Smooth Integration of Decision Support into an Existing Electronic Patient Record

S. Quaglini[1], S. Panzarasa[2], A. Cavallini[3], G. Micieli[3], C. Pernice[4], and M. Stefanelli[1]

[1] Department of Computer Science and Systems, University of Pavia
[2] CBIM, Pavia
[3] Stroke Unit, IRCCS "C. Mondino", Pavia
[4] TSD Projects, Milan

Abstract. Willingness to use computerised decision support systems is often jeopardised by lack of effective integration into existing user interfaces for electronic patient record. Concepts illustrated in this paper stem from the need of developing a project for the comparison of the physicians' compliance to a clinical practice guideline before and after an electronic version of the guideline was introduced. Before starting the implementation, we performed a deep users' needs analysis. It was accomplished also on the basis of lesson learned on past guideline implementations. The new idea was to classify guideline suggestions on the basis of some attributes, whose values will determine the modality of presentation of the suggestion itself, and on a different management of non compliance advice.

1 Introduction

Despite broad agreement on the necessity to improve quality of care through implementation of clinical guidelines (GLs), and the incredible number of GLs diffused in last years, there is still lack of adherence to them. Since it was soon clear that paper-based GLs, as well as their hypertext representation over the internet, didn't offer adequate decision support in clinical practice, the medical informatics community hypothesised that more formal electronic versions would increase physicians' compliance. Recent reviews are available to compare different GLs representation formalisms [2,5]. However, integrating Gls within a clinical workflow remains a critical issue, and many efforts have been put in developing standard data models for facilitating data sharing among systems. Projects for the Electronic Patient Record (EPR) standardisation are under development [7], but we are still far from a solution. Moreover, in real-world situations a crucial issue is the integration of GLs with existent software and local workflows. If a user is happy with his current information system, the existing human-computer interaction should be preserved and a new system perceived just as a "new release" with some additional functionalities. This paper does not deal with a new formalism for GL representation, nor with standards for EPR, but it describes a users' needs-based approach to challenges posed by the integration of a GL within existing information systems. As a matter of fact, our approach stems from a lesson learned about non compliances with a previous implemented GL [3], and starts analysing the physicians' needs in the various

S. Miksch et al. (Eds.): AIME 2005, LNAI 3581, pp. 89 – 93, 2005.

phases of a patient's management. Not only need for GL suggestions, but also communication facilities with colleagues, automatic production and printing of reports in natural language, etc. have been considered. If physicians are not provided with an integrated solution for all these problems, they will not perceive the system as a support, and also GL suggestions will not be taken into the due account. These concepts are currently exploited within a project dealing with the evaluation of compliance to "The Italian guidelines for stroke prevention and management" edited by SPREAD on March 2003 [www.spread.it].

2 The System Analysis

Our goal is to compare the physicians' compliance to GLs before and after the electronic support introduction. Twenty Neurological Units are currently using the same EPR without any decision support (DS). Data will be collected for six months. Then, the same Units will use the GL-supported EPR for additional six months. The EPR has been developed with WINCARE®[1]. The user's interface is based on *Events*, i.e. sections of the clinical chart through which it is possible collecting patient data and generating textual reports. Username and password define the visualization of competent events. In the current version the list of events is not structured at all: it is given in alphabetic order and it is not tailored to the specific patient. As the first step of the study, we performed an analysis of the existing EPR and its user interface in order to (a) find out which additional data needed to be stored, and which data needed to be encoded, in order to verify the compliance with GLs; (b) realise how to integrate the new DS functionalities, within the existing interface, on the "minimal invasiveness" principle. Moreover, we assessed collaboration and agreements with the company providing the EPR in order to (a) allow additional, or different, data input, as derived from point 1; (b) devise a middleware for data sharing between EPR and the GL. As an example for point 1a, the patient's and family's histories were traditionally entered as free text: this was not compatible with the need of interpreting rules such as: "if the patient had a previous myocardial infarction, then ...". "Previous myocardial infarction" of course must be encoded. Thus all the historical information has been encoded through ICD9-CM. This would have been an advantage for the GL engine, but a disadvantage for another aspect of the clinical workflow: in fact, physicians were used to print the histories and attach them to the discharge letter, "as they were": to make ICD9-CM encoding acceptable, a parallel tool has been developed translating the encoded diseases, plus some associated comments, into natural language sentences. The other points are detailed in the next paragraphs.

3 Classification of Guideline Recommendations

We searched for an agreement with neurologists about the best way of communicating GL suggestions; we mean real-time pop-up windows, user's agenda update, use of different colours, special icons, etc. Also non compliances need different management according to suggestions they refer to. Instead of developing ad-hoc solutions, we formulated a general classification of GL recommendations, in which each class could be

[1] WINCARE® is a product of TSD-Projects.

associated to a particular GUI modality. This allows building reusable modules for the visualisation of reminds. The key elements of the methodology are that GLs are developed by multidisciplinary groups, they are based on scientific evidence, and recommendations are explicitly linked and graded according to the strength of the supporting evidence[1,6,8]. In the SPREAD GLs, this grade summarizes scientific evidence and applicability. Whichever indicators the GL adopts, users should be aware of how each GL recommendation has been graded.

Our idea has been to build a classification of recommendations taking into account first of all the grading provided by the GL itself, but also other attributes, such as:

1) type of the recommendation: whether it is a diagnostic process, a treatment, a variable monitoring, a message;
2) *sign* of the recommendation: if it is something to do or to rule out;
3) urgency: acute situations must be managed as fast as possible.
4) care provider to whom the recommendation is directed: the communication language could be different for physicians, nurses, technicians, etc.;
5) whether a suggestion addresses a single user, a role (physician, nurse, etc), a group of users or all the care providers involved in a patient treatment.

In agreement with our clinical partners, in order to manage non compliance in a non invasive way, we choose to do it at the patient discharge, in fact preparing the discharge letter requires summarizing the patient hospital stay, and reasoning about. In practice, when physicians fill the DISCHARGE FORM, a set of queries is activated and a sheet is printed with the list of non compliances, that the system can detect automatically starting from the EPR (at that time all data should have been entered).

4 Integration of the Decision Support into the EPR Management

To add the DS functionalities, reengineering of both structure and interface of the EPR was performed. More precisely, we refer to our previous terminology definition given in [4], borrowed from the Workflow Management Coalition. We defined a CfMS as a system that defines, creates and manages the execution of Careflows (Cfs) through the use of software, running under the control of one or more Cfs engines, which are able to interpret the care process definition, interact with Cfs participants and invoke software applications. The Cf model, described on the basis of the SPREAD GL, has been formulated using Oracle Workflow ™. The CfMS needs patient data in order to fire the GL rules and to generate patient-specific recommendations that, together with messages and alerts, should be communicated to the users (Cf participants) via the end-user application. As already said, our choice is not to create a new specific inter-

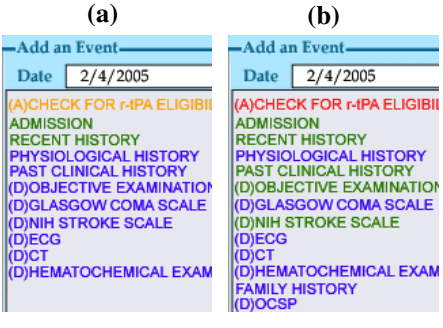

Fig. 1. Changing the list of the tasks as a function of urgency

face for the CfMS, but to integrate all the needed functionalities within the existing system. To this aim, first of all a middleware for data sharing has been developed: whenever there is a new data entry the EPR transfers this data into a support database. On the other hand, when the GL generates a suggestion, or a new list of events, they are put into the same database, and WINCARE can read them and show them through its interface. In the following paragraphs the management of different situations is shown.

Diagnostic and Treatment Processes. In general, GLs suggest a sequence of tasks to be performed according to some routing. Some of these tasks are for all the patients; others are reserved to patients with particular clinical conditions. Concerning scheduling, some tasks are to be done in particular points in time, others have no time constraints. We integrate this information in the events list of WINCARE. In the updated system, the list is no more unstructured: on the contrary it is built taking into account the patient's data and the time spent since the patient's admission. Colours are used to mean that a task has to be done (blue), is being done (orange), it is completed (green) or it has not been executed due to an exception (red). In Fig. 1a, the patient is potentially eligible for the thrombolytic drug r-tPA (information coming from the recent history table). This treatment is both extremely important and delicate: the task list only refers to actions to be done in order to detect possible contraindications. In Fig. 1b, for some reasons, the three-hours temporal window is over, and r-tPA cannot be administered more: “Check for r-tPA eligibility” is red and also less urgent tasks appear in the list.

Grade of Recommendation. It's worth noting that the list of events is not only composed by tasks suggested by the GLs, but also by all the other events useful for the whole patient's management. The GL-related tasks can be recognised by their associated grade (shown as in the textual GL, by letters A-D).

Sign of Recommendation. It's very important to advise also about actions that must not be performed. In fact, if a GL reports such actions, it is very probable that they have been recognised as frequent medical errors. Recommendations with negative sign are represented with crossed text (eg: "~~I.V. ADMINISTRATION OF STREPTOKINASE IS NOT RECOMMENDED~~").

Urgency of Recommendations. When there is a tight temporal window for accomplishing a task, the corresponding management form is pop-up window. The window shown in Fig. 2 reports all the contraindications to the r-tPA. The system fills the most crosses as possible, given the available data in the EPR. But the window is popped-up even if the list is not complete, because the decision has to be taken in few tenths of minutes. The remaining crosses will be put by the physician himself. On the other hand, when the suggestion is not urgent, a pop-up window would be boring. In that case, the recommendation is translated into a simple communication, sent to the appropriate

THERE IS AT LEAST ONE CONTROINDICATION. THROMBOLYYIC THERAPY IS NOT INDICATED

Contraindications	Presence	Absence	Unknown
Suspect of FSA (even with normal CT)			x
Unknown time of the stroke onset		x	
Age > 80 years		x	
Severe patient: stupor or coma		x	
Too mild patient (Scandinavian Stroke Scale score>50 or NIHSS score<6)	x		
Quick improvement before the treatment			x

Fig. 2. Contraindications to thrombolysis. A red sign rules out the treatment

roles, which will be visualised when the users will access their "communication box". A red screen icon on the right top of the screen indicates that the communication box is not empty. An example is shown in Fig. 3: heparin treatment for secondary prevention of deep venous thrombosis may be undertaken in whichever day during the hospital admission.

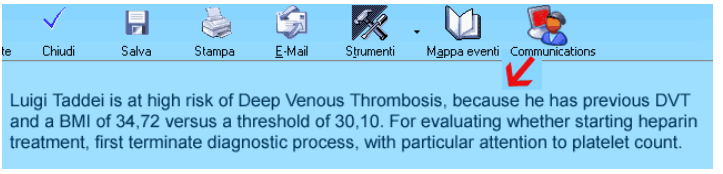

Fig. 3. A communication sent to physicians for evaluating a particular therapy

5 Conclusion

We have illustrated a re-engineering process of a DSS, based on a user needs analysis. The aim was of letting physicians and nurses to exploit system suggestions with the minimum effort and invasiveness with respect to daily routine. To do this, we worked on different levels. At the interface level, we fully integrated the decision support into the EPR interface that neurologists were using since some years. At a cognitive level, we designed modality presentation of both suggestions and non compliances according to a pre-defined classification, based not only on scientific evidence, as in the past, but also on a set of attributes related to the clinical workflow.

References

1. Cook, D.J., Guyatt, G.H., Laupacis, A., Sackett, D.L., Goldberg, R.J.: Clinical recommendations using levels of evidence for antithrombotic agents. Chest **108**(4 Suppl) (1995) 227S-230S
2. de Clercq, P.A., Blom, J.A., Korsten, H.H., Hasman A.: Approaches for creating computer interpretable guidelines that facilitate decision support. Artif Intell Med. **31**(1) (2004) 1-27
3. Micieli, G., Cavallini, A., Quaglini, S.: Guideline Compliance Improves Stroke Outcome-A Preliminary Study in 4 Districts in the Italian Region of Lombardia. Stroke **33** (2002) 1341-1347
4. Panzarasa, S., Bellazzi, R., Larizza, C., Stefanelli, M.: A careflow management system for chronic patients. In: Fieschi, M., Coiera, E., Yu-Chan Jack Li (eds): Medinfo 2004. IOS Press, Amsterdam Berlin Oxford Tokyo Washington DC (2004) 773-777
5. Peleg, M., Tu, S., Ciccarese, P., Kumar, A., Quaglini, S., Stefanelli, M. et al.: Comparing models of decision and action for guideline-based decision support: a case-study approach. JAMIA **1** (10) (2003) 52-68
6. Sackett, D.L.: Rules of evidence and clinical recommendations on use of antithrombotic agents. Chest **89**(2 Suppl.) (1986) 2S-3S
7. Tu, S.W., Campbell, J., Musen, M.A.: The SAGE guideline modeling: motivation and methodology. Stud Health Technol Inform. **101** (2004) 167-171
8. Yusuf, S., Cairns, J.A., Camm, A.J., Fallen, E.L., Gersh, B.J. Evidence-Based Cardiology. 2d edition BMJ Books London (2003)