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Integrating specialized application systems into hospital information systems – obstacles and factors for success

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Abstract
Hospital information systems are often huge and heterogeneous systems. To support physicians with their daily clinical work, application systems are developed which are dedicated to particular medical fields or tasks and which have to be integrated into the hospital information system. The integration process is quite complicated, because it makes the information system's infrastructure even more heterogeneous. We developed an application system for documentation and therapy planning in pediatric oncology (DOSPO) and we started to introduce it into the Department of Pediatric Oncology of Heidelberg University Hospital. The fact that DOSPO is developed as a universal system for nationwide use made the integration process more difficult. In any case, the introduction of specialized application systems has to be planned systematically in advance, regarding the prevailing information system's infrastructure, available resources and established processes. To simplify the integration process comprehensive electronic patient records for the future should be designed in a way that they can be enhanced easily by new clinical functions.

1. Background information

Problems

We regard a hospital information system (HIS) as "the partial system in a hospital, which is dealing with the complete information processing and information storage of the hospital" ([1], p. 379). In this comprehensive view on HIS we can recognize - at least in bigger hospitals - the following trends:

HIS are often huge and heterogeneous systems (e.g. [1])
starting point of computer-based functions of a HIS are mostly application systems for administrative functions
the demand for computer-based clinical functions of HIS is growing and results in research on electronic patient records (EPA, e.g. [2])
currently there is no comprehensive EPA available that serves all the demanded clinical functions.

To fulfil the physicians' needs of an efficient support of their daily clinical work and not only of administrative tasks it is often necessary to develop computer-based applications systems which are dedicated to the information needs of a particular medical department or a specialized task like therapy planning or information retrieval (e.g. [3-5]). Even if those systems are integrated into the HIS, they are making it more heterogeneous. This makes the

task of introducing new application systems quite sophisticated. Interfaces for integration have to be planned and implemented, so that multiple data entry can be avoided and that users have not to work with two completely independent application systems.

It may also become more difficult to introduce new computer-based hospital-wide functions, if there are already specialized application systems in routine use: If there is an overlap of data and functions it may be difficult to motivate the users to use an application system he is not used to and that is less dedicated to his needs.

Objectives of the paper

The Department of Medical Informatics at the University of Heidelberg has developed in cooperation with the German Society for Pediatric Oncology and Hematology (GPOH) a documentation and therapy planning system (DOSPO) for nationwide use ([6]). We developed DOSPO as an incremental prototype and we started recently with introducing it into routine use. As a pilot hospital Heidelberg University Hospital was chosen, where already a sophistated computer-based information system infrastructure is established ([7-9]). Therefore, we had to carefully plan and carry out the introduction process. It is the aim of this paper to discuss obstacles and factors that enable a successful introduction and integration of specialized application systems into a HIS and the routine work of the hospital's staff regarding our experiences with DOSPO at Heidelberg University Hospital.

2. Brief description of the application

Motivation for DOSPO

Pediatric oncology is a medical discipline, where children with cancer are diagnosed and treated. In Germany, the age-standardized incidence rate is about 13,2 per 100.000 for all kinds of malignancies. 90% of these children are treated in the framework of nationwide multicenter clinical trials which are spreaded all over Germany. Treating childhood cancer is a complicated and long-lasting process. The documentation that accompanies the clinical trial is extensive and comprehensive. At several points of the therapeutic process a considerable amount of data has to be transmitted to the respective trial center. The aim of DOSPO is to support the physician with the documentation for the trials and to establish on a medium-term basis a computer-based data exchange between hospitals and trial centers.

Functions

DOSPO provides three categories of functions: documentation functions, therapy planning functions and routine functions.

1.) Documentation functions: In former years the Working Group "Medical Informatics" of GPOH has defined a standardized basic data set for pediatric oncology ([10]). The aim was to avoid different documentation concepts in different clinical trials and to enable a better integration of clinical work and documentation. The basic data set is a minimum data set which is applicable for all clinical trials. Documentation functions of DOSPO enable the computer-based recording of all its data. However, these data cover only a part of the documentation that is necessary for the clinical trials. DOSPO is stepwise enhanced by the comprehensive documentation of data for particular clinical trials.

2.) The trial centers release therapy protocols which specify the treatment of the children. Basic component is in most cases chemotherapy. For treating a particular child the dosage of drugs proposed by the protocol has to be adapted to several patient-specific parameters. These calculations can be complex and an error may have severe consequences. Therefore, DOSPO comprises a therapy planning function like it has been implemented in the former application system CATIPO ([11]). CATIPO, which is dedicated to this task is used in about 20 hospitals in Germany. For being able to derive patient-specific therapy plans DOSPO has to provide a knowledge-acquisition function for defining protocol knowledge.

3.) Although the main functions of DOSPO are trial documentation and therapy planning we implemented some functions for supporting the physician with routine tasks of his clinical work. These are among others: reports for the conventional patient record, medical

report writing, documentation of the administered chemotherapy, data exchange with the German Childhood Cancer Registry, and cross-patient analysis. With these functions DOSPO can also be used in the sense of an EPA and multiple data entry can be avoided.

Architecture

DOSPO is designed as a core-system which can be enhanced by modules for trial-specific documentation. The core-system comprises the documentation of the basic data set and provides the above mentioned functions. The functions are implemented in a way that they work with the data of the basic data set as well as with the trial specific data from the modules. Trial specific modules are implemented in the trial-centers and they have no own functionality. When a trial releases a new protocol it has to be accompanied by a new trial-specific module.It will be installed in the hospitals by the respective system's administrator. We intend to provide a generic tool to support the trial center with implementing trial-specific modules, that can easily be integrated in the DOSPO core-system. Additionally, we want to standardize and unify the terminology of all multicenter trials in pediatric oncology in Germany and represent it formally in a data dictionary. For that we will provide a computer-based application system to enter and maintain the terminology.

Aspects of integration

For introducing DOSPO it has to provide three different kinds of communication interfaces:

The DOSPO-internal communication interface enables the integration of the trial specific modules. Main requirement is here, that the trial-specific data are available for the DOSPO functions as well as the data of the basic data set. For that we defined a description of a meta-database that can store the information how the database of the trial-specific module is built up and that can be interpreted by the DOSPO core-system.

The DOSPO-HIS communication interface enables the integration into the local HIS. Since DOSPO is intended to be used in various hospitals all over Germany we decided to work with HL7 as communication standard. Currently, DOSPO interfaces are available for patient data and laboratory results.

The external communication interface enables the data exchange with the trial centers. For this task there is currently no (inter-)national standard available. Therefore, we specified our own DOSPO-standard and we revealed that to the trial centers. Thus, they can take over the transmitted data into the trial's data base.

3. Conclusions – Lessons learned

Introduction of DOSPO to routine use

The DOSPO core-system with all its functions is available since the beginning of 1999. Since the functionality of DOSPO is quite comprehensive and complex a systematic approach is needed for introducing DOSPO into routine use in a hospital. We had to realize on the one hand that in most pediatric-oncologic wards no qualified staff was available for systematically planning a stepwise introduction process. On the other hand it is not possible for us to accompany the introduction process of a variety hospitals in a nationwide project. In order to gain experiences we started with the Department of Pediatric Oncology at Heidelberg University Hospital. In this department the application system CATIPO ([11]) is used for therapy planning since several years. Therefore, we have chosen the substitution of CATIPO by the DOSPO-therapy planning function as a starting point. Therapy protocols that had already been defined in CATIPO were imported to DOSPO. For several weeks the therapy plans of a patient were calculated twice, so that we could validate the quality of the DOSPO therapy planning function. Due to positive results of this phase therapy planning has now been substituted completely by DOSPO. As a next step in Heidelberg University Hospital we will introduce the HL7 communication interfaces. Additionally, we plan the integration of DOSPO documentation with the documentation of the tumor center Heidelberg/Mannheim in order to avoid multiple data entry.

We now started to expand the introduction activities on two further clinics by supporting the installation of the client-server version of DOSPO and importing of existing therapy plans. Progress is here less fast, because we are not directly on the spot. Several further clinics have requested to start with a routine use of DOSPO.

Obstacles and factors for success

When introducing DOSPO as a specialized application system we regarded obstacles and factors for success with respect to the available information system's infrastructure, available resources and processes in the wards/clinical departments and the universality of the application system.

Available information system infrastructure: The general problem of introducing a specialized application system into an existing HIS-infrastructure has already been discussed briefly in the introductory part of this paper. Problems can be minimized, when standardized communication interfaces are available and it will be successful, when multiple data entry can be avoided. Several approaches to this are already known from adult oncology (e.g. [1213]). But we have not considered so far that HIS are changing over the time and that communication interfaces provided once, may not be sufficient in the long run. The people responsible for the strategic management of a HIS have to be aware that there may be running dedicated application systems that have to be preserved when expanding the local HIS. The introduction of DOSPO in Heidelberg University Hospital overlapped with regard to time with the hospital-wide introduction of a clinical workstation and an EPA. Concerns of clinical staff that they will have to use different application systems with different user interfaces were quite an obstacle for motivating them to use DOSPO. Documentation staff enters data for the tumor center Heidelberg/Mannheim into another specialized application system (KRAZTUR, [14]) which is established since several years. For that we have to develop another communication interface and to harmonize the terminology of DOSPO and KRAZTUR.

Available resources and processes: It is quite often stated that the success of an application system is dependent on the motivation of the users and that the motivation is dependent on the expected benefit of the system. In our opinion this describes the problematic nature not sufficiently. Normally, the introduction of a new application system requires provision of staff resources and a change of established procedures. The threshold for doing this is often quite high, because the benefit can only be reached after a certain time of settling. Staff resources are needed for administration of the application system (installation, adaptation, updates), educating and advicing the users, and so on. These tasks should be performed by qualified personnel. It is very important as well for the clinical staff as for the developers that these persons remain the same over a certain period of time. Since we introduced DOSPO in Heidelberg University Hospital by ourselves this was a minor problem. The next hurdle will be to hand over our current activities to the clinical staff.

Universality of the application system: If a dedicated application system is developed not only for a certain medical field or task, but also for a certain institution of patient care, the integration process is feasible with common approaches. Right from the beginning of specification and implementation the particular needs and circumstances of the institution can be considered. For a more universal approach an adaptation process is necessary after implementation and normally these solutions do not cover all the requirements of a particular institution. This problem is especially true for DOSPO, because it is a nationwide project. When we regard for example the communication interfaces, we have to be aware that the HL7 standard is varying between the hospitals. Thus - despite we are using an international standard - we have to make adaptations of the communication interfaces for each hospital. Other hospitals do not even offer a HL7 communication interface so that we have to develop completely individual solutions. In both cases successful integration is dependent on cooperation with qualified medical informatics staff of the hospitals.

Strategies for a successful introduction

In our opinion it is currently not possible to define a general strategy for effectively integrating specialized application systems. The mentioned problems are too complex on different levels and are highly intersecting. Additionally, local conditions are varying and

not only depending on technical constraints but on human preferences and attitudes. We highly emphasize to plan every introduction process systematically and goal-orientedly. Methods for that are available from the field of project management, but the particular circumstances in the medical field have to be considered carefully. Obstacles and factors for success have to be foreseen, observed and analysed. Regarding them, a stepwise approach of introducing the application system should be specified. We have to be aware that the necessity of performing this planning activities is often underrated.

4. Perspective

Despite continuing research in the field of HIS we are convinced that heterogeneous information systems will still be prevailing for a certain time in bigger hospitals. When we integrate an application system dedicated to the needs of a certain medical field or task into such a HIS we have to consider a variety of influencing factors. Main factors for success are the avoidance of multiple data entry and an adequate integration into the clinical processes. A perspective to minimize these problems in the future are research activities in the field of comprehensive EPAs. They should be designed in way that they can easily be enhanced by new clinical functions.

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