Medical Guidelines – Past, Present, and Future

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Quality Checking

Medical guidelines give recommendations for good practice medicine based on the best available evidence. Hence, these criteria can be formulated into verifiable properties once a guideline is formalised to quality check a medical guideline. Several approaches are and have been investigated to verify the quality of a guideline:

- Interactive verification [1]
- Model checking [4]
- Petri nets [2]

However, guidelines should not be considered static objects as they are changed on a regular basis as new scientific evidence becomes available, i.e., sometimes also called *living guidelines*. Hence, the quality of a guideline, i.e., the conformance to the best available evidence, may change with changing and evolving evidence. This puts additional demands on the ease of the verification process.

The properties one can formulate for a guideline can take a variety of forms and can be obtained from a number of sources (e.g., indicators). For example, one can write standard properties for the validity of the formal model (e.g., reachability of all states) or properties related to the evidence. Another possibility is to investigate the guideline in terms of general properties of good practice medicine [1]. Formulating the right kind of verifiable properties, especially those incorporating medical knowledge (medical goals), has been found difficult in practice.

[1] **A. Hommersom**, **P. Groot**, **P. Lucas**, M. Balser, and J. Schmitt. Verification of Medical Guidelines using Background Knowledge in Task Networks, *IEEE Transactions on Knowledge and Data Engineering*, 2007.

[2] K. van Hee, I.A. Lomazova, O. Oanea, **A. Serebrenik**, N. Sidorova, and M. Voorhoeve, *LNCS*, vol. 4024, Springer Verlag, pages 241–260, 2006.

Background knowledge

A typical fragment of a medical guideline is the one shown below, which is about the treatment of diabetes mellitus type 2.

Step 1: diet.

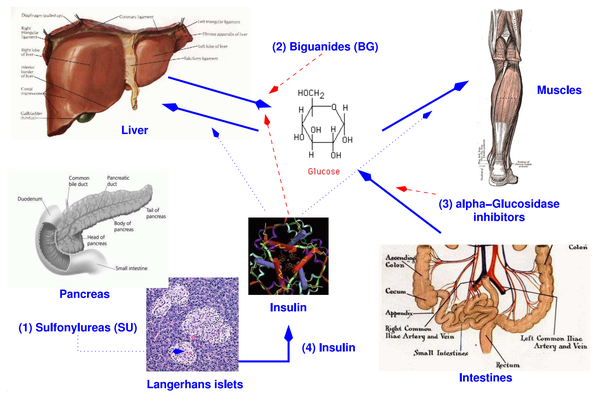
Step 2: if Quetelet index (QI) ≤ 27, prescribe a sulfonylurea drug; otherwise, prescribe a biguanide drug.

Step 3: combine a sulfonylurea drug and biguanide (replace one of these by a α-glucosidase inhibitor if side-effects occur).

Step 4: one of the following:
- oral antidiabetic and insulin
- only insulin

Guidelines typically contain information about treatments, treatment order, and patient groups. These are used by guidelines to specify *neccessary* constraints about good practice medicine. However, these constraints are not necessarily *sufficient*.

Diabetes mellitus type 2 is a complicated disease, whereas the above guideline fragment is not, which indicates that much knowledge is missing. Formalising and quality checking of medical guidelines therefore additionally need the specification of *background knowledge* [1].



Background Medical Guidelines

The trend of the last decades has been to base clinical decision making more and more on sound scientific evidence. This has been called *evidence-based medicine*. In practice this has led organisations of medical specialists to develop medical guidelines. An often cited definition of medical guidelines is the one by Field and Lohr:

> "Clinical practice guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."

Researchers are working towards offering computer-based support in the development and deployment of guidelines using computer-oriented languages and tools. This has given rise to the emergence of a new paradigm for the modelling of complex clinical processes as a 'network of tasks', where a task consists of a number of steps, each step having a specific function or goal. Examples of languages that support task models include PRO*forma*, Asbru, EON, and GLIF3. Other formal representations (sometimes translations of previous languages) have also been investigated, depending on the research goal, e.g., algebraic specificatios, transition networks, petri nets, etc.

However, formalising a medical guideline is difficult, because they are often large (sometimes over 100 pages) and may be ambiguous and incomplete. Also, guidelines may exist at different levels of abstraction depending on their use (e.g., disease management, hospital workflow), which is currently not reflected in existing languages.

Integration

When a situation is reached that we have formalised (quality checked) guidelines, these guidelines can be used in further applications. One of the challenges will be to incorporate them into *decision support systems*, which may take a variety of forms.

For example, formal guidelines can be incorporated into workflow systems. Often, guidelines do not contain enough information to be directly applicable into practice, there still has to be made a mapping to the workflow in the healh care organisation. Also, when a guideline is updated, this may mean that the health care processes can be redesigned to be more efficient [3].

Furthermore, Nictiz (http://www.nictiz.nl/) is currently active in building an infrastructure for electronic access to electronic patient records (EPDs). A formal representation of a guideline can be connected to an EPD to automatically collect and store data. The connection to EPDs can be extended further by using the guideline model to critique the treatment plans followed by a phycisian.

Usually, medical guidelines are developed for nation-wide use, which are refined by local hospitals into medical protocols for local use. Usually, medical protocols include more detailed information. Support for the refinement of medical guidelines into medical protocols or the localisation of differences between guidelines and protocols [4] is still lacking.

[3] M.H. Jansen-Vullers and **H.A. Reijers**. Business Process Redesign in Healthcare: Towards a Structured Approach. INFOR: Information Systems and Operational Research, 43(4), 321-339, 2005.

[4] **A. Hommersom**, **P. Groot**, and **P. Lucas**. Checking Guideline Conformance of Medical Protocols using Modular Model Checking. In the 18th Belgium-Netherlands Conference on Artificial Intelligence, pages 173–180, 2006.

Future Work

The use of medical guidelines will probably continue to grow in the future. To make effective use of guidelines, guideline developers will move to the development of electronic versions in the near future.

One of the major open research questions will be what kind of formal methods one should use for quality checking certain types of properties of medical guidelines as a higher assurence level will correspond to more effort (see figure below). Furthermore, the nature of medical guidelines (incompleteness, different levels of abstraction, repeated updates) raise additional questions about the way they need to be formalised.

Europe has a number of skilled researched working in the area of medical guidelines (e.g., Protocure http://www.protocure.org), with whom we will continue to collaborate to deal with the issues raised here.