

# Work Process-oriented Implementation of Medical Guidelines

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**Abstract.** The development of medical guidelines aims at the increase of quality and the reduction of costs of medical services. Though guidelines are widely diffused, they still have hardly considerable influence on patient treatment particularly within the ambulatory sector. Considering this, we interviewed practicing physicians about their problems with the implementation of medical guidelines in primary care. These interviews and our study of related work revealed that the actual needs of practicing physicians have largely been neglected during the development process of medical guidelines. In an attempt to implement medical guidelines into primary care we analyzed the concrete requirements of physicians in order to meet their information demands. Based on these requirements we developed an approach of a work process-oriented implementation of medical guidelines. We also implemented a web-based prototypical application in order to put the concept into practice.

eHealth, Medical Guidelines, Clinical Pathways, Clinical Decision Support Systems

## 1 INTRODUCTION

Many countries presently launch health initiatives, usually to lessen the rate of increase in costs of health care. Medical providers are expected to take measures to reduce costs and to improve quality of public health services. Medical guidelines are intended as an instrument to achieve this aim. They impart knowledge and expertise in combating special diseases and are geared to the best current available evidence [1]. The use of guidelines enables the attending physician to provide patient care with minimal variability. Care that is goal-oriented, economically appropriate and of high quality.

Although medical guidelines are developed in principle for practicing physicians, this target group is hardly reached. The interests of the guideline authors are often too much in the fore. This conclusion is based on expert interviews, on statements in the quality report of the Institute of Medicine (U.S.) [2], and on other studies [3-5], according to which the scale of influence of guidelines on medical treatment is small. The important but still unsolved question how to embed guidelines into medical practice was also stressed on the 16. Guideline Conference of the Working Group of the Scientific Medical Specialty Societies (AWMF) in December 2005 in Berlin.

While the implementation of medical guidelines is promoted in stationary facilities e. g. by the realization of clinical pathways, their integration into the ambulatory sector has been neglected due to simpler organizational structures, missing monetary incentives and the lack of legal obligations. Since family doctors as well as general practitioners are the central contact person for patients with variable diseases of different ranges of severity, in many cases they are responsible for the initial diagnosis, the education about possible therapy approaches, the creation of individual medical treatment plans and the referral to specialists or hospitals. In this function family doctors usually make important decisions regarding patient care. Due to the capacity overload of specialists and the necessary aftercare following a stay in hospital, they often take over the ongoing medical attendance and therapy of the patients.

In this respect, a survey regarding the guideline knowledge of practicing physicians in Germany has shown that adequate guideline knowledge decreases according to the descending level of specialization (cardiologists 37,1%, internists without further specialization 25,6%, general practitioners 18,8%) [6]. In another survey 60% of family doctors in Hessen and 61,1% of family doctors in Berlin replied "rarely/never" to the question regarding the frequency of using medical guidelines [7].

This observation leads to the conclusion that medical guidelines are insufficiently adapted to the special needs of general practitioners. In summary, we identified the following main problems when implementing medical guidelines in primary care:

- The knowledge regarding medical guidelines and their use in patient care is decreasing due to general information overload and continuous changes affecting the health care system.
- In view of the abundance of regional, national, and European guidelines, physicians find it difficult to identify the currently needed guideline [8].
- Medical guidelines are usually available as comprehensive, insufficiently structured paper-based, or electronic documents, which complicates an efficient search for relevant information.
- The guideline development aligns only inadequately to real medical treatment (e. g. multi-morbidity) and hardly takes into account the different information demands of specialists and family doctors.

The use of information technology is considered a promising approach to implement medical guidelines [9]. In the following, we analyze the special requirements of practicing physicians in terms of software solutions for the implementation of guidelines. Subsequently, we examine current approaches to disseminate and implement medical guidelines if appropriate to use within the ambulatory sector. Finally, we present a potential solution to the current problems mentioned by practicing physicians.

## 2 REQUIREMENTS OF PRIMARY CARE PHYSICIANS IN TERMS OF SOFTWARE SOLUTIONS FOR THE IMPLEMENTATION OF MEDICAL GUIDELINES

Following a survey that we conducted to determine the information demands of physicians on their workplace [10], four primary care physicians participated in seven semi-structured interviews in order to validate and detail the results of the initial survey. The goal of these interviews was the identification of requirements in terms of a practical implementation of medical guidelines.

It turned out that the determination of the medical guideline needed for the treatment of a case, is the first concern that stands in the center of attention of physicians. Thereby, the search of the relevant guideline should be supported by possibilities to indicate the symptomatology and to make a first experienced-based classification into a symptom area. The term “symptom area” involves e.g., symptoms related to metabolic disorders, traumatic accidents as well as forms of arthritis and rheumatic diseases.

After the identification of the guideline a practice and work process-oriented implementation has to give a complete overview of all steps of a guideline-compliant treatment process. Physicians place great importance to a general, complexity-reduced description of all activities. Besides, the software solution should primarily refer to the concrete processes in medical practice, less to the course of treatment suggested by a guideline. But during the individual medical treatment guideline contents should be available regarding the current context. In this way currently arising information demands can be satisfied e.g., during doctor-patient talk. The interviewed general practitioners also appreciate an optional guideline version in more detail. This supports preparation and review activities concerning guideline-compliant patient care in order to close possible knowledge and experience gaps. Providing information from medical guidelines can be done on request of the physician. Furthermore a holistic, integrated solution is preferred which prevents time-consuming switching between different applications and systems.

In the following we summarize central requirements regarding the implementation of medical guidelines, determined by the survey [10] and the expert interviews:

1. **Support in selecting medical guidelines:** In advance to the use of guidelines it is particularly important to support the selection of a suitable, indication-specific guideline. E.g., the physician could specify the symptomatology of the patient in order to draw conclusions about available guidelines.
2. **Demand-oriented volume of medical guidelines:** According to the requirements of practical health care, it should be possible to get a quick grasp of guideline information and to deal with the subject more intensively. Therefore, physicians need

either an edited version of medical guidelines e.g., in the form of checklists and abstracts, and detailed version.

3. **Structuring of medical guidelines:** In order to be able to use guidelines as efficiently as possible, it is expedient to choose a standardized document structure. This facilitates e.g., the direct comparison of several guidelines to confirm a diagnosis.
4. **Intelligent content-based search functions:** When searching for relevant information within a guideline, methods should be available beyond the linking of several sections by hypertext structures. In this respect, content-based search functions are important that allow quick access to currently interesting information.
5. **Different data formats:** Beside the wide-spread PDF format, more data formats e.g., XML should be provided in order to improve the possibilities of processing medical guidelines.
6. **Interactive process visualization:** The usability of guidelines during medical treatment can be increased by visualization methods. Interactive process diagrams have to be closely adapted to the activities in medical practice.

### 3 EXISTING INFORMATION TECHNOLOGICAL APPROACHES RELATED TO THE DISSEMINATION AND IMPLEMENTATION OF MEDICAL GUIDELINES

The approach of using medical guidelines to contribute to an optimized health care was developed in the 1990s in the USA and has meanwhile been established in most western industrial nations. Since 1995 member societies of the AWMF also provide medical guidelines in Germany [11]. In order to coordinate the process of guideline development, clearing houses were created on national and international level. These tasks are undertaken e.g., by the National Guideline Clearinghouse (NGC) in the USA, the National Institute for Clinical Excellence (NICE) in Great Britain and the Medical Center of Quality Assurance (ÄZQ) in Germany.

There is a wide range of providers of guideline contents. Therefore, we limited our analysis of relevant web portals to the most important national and international ones.

#### 3.1 Web-based Dissemination of Medical Guidelines

Medical guidelines are made available by different national and international web portals. We examined and evaluated several platforms regarding their range of features to fulfil the requirements of practicing physicians.

We analyzed portals from the USA, Great Britain, Germany, France, Australia, and New Zealand concerning the criteria mentioned above. An overview of these portals is given by Table 1.

**Table 1 Overview of analyzed web portals providing medical guidelines**

Portal	Country of origin	Link
AMA (Australian Medical Association)	Australia	<a href="http://www.mja.com.au/public/guides/guides.html">http://www.mja.com.au/public/guides/guides.html</a>
ANAES (Agence Nationale d'Accréditation et d'Evaluation en Santé)	France	<a href="http://www.anaes.fr/anaes/anaesparametrage.nsf/HomePage?Read-Form">http://www.anaes.fr/anaes/anaesparametrage.nsf/HomePage?Read-Form</a>
AWMF (Working Group of the Scientific Medical Specialty Societies) Online	Germany	<a href="http://www.awmf-online.de">www.awmf-online.de</a>

Cochrane Library	Cross-national	www.cochrane.org
GIN (Guidelines International Network)	Cross-national	www.g-i-n.net
NGC (National Guideline Clearinghouse)	USA	www.guidelines.gov
NZGG (New Zealand Guideline Group)	New Zealand	www.nzgg.org.nz
NICE (National Institute for Clinical Excellence)	Great Britain	www.nice.org.uk
SIGN (Scottish Intercollegiate Guideline Network)	Great Britain	www.sign.ac.uk

The result of the evaluation is that the examined portals are primarily author-centered. On the one hand, great importance is attached to the illustration of a sophisticated review process, to the elaborateness and completeness of the document, as well as to the consideration of the individuality of the group of authors. On the other hand, the concrete requirements and information demands of potential guideline users, namely physicians from medical practice, are only partially taken into account.

During intensive discussions, family physicians voiced the need for support in selecting suitable guidelines. Starting point is usually the symptomatology described by the patient, rather seldom a specific medical area or an already known diagnosis. The portals of AWMF, NGC, NZGG, and the Cochrane Library render some assistance by providing keyword search features. Otherwise, the selection can be made by choosing a specific medical area or by using topic lists. The SIGN-Portal provides a very well structured quick reference on guidelines. Though, a detailed characterization of what the patient has expressed, whether a complaint or a symptom, is not possible. Concerning the document volume, guidelines are usually provided in two versions: A summary of one to two pages and a full paper of 50 to 80 pages. Medical guidelines often have a standardized structure only on the first semantic level. Only AMA provides additional structuring by document internal linking. The portal of NGC distinguished itself from the others in the possibility to make structured comparisons between guidelines. This feature saves time and effort for physicians when confirming a diagnosis. AWMF portal, Cochrane Library as well as the portals of NGC and NZGG offer search functions in standard and expert mode, which facilitate access to guideline contents. While the other portals are limited to a listing of guidelines, NGC makes predefined retrieval queries available. HTML and PDF are standards regarding the data formats. Only the NGC portal offers guidelines also in XML format, as MS Word document or downloadable for mobile devices. After the download as XML file, guideline contents can be efficiently processed by appropriate applications in local systems. None of the portals visualizes guidelines as interactive process diagrams. Mostly process representations are available as illustrations within text documents. So the interactive access to selected activities and contents during the guideline-compliant medical treatment is not possible. This is one of the main deficits of these portals concerning the implementation of guidelines in medical practice.

Overall, the investigation into currently available portals revealed that none of the portals comply with the necessary usability standards, and the user-friendliness was lacking through-out. This explains the rather rare use of medical guidelines in spite of the high availability via Internet [12].

### 3.2 Software Solutions for the Implementation of Medical Guidelines

After analysing web-based guideline portals, we now like to present some software applications which aim at implementing medical guidelines. Concerning the selection of technologies we confine ourselves to describing only such, which are currently of importance for our work. In the following these solutions are examined for their practicability within medical practices.

## 1. Clinical Pathways

A possibility for the integration of medical guidelines in health care is the realization of clinical pathways. These are control instruments based on medical guidelines which describe the way of a special type of patient with the crucial diagnostic and therapeutic achievements and its schedule [13]. Especially hospitals make more and more frequently use of software applications that implement clinical pathways. But the pathways are usually adapted to the specific requirements of one hospital and thus only rarely portable to other medical facilities.

Organizational structures and scheduling in the ambulatory sector exhibit a clearly reduced complexity compared with hospitals, whereby the integration of medical guidelines in form of clinical pathways appears too expensive and too time-consuming. Nevertheless, according to the model of clinical pathways it is necessary to conceive and develop IT applications in order to guide the user through the medical treatment and to support practicing physicians in embedding guidelines into medical care. In contrast to clinical pathways organizational aspects of medical facilities can remain unconsidered, because this is not mandatory in the more clearly arranged ambulatory sector. However depending on the particular guideline, it is possible to realize features like decision support, check lists, and variance documentation for quality assurance. When deciding on a special therapy, physicians could get assistance by receiving advice from the medical guideline. With the use of checklists e.g., physicians can control that all relevant questions are responded during the anamnesis. In cases of deviating from the medical guideline, a variance documentation would finally make a contribution to improve the guideline itself.

## 2. Clinical Decision Support Systems (CDSS)

Clinical decision support systems (CDSS) are another approach to implementing medical guidelines. They aim at the linkage of patient-specific data with medical knowledge bases in order to generate recommendations concerning current patient care. The knowledge can also originate from medical guidelines. The features include the provision of information about drug dosage, composition and adverse effects as well as support during diagnostics, treatment and recovery. Some systems assist in interpretation of medical images such as CT- or MRI-scans [14].

To realize CDSS on the basis of medical guidelines, it is required to transform each recommendation of a guideline into a computer processable algorithm, which is executed in accordance to the patient characteristics stored in medical information systems. Even though this solution is proved as useful in controlled studies, its practical application is limited. Due to the fact that each medical guideline contains an abundance of recommendations of best medical practice that have to be transformed into algorithms, implementation and update procedures within the system are very extensive. Also the diversity of systems and applications within community health impedes the deployment of the same program on different platforms [15]. Many CDSS developed so far specialized in the fulfilment of certain decision tasks. For this reason, physicians are obliged to deal with different systems depending on the kind of decision to be made. Also contents, to which a system refers, are not easily interchangeable between the different health care sectors, since the relevance of information is bound to the level of specialization of a medical facility. The adjustment to specific requirements and information demands of physicians is only difficult to reach. In addition CDSS do not always work error-free which has a negative influence on user acceptance [14].

Most of these systems have been conceived to be used in single medical facilities and to address a concrete medical problem. Due to their degree of development CDSS appear suitable for implementing guidelines in special cases, but not for a broad employment in medical practices.

## 3. Example Software Solutions

Prescribing Rationally with Decision Support in General Practice Study (PRODIGY) represents one of the rare examples of a nationwide used CDSS. The system is to support physicians in Great Britain during the patient treatment starting from a known diagnosis.



PRODIGY gives recommendations regarding prescriptions as well as non-drug therapies, provides furthermore learning content, and makes medical brochures available particularly for patients. The National Institute for Clinical Excellence (NICE) took over the management of PRODIGY. The Sowersby Centre for Health Informatics (SCHiN) provides and updates the contents [14]. The web-based version of PRODIGY supplies medical guidelines partly in form of HTML documents and partly as summaries in PDF format. Similar problems as in case of guideline portal providers (as discussed in chapter 3.1) arise from clarity lacking. There is no possibility of pre-selecting guidelines by means of certain factors e. g. symptoms or pain localization. The PRODIGY browser demonstrates the embedding of the above-mentioned features in medical practice software and clinical information systems [16]. The direct use of the system during the medical treatment appears difficult due to the complicated handling and the abundance of information, which can only be roughly filtered.

medrapid is a further web-based solution for specifying disease patterns and providing relevant expertise in regards to symptom complexes. It came out of a set of research projects at the medical faculty of the University of Heidelberg in Germany [17]. In the context of differential diagnostics, the application allows physicians to reduce the number of possible diagnoses by selection of specialist subjects, symptoms, pain localization, medical measures taken etc. If several diseases come into consideration the physician can prompt the system to automatically compare the different disease patterns. This solution could be enriched with guideline contents in a simple manner. Just the plentitude of options makes the application partially complex. Information about disease treatment is only available as HTML based summaries.

Map of Medicine is also a web-based application developed by "medictomedic" which maps medical guidelines to process diagrams [18]. The way of illustration reminds of clinical pathways, but without an organizational component or a linkage with patient data. Just the contents of guidelines are presented in a compressed form. In this way physicians have the possibility to adapt their medical treatment to the process diagram of Map of Medicine. Within some process steps comprehensive additional information is provided that can be difficultly received regarding its undefined length. Depending on the course of medical treatment the process diagram branches out to different directions e.g., if there are several therapy alternatives. Concerning the plentitude of branchings and references to other pathways, the reconstruction of the course of medical treatment is not so easy. There is no support for choosing the right guideline. Under these aspects, Map of Medicine is only usable to a certain degree during medical treatment.

## **4 SOLUTION APPROACH TO WORK PROCESS-ORIENTED IMPLEMENTING OF MEDICAL GUIDELINES**

In the following, we like to present a concept which describes how to realize the requirements on software solutions for the implementation of guidelines in medical practices identified in chapter 2. In order to implement this concept, we developed a prototypical web-based application.

### **4.1 Solution Concept**

The approach to a symptom specific selection of medical guidelines requires the extraction of all symptoms mentioned in the guideline as well as their classification by predefined suitable symptom areas. Attending physicians can reduce the number of possible diagnoses and guidelines respectively, by assigning the symptomatology to a symptom area during the anamnesis and by specifying important symptoms. In this way medical guidelines gain already importance in regard to differential diagnostic measures.

The solution approach of implementing medical guidelines is geared to the concrete activities of a physician during medical treatment. In order to develop an appropriate IT-support and edit medical guidelines, it is necessary to determine which activities are typically part of primary care. Thereby, an activity indicates the task of a role with a clearly defined (intermediary) result. Furthermore, it is important to specify coherence and order in which to process the different activities. In order to provide a good overview

of the medical treatment, the activities are then visualized by using a graphical process modeling language. In this respect, two solution alternatives exist:

1. The detailed activity and process modeling based on the concrete textual presentation of medical guidelines.
2. The simplifying activity and process modeling which defines activities on a general, cross-guideline applicable level.

During the expert interviews the general practitioners expressed great demand for compact, cross-guideline solutions with a high degree of recognition and an intuitional usability. The objective is to avoid that physicians must repeatedly familiarize themselves with the structure of each medical guideline. Therefore, in close cooperation with the experts we designed a consistent process model that consists of the four simplified activities “anamnesis”, “diagnostics”, “make diagnosis” and “therapy”. This process in principal is valid for each primary care process and was used to structure and assign the contents of medical guidelines.

In editing the guideline contents, we provided both a short, pass-point like summary of the substantial information and a detailed, flow text-based version. Therefore, we can support ad-hoc-processes in the examination room as well as preparation and postprocessing.

Thus it was possible to guarantee the comprehensive implementation of medical guidelines, in line with standard usage. It enables the physicians to access additional information at any time to ensure quality of their own work. Because diversified differential diagnostic considerations become redundant by use of existing evidence-based recommendations and can be substituted by purposeful diagnostic measures, the presented solution approach supports a cost-minimal and quality-oriented medical care.

## 4.2 Prototypical Implementation

For the implementation of the solution approach we used an existing web-based Content-Management-System. The prototypical application “www.aerztearbeitsplatz.de” exhibits two main features, which were developed on the basis of released medical guidelines with quality level “S3”:

1. Guideline-supported differential diagnostics

Regarding the available medical guidelines, symptom specific diagnoses are reported to the attending physician. In this way he/she receives a complete overview of the symptoms, on whose occurrence the diagnosis depends according to the guideline.

2. Process-oriented provision of relevant guideline contents

Physicians get the option to access relevant contents of selected medical guidelines depending on their current activity.

In order to realize a guideline-supported differential diagnostics, we extracted the symptoms mentioned in medical guidelines and linked them with the particular diagnosis. So the user has only to choose a certain symptom area and to select the described symptoms (as shown in Figure 1).

**Figure 1 Selection of symptom area and symptoms**

**Guideline-supported Differential Diagnostics**  
[Main Page](#)

**Symptom areas**  

- All
- Abdominal symptoms
- Cardiovascular diseases
- Change of weight
- Drug side effects
- General symptoms
- Infections
- Laboratory test results
- Miscellaneous symptoms
- Musculoskeletal system diseases
- Neurological symptoms
- Psychosomatic symptoms
- Respiratory system

**Symptoms**

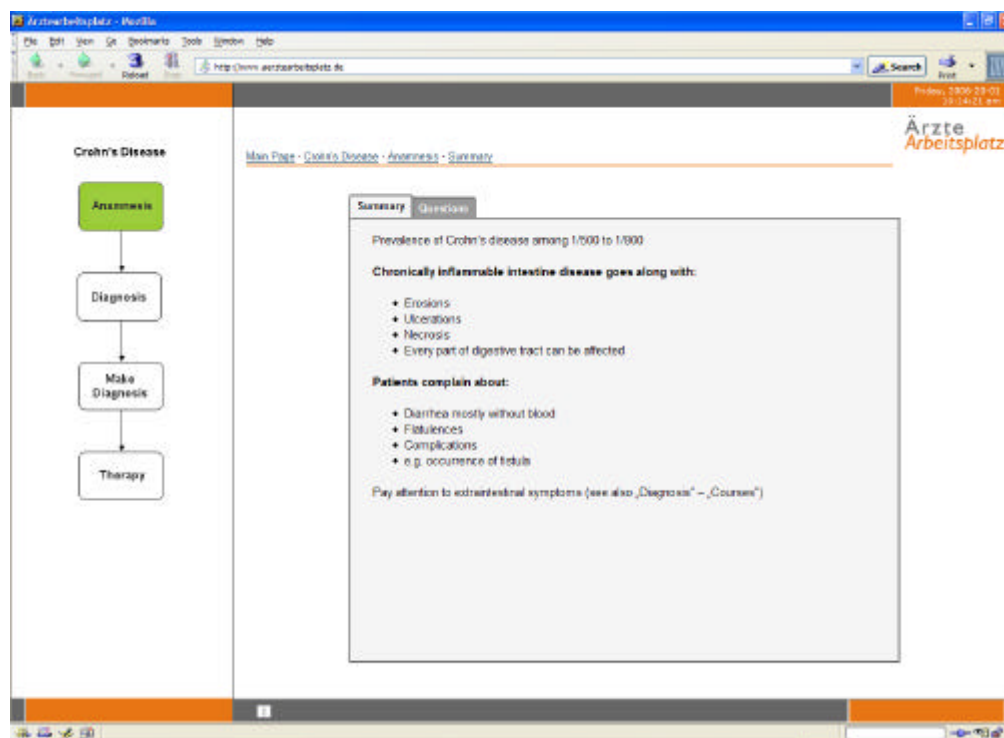
- ☐ Acute abdomen
- ☒ Bloody diarrhea
- ☐ Discharge of perforation
- ☐ Diarrhea and constipation of distal colon
- ☒ Feeling of incomplete defecation
- ☐ Gallstone complications
- ☐ Ileus
- ☒ Increased bowel movement frequency
- ☐ Megacolon
- ☐ Rectal defecation
- ☐ Strains

The results of the anamnesis in connection with the expertise of the attending physician are decisive for the selection of a symptom area. Based on these inputs the application presents possible diagnoses. In addition, the user gets an overview of all symptoms typical for a certain diagnosis, which can be surveyed and clarified for confirmation. So the physician receives guideline-compliant support during the ambulant medical treatment service. According to medical guidelines, a better-focused, cost-minimal differential diagnostics can take place which guarantees the quality of health care.

Additionally the prototypical web application allows to access relevant information, advice, strategies and procedures from medical guidelines aided by a graphical, process-oriented diagram. In cooperation with the practicing physicians a suitable mix could be found and realized, that considers both brief and easy comprehensible information as well as detailed explanations. Basic information about each process step appears on the first tab of the user interface, additional information is available on the rear tabs. Figure 2 exemplifies the tab “summary” regarding the anamnesis of Crohn’s disease on the right hand side.



**Figure 2 Summary of the anamnesis of the medical guideline about Crohn's disease**



Due to the differentiated presentation of relevant information, the attending family physician and the general practitioner respectively has the possibility to get an overview of the guideline ad hoc during medical treatment; it is also an option to access detailed information by selecting the rear tabs of the user interface. According to statements of the user group, it is not common to conceive these contents during patient care, so that a detailed, textual description seems to be adequate. Thus the application supports both the ad hoc information policy of physicians during the medical treatment and the impartation of expert knowledge before and after patient care. In this way, the application considers and supports the changing work contexts of family doctors and general practitioners in a balanced manner.

### 4.3 Results

After the presentation of the prototypical application we got a very positive feedback from the physicians. The possibility of selecting medical guidelines by choosing a symptom area and particular symptoms meets their requirements. Also the transformation of pure text-based guidelines into interactive process diagrams, which are easy to handle, is an increase of user-friendliness. Because of the availability of edited guideline versions and further detailed information, physicians can imagine to use the application during the patient treatment as well as for preparation and postprocessing.

The practical use of the application can be illustrated by as follows: A patient suffers from diarrhea for a prolonged period of time. Recently he discovered blood in stool, that's why he goes to see his family doctor. The physician starts the application, chooses "Abdominal symptoms" as symptom area and selects the respective symptoms. Thereupon "Crohn's disease" and "Ulcerative colitis" are indicated as possible diagnoses. The application supports the physician during the medical anamnesis by presenting further symptom information of which the patient may not even be aware. Laboratory values, whose examination is relevant in context of differential diagnostics, are also specified. If the physician determined a diagnose e. g. "Crohn's disease" he is able to look at the interactive process picture associated with the medical guideline. Here he gets information about therapies and contraindications. During the doctor-patient talk the information provided can be confined to summaries. If questions and problems arise afterwards, the physician has the possibility to find a solution by studying the detailed explanations.

These initial results regarding the acceptance of the developed application are encouraging. However, to find evidence for the benefits of computer-based medical guideline applications in primary care, our results have to be confirmed within a large-scale user study.

## 5 CONCLUSION AND FURTHER WORK

The implementation of medical guidelines into everyday life of practicing physicians in private practice is a central problem and requires a change of structures, attitudes and behavior. Traditional implementation strategies like dissemination by further training and provision of paper-based or electronic documents, turned out to be ineffective [19]. The implementation of medical guidelines still fails the demands of everyday life in medical practice. The process-oriented use of information technology for the implementation of guidelines makes it possible to provide guidelines in such a way that relevant contents are available within a short time. Our study revealed that web portals and software solutions for implementing guidelines do not satisfactorily meet the requirements of practical physicians. Often the use of several tools is necessary in order to cover all desired features. Therefore, in close cooperation with practical physicians, we developed a solution that is geared to actual patient treatment in medical practice as close as possible. It supports differential diagnostics measures and therapy approaches. The next step is the integration of the application within existing medical software systems in order to provide a comprehensive solution. In this way physicians get constantly in touch with medical guidelines and get trained in their use. Such a training-on-the-job promotes the effective implementation of guidelines in everyday work life. By linking patient-specific data with guideline contents, it could be possible to conduct documentation and computer matching to promote decision support. Furthermore, within the scope of controlling, users could give relevant information about quality and practicability of medical guidelines.

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