berg criticize current technology-driven approaches towards advancing clinical decision support systems for not adequately addressing the needs of physicians. They claim that any solution will not be effective with respect to yielding high-quality care, if it isn't tailored to the actual users and their specific environment.

3. SOLUTION APPROACH TOWARDS THE IMPLEMENTATION OF MEDICAL GUIDELINES

Our Web-based approach towards the implementation of medical guidelines focuses on two main features. The first one helps physicians to select appropriate guidelines, whereas the second feature adjusts the content and the layout of guidelines to the current task of a physician.

1. Assistance when searching for relevant guidelines
   In response to physicians reporting difficulties in identifying the appropriate medical guideline, particularly before the exact diagnosis is known, our solution makes it possible to select guidelines regarding the patient's symptomatology. By specifying main symptoms, it is possible to confine the number of diagnoses related to indication-specific guidelines. Furthermore, physicians get an overview of the complete symptomatology that is characteristic of a specific disease according to the guideline.
2. Process-oriented supply of relevant guideline information
   Physicians use medical guidelines for different reasons: E.g. they need specific guideline information during a patient's examination or they would like to deepen their knowledge about the treatment of a particular disease. In order to meet these requirements we developed two solution alternatives to visualize guidelines:
   - Due to the fact, that physicians don't want to adapt their daily routine to medical guidelines, it is necessary, to determine the activities that are typically part of the treatment process. By this means, we developed a simple process model consisting of the activities "Anamnesis", "Diagnosis", "Make Diagnosis", and "Therapy" and adjusted structure and content of medical guidelines to these activities. Thus, it is possible to provide guideline information on a cross-guideline applicable level. Therefore, physicians can find relevant information more easily, independent of the particular guideline and without having to adapt general treatment processes. This model is intended to be used, e.g. during doctor-patient talks.
   - In order to assist physicians who would like to get known a medical guideline in more detail, we also provide an indication-specific process model. This model is not adapted to physicians' treatment processes but describes the course of treatment recommended by the medical guideline.

4. INTEGRATION OF MEDICAL GUIDELINES INTO INFORMATION SYSTEMS

Although the feedback received from primary care physicians who tested our stand-alone application has been very positive, we would have preferred our solution to be integrated within existing information systems for many reasons. Our current prototypical Web-based application offers low-level context oriented access, because only the current activity is taken into account. But there are other aspects, like e.g. the available amount of time, the physician's specialization, risk factors etc., which must be considered before it is possible to provide adequate guideline information. These context data could be made available by clinical information systems. Furthermore, our solution would be more valuable, if it's integrated in systems that physicians are accustomed to using, since they should not have to interrupt their current task to switch between different applications. Some physicians are also suspicious in terms of data protection and network security; that's why they don't like to access the internet from a computer on which patients' health records are stored. Besides, medical guidelines are supposed to gain importance as proof of quality assurance. Therefore, physicians would like to have documented evidence that patient's treatment conforms to guideline recommendations.

4.1 Objectives of Guideline Integration

Guideline integration seems to be a valuable improvement of our solution approach, because it provides the possibility of a tighter interconnection between guideline content and data stored in information systems. The objectives of guideline integration into information systems can be described as follows:

- Context-oriented information supply: Medical information systems contain data, e.g. patients' medical histories, that can be used to determine the current physician's needs in terms of guideline information. E.g., references to prophylactic measures should correspond to patients' health profiles and the comprehensiveness of the information supplied, should depend on the amount of time that a physician has available. Thus, it would be possible to regard a more extended set of context information instead of just the current activity.
- Continually education: By integrating medical guidelines into existing information systems, physicians constantly get in touch with guideline information. Such a "learning-by-doing"-strategy promotes the effective implementation of guidelines in everyday work life.
- Effective risk management: In the future, medical guidelines could gain importance in cases of legal disputes. If physicians can document patients' treatment according to guidelines, they are enabled to verify that healthcare was compliant to evidence-based medicine.
- Marketing instrument: The increasing competition in the healthcare market prompts hospitals to assure that their medical treatment meets high quality standards. Therefore, an effective integration of medical guidelines into physicians' daily practice could lead to a competitive advantage.

We identified several levels of guideline integration that differ from each other regarding the possibility of achieving the objectives mentioned above.

4.2 Web-based Information Supply

The easiest way of integrating guideline content within information systems is by providing access to Web applications resembling our prototype. The disadvantage of this approach is that the possibilities of information exchange between information system and web application are very restricted. It is possible to pass context parameters from the information system to the web-application. Thus, the guideline information that a physician is interested in, with respect to the current context, could be more precisely defined. Though, Web applications usually serve the purposes of information supply, due to data protection and limits regarding the interoperability with client systems, a comprehensive and integrated documentation of treatment processes is not possible. Furthermore, physicians have to use an additional tool; that could reduce acceptance and thus, the implementation success. Therefore, a full integration of medical guidelines requires more complex solution methods.

4.3 Assistance by Selecting Appropriate Guidelines

In order to prompt physicians to use medical guidelines, the system should indicate the existence of appropriate guideline information as soon as possible. Those hints can be made available automatically or on request. The system can identify potentially useful guidelines at two different points of time:

- The physician enters a diagnosis according to a well known classification standard, e.g. ICD-10 [17].
- The system compares the data, entered by the physician, with guideline information, e.g. typical symptoms, lab values etc. This requires the integration of comprehensive medical thesauri, e.g. SNOMED-CT [12].

Classification standards like ICD-10 are widely diffused and already integrated by most of the information systems. Therefore, it is only necessary to determine which medical guidelines correspond to which ICD-10 codes. The disadvantage of this approach is that most of the diagnostic measurements are already made. Therefore, physicians probably won't get guideline support during differential diagnostics. Furthermore, the amount of data that can be used to identify an appropriate guideline, like symptoms, risk factors, test results etc., is reduced to simple diagnosis codes. That's why this approach causes loss of data, that would be useful for purposes of information retrieval.

Standardized terminologies used for medical documentation and data exchange improve the semantic interoperability between different systems and applications. Physicians document clinical pictures and therapeutic procedures, which will be automatically enhanced with additional medical terms. Further on, these terms are used to improve the potential of information retrieval tools. Thus, the integration of medical thesauri is a promising way to identify relevant guidelines during the course of medical treatment.

4.4 Context-Oriented Information Supply

Since medical thesauri facilitate semantic interoperability, they could not only contribute to support the identification of appropriate guidelines, but also to provide guideline information regarding the context of treatment processes. As mentioned before, our prototypical Web application only considers the current activity of a physician to determine the required information. If the context of a treatment process is described by standardized medical terms in more detail, the filtering rules applied to guideline content will work more precisely.

Besides the current activity and a patient's symptomatology, there are other aspects that have an impact on what content is meaningful to be delivered. E.g. the

physicians' specialization, the available time slot, and patient information (age, sex, medication, etc.) are among these aspects.

In order to support context-oriented information supply, the parameters influencing the relevance of specific parts of guideline information must be defined. The resulting context model can be used in combination with knowledge tools, such as decision support systems. In this respect, the SAGE approach [9-10] describes a guideline model, that defines so called "context nodes". These context nodes correspond to preconditions whose fulfilment will trigger the presentation of specific guideline information, serving purposes of decision support.

4.5 Automatic Controlling of Guideline Compliance

Medical thesauri and context data could be used not only to select relevant guideline information but to implement control functions. These functions are aimed at assuring physicians that their treatment is guideline-compliant. Both, diagnostic measures and therapeutic procedures can be taken into account. The information system derives the activities, done by the physician, from the medical documentation or the underlying workflow management system. Thus, it is able to compare these activities with the recommendations of medical guidelines. Based on the results of the comparison it informs the physician about differences.

For instance, a patient is suspected of having early rheumatic arthritis. Therefore, the physician accomplishes the necessary laboratory tests and enters the resulting values into the system. Then, the activities of the physician are automatically compared with the guideline recommendations. After the data matching, it suggests to make an additional examination, e.g. the test for the rheumatoid factor is missing.

The advantage of this approach is that there is no need for changing user interfaces. Physicians can use their information systems as before. But now, they get the possibility to check if they provide healthcare according to medical guidelines. The control functions could be activated manually or automatically. In the latter case, the trigger events, e.g. the documentation of a diagnosis, that cause the execution of control functions must be specified.

The disadvantage is that the system doesn't actively support treatment processes. The compliance to the guideline is only determined after the treatment. Therefore, unnecessary examinations can't be avoided. As physicians treat patients as before and can only check the guideline compliance with hindsight, it is not possible to achieve the positive effects of a "learning-by-doing"-strategy.

4.6 Guideline-Compliant Documentation Based on Common Practices

If we succeed in making guidelines part of common documentation strategies of physicians, their implementation would be most effective. Therefore, the objective is to modify standard documentation processes as less as possible. E.g. existing documentation forms could be extended by adding a guideline information bar (see Figure 1). Physicians choose whether they use this bar or not. Since the forms don't change, the documentation process remains the same.

As illustrated in Figure 1, we integrated the bar into a documentation form for anamnestic examinations of an existing information system. By combining the bar with the functionality described in 4.3, the system presents relevant guidelines regarding the symptomatology. Additionally, the bar could contain more information, e.g. special notes with respect to drug dosages. Physicians can fill in the form as normal; after that, they can decide if they would like to access the next documentation form and proceed with the next treatment step as recommended by the guideline (by using the NEXT button). Therefore, forms must be connected to each other, according to the medical guideline. Only if the guideline describes activities that aren't covered by existing forms, new forms are necessary. Other functionalities might be included, e.g. physicians can access the relevant passage of the original medical guideline by using the INFO button.

Thus, it is possible to document the treatment process according to medical guidelines, based on common documentation practices. The advantages are, that physicians don't have to adapt their documentation strategy and suppliers of information systems don't have to adjust documentation forms completely, in order to support process-oriented guideline compliant medical documentation. But, as process orientation becomes more and more an important issue in healthcare (e.g. clinical pathways), the systems will have to support process-oriented documentation strategies anyway, in the future. However, this solution approach could contribute to smooth the transition from the current medical documentation, that mainly considers aspects of reimbursement, to a documentation strategy, that allows to follow the treatment process that led to specific medical decisions more easily. Additionally, a history function could be implemented, that stores the sequence, in which a physician filled in documentation forms. Thus, it is possible, to check the compliance of the treatment with guideline recommendations with hindsight, as described in chapter 4.5.

4.7 Process-Oriented Documentation According to Medical Guidelines

The objective of medical guidelines is to influence physicians' decisions and practices. For acceptance purposes, in 4.5 and 4.6 we described strategies that can assure a guideline-compliant treatment and documentation without fundamentally changing treatment processes. With respect to educational purposes, it should be possible to adjust treatment processes to guidelines. This requires developing a

Figure 1. Guideline information bar to support guideline compliant treatment

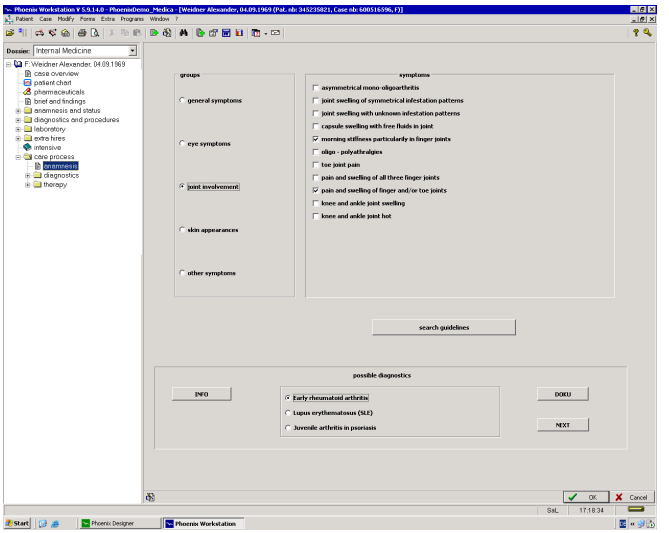
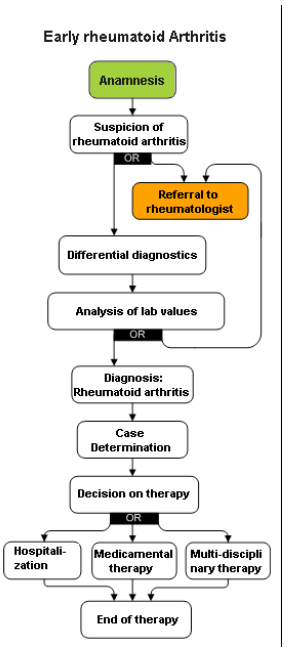


Figure 2. Process model of the medical guideline "Treatment of early rheumatic arthritis"



detailed process model of every guideline. Figure 2 shows an exemplary process model of a German medical guideline about the treatment of early rheumatic arthritis. We developed this model for our prototypical Web application.

The suppliers of information systems have to create documentation forms related to these process steps. E.g. if the physician confirms the activity "Referral to rheumatologist", the activity has to be registered as done and optionally a corresponding referral form should be issued automatically. Additionally, active decision support based on guideline information and patient's data, should be realized. If the physician confirmed the diagnosis and has to decide on therapy, the system could indicate which therapy appears to be most appropriate according to the patient's health status and medical preconditions. This requires the implementation of the functionality described in 4.4. Thus, this integration method would fulfil all the objectives mentioned in 4.1. The disadvantage of this approach is that treatment processes differ from guideline to guideline and therefore, physicians have to reconsider medical documentation depending on the current diagnosis.

5. CONCLUSIONS AND FUTURE WORK

Medical guidelines define recommended strategies for managing health care in order to improve quality, to reduce variations in practice and to help control costs. Since studies have shown that physicians lack adequate guideline knowledge, there is a growing interest in finding effective ways of integrating guidelines within information systems in order to deliver patient-specific recommendations at the point of care. Regarding the variety of formal guideline models and experiences with clinical decision support systems, it is essential to identify promising clinical settings and to determine the functional requirements in terms of practice-oriented guideline implementation.

Therefore, our fist step was a detailed analysis of the physicians' needs. After that, we developed a solution concept towards a process-oriented implementation of medical guidelines. Based on this concept, we developed approaches to directly implement guideline content into information systems. It turned out, that the full implementation of some features previously requires the implementation of other features. For example, in order to document treatment processes according to a specific guideline, first of all, the relevant guideline has to be identified. Furthermore, if systems should provide relevant guideline information in order to support physicians' decisions, it must be possible to determine the context parameters of the current treatment.

In cooperation with a number of German physicians and a commercial supplier of information systems, it is planned to develop a prototype that evaluates the integration options as described in chapter 4 with respect to a specific clinical setting. Thus, it will be possible to give recommendations on appropriate guideline modelling.

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