PROCEEDINGS

55. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

13 - 17 September 2010

Crossing Borders within the ABC

Automation,

Biomedical Engineering and

Computer Science

Faculty of
Computer Science and Automation

www.tu-ilmenau.de

TECHNISCHE UNIVERSITÄT
ILMENAU

Impressum
Published by

Publisher:	Rector of the Ilmenau University of Technology Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor:	Marketing Department (Phone: +49 3677 69-2520) Andrea Schneider (conferences@tu-ilmenau.de) Faculty of Computer Science and Automation (Phone: +49 3677 69-2860) Univ.-Prof. Dr.-Ing. habil. Jens Haueisen
Editorial Deadline:	20. August 2010
Implementation:	Ilmenau University of Technology Felix Böckelmann Philipp Schmidt

USB-Flash-Version.

Publishing House:	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16 98693 Ilmenau
Production:	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts
Order trough:	Marketing Department (+49 3677 69-2520) Andrea Schneider (conferences@tu-ilmenau.de)

ISBN: 978-3-938843-53-6 (USB-Flash Version)

Online-Version:

Publisher:	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=16739

MEDICAL WORKFLOW ASSISTANCE WITH CLINICAL PATHWAYS: BRIDGING THE GAP

Sebastian Röhr, Danny Ammon, Vesselin Detschew

Ilmenau University of Technology

ABSTRACT

Presently, public health is more and more focusing on standardized treatment of certain diseases. The introduction of clinical pathways in healthcare institutions is a gradual approach to optimize quality, time, costs and service in terms of evidence-based treatment standards. However, clinical pathways as process models are currently often used for documentation aspects of present situations. In this contribution, we presume a lack of procedural support in the current use of clinical information systems. Therefore, a methodic and technical approach of transferring appropriate clinical process models into daily routine via workflow-based health information systems is suggested. We give a description of a structured semiformal process modeling in UML, and propose the application of a model-driven architecture for the transformation of general process models into standard xml-based languages of workflow-supporting health information systems. The contribution sets a work plan and closes with the discussion of open issues in the introduced method.

Index Terms – healthcare, clinical process modeling, software architecture, workflow management

1. MOTIVATION

Currently, the influence of standardized treatment in public health is increasing. Hospitals, for example, can implement clinical pathways to standardize the procedures of in-house patient treatment. Thus, medical quality via guideline representation as well as economy of processes or avoidance of risks and structure-based problems in patient flows can be controlled through clinical pathways. They represent a procedural view as counterpart to structural views of hospitals or connections of institutions in healthcare, underlining their functions as therapists of diseases and as service providers.

However, the actual use of process optimization techniques in health institutions is very limited. Clinical pathways are often used for describing present conditions, e.g. in efforts of quality management certifications (and are then being archived), but not for the execution of quality- or efficiency-increasing changes in the daily routines.
How activity models can serve as a basis for fundamental improvements of healthcare processes instead of depicting simple as-is-state, remains therefore as an open question.

In answering this question, the support of information technology plays a central role. The administration of operation sequences with the help of IT systems, however, is a definition for the field of workflow management. Providers of modern hospital information systems progressively integrate workflow management approaches and offer process-oriented directions to the user. The next step after the adoption of such types of information systems in medicine is a methodic transfer of consented best practice into clinical routine by the support of adequate information technology.

2. BACKGROUND

Medical guidelines serve as an instrument for qualitative and economic improvement as well as for professional and administrative support of the medical treatment process.

There remain, however, certain barriers to this guidance which prevent a proper implementation of it into clinical routine, insofar as “lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, the inertia of previous practice, and external barriers” [3] for more

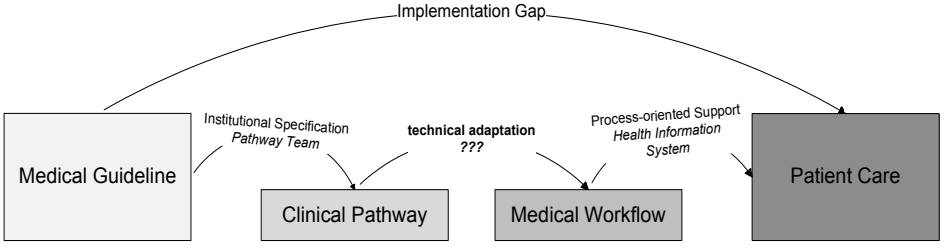

Figure 1: Clinical Pathways and Medical Workflows: Instruments for Bridging the Gap?

than ten years stayed as resentments against standardized treatment between clinicians.

Increasing pressure of cost and quality in patient care have since then led to a search for instruments and methods suitable for bridging the gap (figure 1) of schoolbook-like explicated medical knowledge and experiential-based patient treatment. [6]

To support clinical routine, on one hand, requires the application of a complete workflow management approach which should operate fully integrated into existing clinical information systems. Considering this, medical guidelines can only serve as the content of an efficient support of healthcare processes, not as a method for it.

On the other hand, medical guidelines can be enhanced by adding organizational-, personnel-, and time-related information to the certain activities carried out at the specific institution. We call these self-developed process models clinical pathways.

Pathways are defined as "a method for the patient-care management of a well-defined group of patients during a well-defined period of time. A clinical pathway explicitly states the goals and key elements of care based on Evidence Based Medicine (EBM) guidelines, best practice and patient expectations by facilitating the communication, coordinating roles and sequencing the activities of the multidisciplinary care team, patients and their relatives; by documenting, monitoring and evaluating variances; and by providing the necessary resources and outcomes" [2].

The remaining question is now: How can clinical pathways serve best for a well-fitting workflow management approach in medicine?

3. PROCESS MODELING

Clinical pathways as institution-specific models of patient treatment can be utilized in different ways:

- identification and education of clinical core processes
- modeling of multi-professional and complex systems
- pathway documentation and benchmarking
- process controlling
- quality management
- simulation of procedural or structural changes as well as extreme situations
- workflow management

Although these functions of clinical pathways require specific forms of modeling, a wide variety of pathway representation is currently in use, starting with free-text documents, from Excel spreadsheets to various graphic notations. [1]

Usable for fast understanding, clear arrangement and quick validation by clinicians, is on one hand the graphic notation, while the application of simulation or cost calculation pathways requires formal notation in a programming language. Therefore, a pathway format which connects the visual advantage of a graphic notation with underlying program code is best-suited for the implementation of all desired pathway functions.

A wide range of domain specific languages (DSLs) in healthcare supporting the modeling of guidelines has been developed, such as Asbru, EON, GLIF, PROforma and GUIDE. These languages enable a computer-supported execution of medical workflow assistance. The main problem of these is that each language uses it own semantics, syntax, data format and guideline execution engine. That restricts for instance sharing of clinical guidelines between different healthcare institutions and the ability of using custom modeling tools. Owing to the fact that there is only little standardization, the transformation from Computer-Interpretable Guideline Languages (CIGs) in other modeling languages is not a walkthrough. Further research also showed that CIGs are very similar to general process modeling languages used for the description of workflows [4]. Hence, hospital information system providers plan to integrate commonly used workflow management systems (WFMS), offering the functionality medical workflow assistance, supported by process models.

Using well-tested and highly optimized business

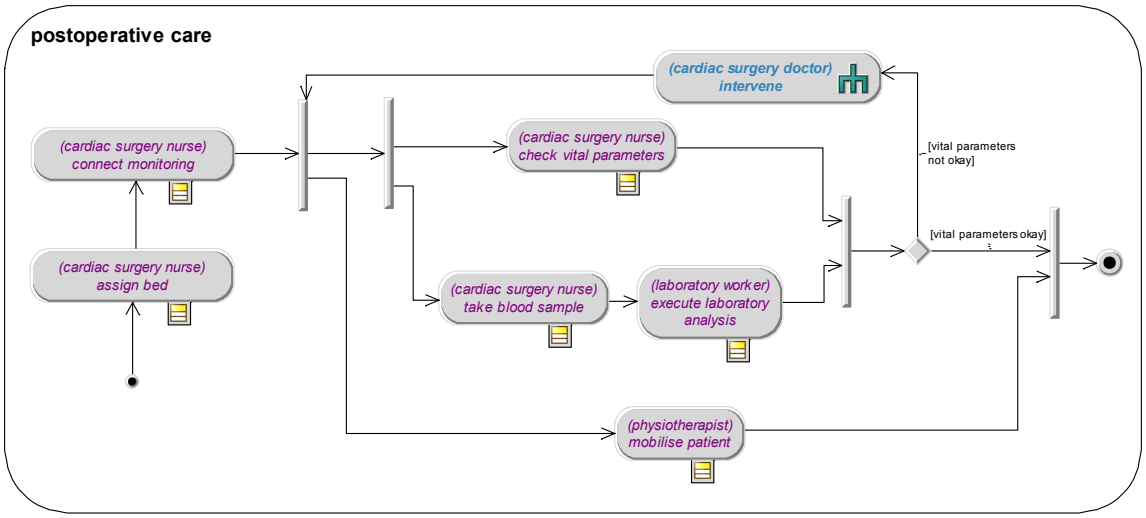

Figure 2: Example of Clinical Pathway model in UML (shortened)

process management (BPM) technology for visualization and assistance of healthcare processes allows a reduction of development costs and offers more flexibility in tool support for customers due to (almost) accepted standards, like BPMN, XPDL or BPEL.

However, process definitions for medical workflow assistance are different from clinical pathways. Those contain various technical details in connection with the process execution allowing the interaction with the underlying healthcare information system. Also, activity steps in a workflow model are often limited to mere system supported functionalities. Therefore, the fields of application for such healthcare process definitions are confined to workflow execution. To exhaust all above-mentioned possibilities of clinical pathways, utilizing different kinds of models for each purpose would be necessary. This would be not only time-consuming and expensive but would also lead to a high amount of maintenance required.

Our approach aims at bridging the implementation gap from clinical pathways to medical workflow assistance, and, concurrently facilitating the adaption for further scenarios, uses the Unified Modeling Language. UML is an ISO standard (ISO/IEC 19501) of the Object Management Group, applied worldwide [7][8]. It provides thirteen diagram types for the depiction of a (software) system in four different views—use case, structure, behavior, and interaction. Out of these, the activity diagram, which has been developed to show business and operational step-by-step workflows of a modeled system, is best-suited for process modeling. Here, furcations in activities are supported as well as decisions and parallel execution of tasks (figure 2). Single actions can also be refined by further activity diagrams, allowing cascading process connections, which enhances clear visualization and defines several layers of abstraction from the real process.

Therefore, UML can be used for a semiformal description of medical processes based on principles of software engineering—and therefore enforcing a generally structured method of modeling. A structured process modeling approach is inevitable in bridging the gap between medical guidelines resp. clinical pathways and workflow support of daily routine, since it serves as the fundament of generating the semantic basis of the desired healthcare workflow management.

4. MODEL TRANSFORMATION

The prevalent approach of developing a system or process model with UML which should later become or be incorporated into software has to rely on a software development process, since UML itself is and proposes none. But the platform-independent modeling of healthcare processes, which now shall transformed into system-specific formats, i.e.

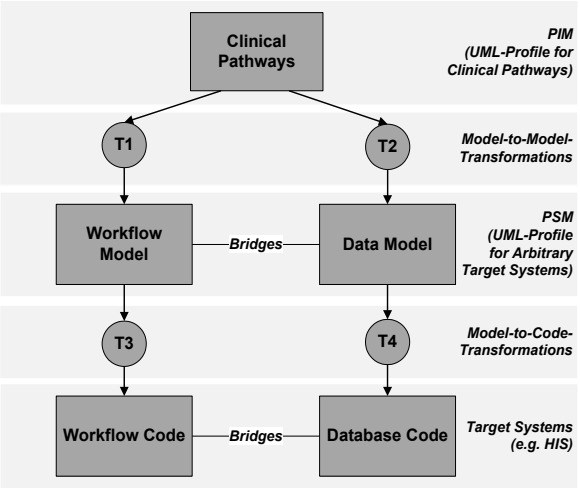

Figure 3: Possible Transformations of Clinical Pathways using UML and MDA

execution languages of workflow engines integrated in healthcare information systems, points to a model-driven architecture [5]. Indeed, we suggest that the MDA software design would be best-suited for the way from graphically noted medical procedures without any technical context to a formal code basis uniting semantic characteristics (What is to be done in the next step?) and syntactic specifications (How can this step be supported?).

The MDA design process (see figure 3) allows starting by a system-independent description of processes and functions, reducing complexity in the beginning, granting readability by clinical as well as computer experts and avoiding proprietary developments suitable for only one special solution. It then requires sets of transformations from the UML process models to particular system-specific languages and codes. Conceivable are transformations from UML into the Business Process Execution Language (BPEL), a widespread format interpretable by workflow engines, as well as transformations into SQL commands, suitable for the manipulation of process-related data altered in the certain medical action performed.

UML models can be transformed and visualized through the use of so-called UML Profiles, describing the formalization of domain models into platform-specific customizations by adding detailed target system-related information and data. This transformation concept theoretically allows the use of one-time defined clinical pathways for different purposes, only limited to supported functionalities of the underlying arbitrary target system.

5. DISCUSSION AND OPEN ISSUES

The here-presented research project is mainly in a preliminary stage. To fulfill the model-driven architecture concept, a platform-independent model is described in a domain-specific language. Currently, our approach includes UML as modeling language,

which is not domain-specific, but is used for the aforementioned reasons. The extensibility of UML, however, allows establishing domain-specific concepts into UML itself by several customization mechanisms.

To develop a UML extension specifically for clinical pathways by the adoption of required concepts shall also be part of this research.

A second open issue remains in the technical functionality of workflow models, which cannot be derived automatically from general medical process descriptions. A systematic integration of the working steps for attaining expedient functions of the information system associated to a certain treatment step has to be performed.

Finally, the practical execution and implementation of the proposed methodical and technical procedures has to be carried out, as well as positive results from a thorough evaluation of the project have to be achieved.

If the suggested universal method of medical process assistance proves valuable, model transformation in information systems other than process-oriented healthcare information systems are imaginable, e.g. service quality control, process quality-based benchmarking, cost calculation, resource utilization simulation et cetera. On this note, we understand our research interest as an attempt or contribution to a standardized form of description of medical action, since, in our opinion, herein lies the missing key element of a process-oriented healthcare.

6. REFERENCES

[1] D. Ammon, K. Eisentraut, V. Detschew, "Grade der Formalisierung von integrierten Behandlungs-pfaden", 52. Jahrestagung der Deutschen Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie, Rheinware, Mönchengladbach, p. 12, 2007

[2] L. de Bleser, R. Depreitere, K. de Waele, K. Vanhaecht, J. Vlayen, W. Sermeus, "Defining Pathways", J. Nurs. Manag. 14, pp. 553–563, 2006

[3] M.D. Cabana, C.S. Rand, N.R. Powe, A.W. Wu, M.H. Wilson, P.A.C. Abboud, H.R. Rubin, "Why don't physicians follow clinical practice guidelines? A framework for improvement", Journal Am. Med. Assoc. 282, pp. 1458–65, 1999

[4] N. Mulyar, W.M.P. van der Aalst, M. Peleg, "A Pattern-based Analysis of Clinical Computer-interpretable Guideline Modeling Languages", J. Am. Med. Inform. Assoc. 14, pp. 781–787, 2007

[5] Object Management Group, "Technical Guide to Model Driven Architecture: The MDA Guide v1.0.1", http://www.omg.org/cgi-bin/doc?omg/03-06-01, 2003

[6] M. Reichert, R. Lenz, "IT Support for Healthcare Processes – Premises, Challenges, Perspectives", Data Knowl. Eng. 61, pp. 39–58, 2007

[7] Object Management Group, "Unified Modeling Language (UML), Infrastructure Specification, Version 2.3", http://www.omg.org/spec/UML/2.3/Infrastructure/PDF/, 2010

[8] Object Management Group, "Unified Modeling Language (UML), Superstructure Specification, Version 2.3", http://www.omg.org/spec/UML/2.3/Superstructure/PDF/, 2010