

Guideline-based Decision Support Systems Concepts, Technical Considerations and Challenges

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ABSTRACT

Introduction: Guideline-based Decision Support Systems helps clinician to choose the best treatment in specific clinical situations. Since it is difficult for doctors to Remember all effective measures of diagnosis and the average visit time for each patient less than 20 minutes, so integrate guideline with clinical decision support system help doctors to choose the best course of treatment in the clinical setting.

Material and Methods: This paper is a literature review and have implication to clinical guidelines concepts, guideline-based decision support system, challenges and technical considerations.

Results: The best and fastest approach to use of guideline is their integration with hospital information system or electronic health record. The development of these systems require careful design of clinical guidelines development, decision models, and reusable software components and appropriate computing infrastructures in the clinical environment. Currently, XML is the best choice for packaging data and information sharing, but there isn't a specific standard that fully provide interoperability with EHR.

Conclusion: Ease of learning is one of the main issues in the guideline based EHR. Guideline must be designed that their use is simple so developers. Clinical guidelines integration with information systems and electronic medical records lead to increase adherence to clinical guidelines in health care, quality of care provided to patients, ensuring patient safety and reduce costs.

Article History

Received: 2015-11-25

Accepted: 2016-03-31

Published: 2016-04-15

Keywords

Guideline-Based Decision Support

Concepts

clinical practice guideline

Interoperability

Decision Model

©Please cite this article as:

Safdari R, AghaMohammadi A, Langarizadeh M, Sepehri F. Guideline-Based Decision Support Systems: Concepts, Technical Considerations and Challenges. Iran J Med Inform. 2016; 5(1): 19-23. DOI: [10.24200/ijmi.v5i0.105](https://doi.org/10.24200/ijmi.v5i0.105)

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INTRODUCTION

The Clinical Practice Guideline (CPG) is a systematic, well-developed statement by clinical specialists to aid physicians in decision-making and choice of the right medical services under certain clinical circumstances [1-3].

Within the past decade, quite many investigations attested to the benefits of using clinical guidelines in medicine. A guideline or protocol, once used in different clinical conditions including standardized healthcare programs, can cut down on the variety of actions taken and the healthcare costs. Moreover, it can improve patients' health. Though guidelines do not exceed fifty years in life, they have been recently emphasized to be used systematically and in an evidence-based manner in daily medical care for facilitative purposes.

- The different types of guidelines developed so far share common features:
- The different stages of taking care of patients (e.g. screening patients, diagnosis, examination, reference and management).
- Planning different domains (e.g. disease management, protocol-based care and consultation)
- The different modes of using a guideline (e.g. clinical reference, knowledge base, education and quality guarantee) [4].

Clinical practice guidelines possess a high potential of improving quality and responsiveness in different healthcare situations. Though seminal research revealed that the guidelines applied had no effect on doctor's behavior, recent reports indicate that once applied these guidelines significantly affect healthcare procedure and outcomes [3].

Clinical decision-making aiding systems are information systems designed to improve the quality of clinical decisions. Such systems are much to the benefit of clinical data and complicated rules on a large scale [1]. Once developers integrate these guidelines with information systems and electronic medical records, maximal use will be made of improved quality and responsiveness in providing healthcare services. So as to implement guidelines effectively in information systems, developers need to make more detailed and precise comments than manual or traditional guidelines [3].

MATERIAL AND METHODS

The present research is a review of literature in type and deals with the concepts of clinical guidelines, decision-aided systems based on guidelines, technical challenges and considerations in these systems.

RESULTS

Remembering all effective factors in diagnosis is demanding for physicians. Moreover, their high load of work cuts down on the time they visit patients [5]. The mean duration of each visit is less than 20 minutes [6]. Thus, it is often impossible to obtain a patient's full history and make a precise diagnosis. These all would limit the quality of selecting the right medical care [5].

The best and fastest approach to finding and using guidelines is to integrate clinical guidelines and hospital information systems or patients' electronic medical records. The electronic reminder system and more complex guidelines integrated within information systems would increase doctors' adherence to the

guidelines in a given intervention [3]. Once implemented in computer-based decision-aided systems, the guidelines can be used effectively in daily medical services [4]. A body of research concluded that applying these systems manage to tremendously improve the quality of healthcare services [5, 7, 8] especially when integrated with clinical information systems such as patients' electronic medical files.

The question that rises here is that though the computer-based reminder system and the guidelines implemented are beneficial, why the majority of health specialists still stick to paper-based systems? To answer this question, there are two points to consider. First of all, there is no appropriate computations infrastructure to support computer-based guidelines. Without electronic medical records or patient-related databases, a full implementation of computerized guidelines at least for outpatients is not possible. Secondly, as confessed by many healthcare specialists still using paper-based records, there are certain technical challenges in implementing computerized guidelines. Employing guidelines in electronic medical records needs the development of more detailed and precise guidelines by the developers [3].

Choice of the right clinical guideline

The first step in selecting the right clinical guideline is to find the patient's main problem. The next step is to make a text-based search to find the right guideline. Those within the clinical domain possess a high potential of improving both quality and responsiveness in healthcare centers. However, the design and use of clinical guidelines manually can be problematic and exhausting. Furthermore, a guideline development trend is often costly and challenging.

As an instance, Medline is a well-recognized guideline. However searching Medline is faced with two problems. First of all, not all the guidelines are already indexed in journals and secondly, Medline does not often provide a free access to all guideline texts. The World Wide Web has been an appropriate substitute for Medline. Many guideline sources can be accessed through the net which are added to everyday. Web-based sources facilitate the recognition of and access to the right guideline as compared to the paper-based approach.

The question that rises here is that can web-based sources help doctors to find the right guideline to treat their patients? Several factors need to be considered with this respect. The first point is that a simple search would result in a copious number of guidelines for a doctor's individual patient. To find the best guideline, s/he would need to go through them one by one to ensure of the usability of the guideline for treatment purposes. All this can be time-consuming and complicated [3] and what matters most to a doctor is time [6]. The other concern is that any single person can contribute to the development of web-based guidelines and publishing them on the net. Thus, users should take care in evaluating the quality of the content. A good solution to the problem is to set limits on the use of web-based guidelines and only allow well-known and credible sources to make contribution or use. To this aim, many websites are protected and secured by scientific, state or professional organizations [3].

Interoperability of clinical decision-aided systems based on guidelines

The Institute of Electrical and Electronic Engineers (IEEE) has defined *interoperability* as the capability of two or more systems to communicate information and use that communicated information.

Angular defined interoperability in two parts

Functional and syntactic instructions of interoperability: refer to the capability of two or more systems to communicate

information through a well-defined function and syntax of a message in a way that this information ends up readable by human beings.

Semantic interoperability: refers to the capability of sharing information by the system to formally understand the concepts within the target domain in a way that the information ends up processable by a computer system [9].

An electronic health record is part of a truly complicated information system. Sharing and interoperability of electronic health records can be divided into the functional/syntactic and semantic aspects. Interoperability should be such that does not intervene in the process of creating an electronic health record in hospital. Nor should it affect the internal flow of documentation and document management. The semantic interoperability of clinical data would require the standardization of data, terms, information models and arbitrary rules to express clinical issues [10]. The standards of an electronic health record are access to semantic interoperability in exchanging electronic health records. They should pave the way for the establishment of interoperable infrastructure and a body of information adaptable to such exchanges. The advent of Extensible Markup Language (XML) is currently the best choice in data packaging and information sharing. Yet, there is no certain standard that guarantees a full interoperability of electronic health records [9].

Challenges of developing computer-based clinical guidelines

Developing guidelines currently needs time, resources and more specialization than the past. A critical analysis of the related literature requires a meta-analytic approach decision analysis, clinical epidemiology and cost/effectiveness analysis. Therefore, guidelines are produced by well-known organizations with sufficient resources.

The next challenge would be that as guidelines are used in local medical centers, they might practically diverge significantly from each other. Guidelines are often expected to be designed for medical use in personal medical offices.

Thirdly, healthcare centers would require a maintenance and updating mechanism for guidelines. This issue is particularly manifest in the rapidly changing nature of certain domains in medical sciences (e.g. HIV treatment) [3, 4]. The prescriptions within guidelines might get expired every two years or sooner (they might even get forbidden) [3].

Another issue regarding the development and implementation of guidelines is the interpretation of its content. Not always do they contain the precise definition of terms. They might include vague prescriptions even expressed in ambiguous sentence structures. Some other problem is concerned with the development or implementation of guidelines at national (or international) level. Besides, adequate time and efforts, there is a need for motivation for creating general guidelines shared by many organizations. The majority of guidelines are prone to changes so as to make sense to the healthcare providers in a certain context. These changes must be valid and in accordance with the main guidelines. Once the guidelines are updated at the national (or international) level, these changes must also be generalized to organizational guidelines too.

Some of the general problems concerning the development of guidelines include the following

- how to interpret the content of a guideline
- how to control the local adaptability and coordination of national (or international) guidelines and the local
- how to evaluate the guidelines and decision-aided systems in daily medical care

- how to display and share different types of guidelines via a formal unambiguous representation
- how to translate the guidelines of a textual format and formal view
- how to confirm a guideline
- how to connect the decision-aided systems based on guidelines to a patient's external information systems
- how to support the daily medical care providers

Technical challenges of the guideline implementation

When implemented, guidelines are accompanied by many technical challenges for information system developers including:

- record of the required clinical data (e.g. history of coughing in a patient prone to inhibitive drugs (ACE))
- lack of standards for the developers of medical science terminology and data base
- required conditions for the confidentiality of records and patient's information
- lack of confidence in the legal responsibility of a system in making clinical recommendations (or making false recommendations)
- Problem of evaluating the effectiveness and high costs of such clinical information systems [3].

There are certain standards in developing clinical guidelines

- capability of conforming to international medical information standards
- having the least effect on the current healthcare system
- implementation and deployment
- abidance by the current rules and regulations [9].

Decision-making models as an aid for developing guidelines

One research domain is to develop analytic tools to aid the development of guideline recommendations. Decision-making models have been created as the right choice to solve problems in decision-making. They involved alternative treatments or tests, probability of intervening chance events, value of health and economic outcomes. Decision-making models are aids to developers in systematically organizing guideline problems, prioritizing access to information, developing guideline-specific websites and that of cost-effectiveness in combination with patient's preferences [3].

Designing reusable software is an approach to confront the inherent problems of guideline development and to speed up guidelines and protocols by the developers [3].

Recently an approach has been developed that enables users to provide access from distance to the model for analysis purposes through web. Thus, guideline developers can modify model input from distance to accommodate local changes and make sure whether the changes guarantee the different comments made in the guideline or not. If guaranteed, the developer can help to create a specific website to access the guideline.

To facilitate the development of guideline-specific websites, Owens et al. designed a computer-based tool that automatically generated clinical algorithms describing the decision-making models. The system designed has the capability of offering additional information such as the goal of guidelines, the target population, the main assumptions of the decision model and the clinical definitions [3].

Model and guideline development

To implement a guideline in computer-based decision-aided systems, how to display the guidelines is a key point to consider. A formal indicative model should indicate a deep understanding of clinical methods used in the guideline. Moreover, a guideline should contain precise details and unambiguity [4]. The rules and

logic in the guideline are modelled visually using the decision graph [1, 11]. Among these, the Protégé software is free-accessed. The mechanisms of the visual context of Protégé are among the strong tools in modelling the guideline logic and rules using a decision diagram [1, 12]. There are three nodes in Protégé decision graph: 1) start node, 2) information node 3) terminal node. The start node is where any decision making process begins. Information node collects and estimates patient's health-related data required for the guideline logic. The terminal node makes a certain recommendation to the patient based on the guidelines. Two nodes with the same Bullion factor including the patient's information get connected which are derived from the guideline rules. The decision graph is a manifestation of a finite-state machine (FSM) which is translatable through the use of Protégé plugins and the visual display of guideline rules semantically and understandable to a computer. Fig 1 is a sample of Protégé decision-making graph [1].

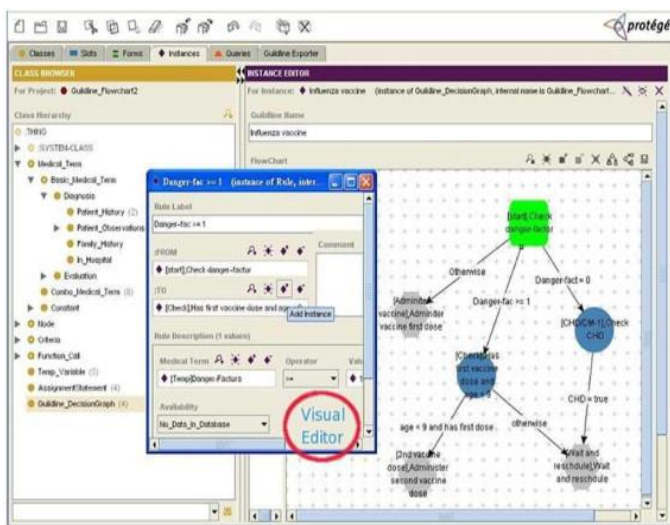


Fig 1: A sample of Protégé decision-making graph

DISCUSSION

Guideline developers should create guidelines containing adequately precise recommendations for the coding process. Computer tools should be more extensive and beneficial for developing guidelines. A concentrated resource (such as a professional organization, a state organization or a healthcare group) provides a tool to help users to make correct changes to the guideline for the clinical context, organizational requirements and patient populations [3]. Finding commonalities between and among different modes of guideline modelling for convergence and a standard display of the guideline would require much effort. Instead of standardizing a guideline model whose syntax is less agreed-upon an accessible possible method of model standardization is relatively simple information and operations [10]. The standards to meet local needs in a particular region should be in accordance with the local needs [9].

CONCLUSION

So as to develop clinical decision-aided systems based on guidelines and integrate them with electronic health records, there are certain features to consider: Ease of learning is a key point in a guideline-specific electronic health record. The guidelines should be designed in a way that maximizes simplicity. Developers integrate information systems and electronic records. The comprehensive infrastructure of electronic health record as well as computerized information systems should be widely accessible. Medical terms should be as standardized as possible so as to ensure that an information system can delve into the meaning and relations of these terms.

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