

Computer-based documentation systems and their integration into hospital information systems

Elske Ammenwerth¹, Reinhold Haux¹, Petra Knaup¹, Ulrike Pohl²

¹Department of Medical Informatics, University of Heidelberg, 69120 Heidelberg, Germany

²Department of Dermatology, University of Heidelberg, 69115 Heidelberg, Germany

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ABSTRACT

High quality clinical documentation is a prerequisite for high quality patient care. Computer-based documentation systems have the potential to reduce the time and effort needed for documentation, to increase the quality and the reusability of the data, and finally, to support high-quality and efficient patient care. But their introduction into a clinical environment is often difficult, and integration seems to be crucial for their success. The aim of this paper is to present different integration aspects which have to be taken into account when integrating new computer-based documentation systems into a hospital information system (HIS). As an example, we will discuss the successful introduction of the computer-based nursing documentation system *PIK* at the Heidelberg University Medical Center.

Keywords: Hospital Information Systems, Integration, Nursing Documentation

1. INTRODUCTION

High quality clinical documentation is a prerequisite for high quality patient care ([1], [2]). Both clinical data (i.e. medical history, diagnosis, and therapy) and administrative data (i.e. patient name and address, DRG-codes and cost data) must be documented timely, correctly, completely, and legibly. Well documented data facilitates communication inside the health professional team, helps to organize the treatment and also guarantees adequate hospital funding ([3]). Clinical data is also used for quality management, research and education.

Nursing documentation is one important part of clinical documentation. In Germany, paper-based systems have been introduced to support nursing documentation. However, nursing documentation is often regarded as a time-consuming task for nurses. High expenses for documentation, low quality of data and limited user acceptance are frequently reported ([4], [5], [6]).

Computer-based documentation systems are developed with the aim to solve these problems ([4]). They have the potential to reduce the time and effort needed for documentation, to increase the quality and the reusability of the data, and finally, to support high-quality and efficient patient care.

Introducing a new computer-based documentation system into a clinical environment is often difficult ([7]). If the benefits of the new system are not obvious to the users and the advantages of the new system do not seem to outweigh the additional efforts and costs, user acceptance can be a problem. If the system requires

multiple documentation of data, does not have a standard user interface, or if it is not adequately adapted to the users' working practices, then a lack of user acceptance may arise

To avoid these costly failures, new documentation systems should be *integrated* into the hospital information system. Various aspects of integration discussed in literature must be taken into account. For example, the computer-based documentation system should be accessible from the clinical workstation. Also, data from other systems should be reusable to avoid multiple documentation. This is especially true, regarding the ongoing research on electronic patient records, which also can be regarded as an application system accessible on the clinical workstation. Integration seems to be crucial for the success of computer-based documentation, otherwise patient care will not be supported efficiently. Considering, understanding, and realizing integration aspects is thus a challenging task of health informatics in the 21st century.

Aim of this paper

The aim of this paper is to present different integration aspects which have to be taken into account when integrating new computer-based documentation systems into a hospital information system (HIS). As an example, we will discuss the successful introduction of the computer-based nursing documentation system *PIK* at the Heidelberg University Medical Center.

2. INTEGRATION INTO HOSPITAL INFORMATION SYSTEMS

A hospital information system comprises all information processing conducted in a hospital, whether computer-based or paper-based ([8]). Hospital information systems are usually heterogeneous, i.e. they include many different tools such as paper-based and electronic patient records, clinical workstations, paper-based documentation systems, telephones and e-mail-systems. The computer-based part of a hospital information system in itself presents a rather complex structure which consists of many different workstations, servers, networks, applications systems, communication interfaces and other functions. Integrating these different systems is a central aim of the overall information processing strategy ([9]). Integration is normally defined as the act of combining or adding parts to make a unified whole ([10]). HIS management must therefore guarantee that the different computer-based components work together smoothly to offer the user an adequate functionality and to support the overall aims of a hospital: cost-effective and high-quality patient care.

Different integration aspects must be taken into account when introducing a new application system into the HIS:

- **Technical integration:** The different computer systems of a HIS must be interconnected ([11]) to avoid technical stand-alone-systems. This can be achieved by using an overall HIS network ([12], or by installing all application systems on a single server. Network integration can be realized, for example, by networking stationary computers, by mobile computers connected via infrared, or wireless networks. A new application system should always be installed on a computer integrated in the overall HIS network.
- **Access integration:** All user relevant clinical functions should be uniformly accessible from one health professional workstation ([13], see also [14]). All relevant clinical client software should be available from one workstation. A new application system should be added to the health professional workstation.
- **User interface or presentation integration:** There should be a uniform graphical user interface and an overall uniform behavior for all user-related functions on the health professional workstation ([13], [15]).

A new application system should therefore follow predefined, hospital-wide guidelines for user interface design.

- **Communication integration:** Application systems should be able to exchange information by using standardized messages ([13]). This is the precondition for data and function integration in a distributed, non-centralized HIS environment. For example, a patient management system should have a communication interface to a documentation system to transmit patient data using a pre-defined format. A new application system should therefore have a communication interface which supports the communication standard used in the HIS.
- **Data integration:** Data should only be documented once and then be reused multiple times([3]). The user will perceive it as if it was stored in a single database ([Degoulet, 1996 #1043. For example, administrative patient data should be documented once in the patient management system and then be reused in other systems such as dedicated documentation systems. To achieve data integration, the HIS should have a global data model ([16]) with clearly defined semantics of its concepts which should be revealed for the development of new application systems.
- **Function integration:** A function should only be offered by one application system, even if it is also used in other systems. For example, the data for patient admission should only be recorded once using the functions of the central patient management system. Admission should not be carried out in other systems. New application systems should therefore be designed so that functions existing in prevailing application systems are used ([12]). To achieve function integration, a HIS should include a repository of services offered globally ([11]).
- **Workflow integration:** New computer-based systems should be smoothly integrated into the daily clinical workflow. Thus, their functionality and usability should match the needs of the users and their typical tasks. The new computer-based system must therefore smoothly work together with the other computer-based *and* paper-based information processing tools. Achieving workflow integration is the most important task from the user's point of view.

As shown, several aspects can be distinguished when integrating application systems into hospital information systems. All of these aspects are important since they form the preconditions for the success of a new computer-based system in terms of benefits, costs, and user acceptance.

3. INTEGRATION OF A NURSING DOCUMENTATION SYSTEM

As an example, we will now demonstrate our experiences with integrating a computer-based nursing documentation system into the hospital information system of the Heidelberg University Medical Center. The new software "PIK" was introduced due to recent problems such as a high time effort and a low quality of the paper-based documentation. PIK offers the following functions:

- **Catalog management:** Catalogs with pre-defined documentation items can be established and maintained. They contain items covering typical problems, aims and nursing tasks. Also, they can be put together to construct pre-defined nursing care plans.
- **Information assessment:** General information about the patient's problem is gathered.

- Care planning: Based on the catalog items, nursing care plans can be constructed and adapted to the patients' needs.
- Documentation of nursing tasks: Nursing tasks can be documented on a time scale.
- Report writing: Nursing reports can be written as free text.

PIK was introduced on one psychiatric ward (12 nurses, 6 physicians, 23 beds, 420 patients/year) at the end of 1998. The effects of PIK were evaluated in a randomized, controlled trial during the beginning of 1999 ([17]). Since 1999, PIK is used routinely on several wards.

The integration was conducted as follows:

- **Technical integration:** At the Heidelberg University Medical Center, 3000 computer systems are used by the approximately 8000 staff members. Nearly all of them are connected by a hospital-wide network. PIK was installed on some of these networked computers. Thus, technical integration was guaranteed.
- **Access integration:** In Heidelberg, 1200 health professional workstations are installed and used on wards, in surgeries and in the physicians' rooms. They offer nearly all clinical functions needed by the medical and nursing staff. These include medical documentation, order entry, report writing and duty scheduling and access to the electronic patient record. The PIK client was also installed on the health professional workstation. All clinical software (including PIK) can be reached by one central menu thus guaranteeing access integration.
- **User interface integration:** Usually, clinical software should follow some basic design rules for windows programs. Unfortunately, PIK is not quite conform with these basic standards. For example, double clicking in PIK means selecting an item from a list, whereas double clicking usually means opening something (for example a folder). On the other hand, most of the other clinical software does not follow basic standards either. Overall, user interface integration is not fully supported by the health professional workstation in Heidelberg.
- **Communication integration:** During the pilot phase, PIK did not offer a standard communication interface. It was used as a stand-alone system. It has now been decided to routinely introduce PIK on more wards. Therefore, to achieve communication integration, a HL7-interface is now being developed. PIK will then be able to import patient data and export nursing documentation data. But at the moment, communication integration is not available.
- **Data integration:** Data integration is not available due to the missing communication integration during the pilot phase of PIK. As a result, administrative patient data has to be documented twice which is time consuming and often faulty. As communication integration is presently being worked upon, we will be able to achieve data integration during the summer 2000. By this time, PIK will be able to receive administrative data from the patient management system, and transmit nursing data to the electronic patient record.
- **Function integration:** Function integration is not available due to the missing communication integration. Consequently, a least two duplicate functions are in use with PIK compared to currently available HIS functions: patient admission and archiving of documents. For example, nursing care plans can only be accessed using PIK, not the hospital-wide electronic patient record system ([18]). Since communication integration is currently being prepared, we hope to achieve function integration by the end of the year. It will then be possible among others to store nursing care plans prepared with PIK as part

of the electronic patient record. Both the PIK admission module and the PIK archiving module will then be uninstalled (this is possible due the modular software architecture) and be replaced by the hospital-wide functions.

- **Workflow integration:** As PIK does not offer data and function integration, it is not integrated well in the overall clinical workflow. For example, PIK requires admitting patients twice and nursing documentation can not yet be added to the electronic patient record. On the other hand, PIK is well integrated in the nursing documentation workflow. All phases of nursing documentation can be conducted using PIK. As documentation is usually carried in the ward office, the two stationary computers installed there are sufficient and mobile computers are needed. In addition, PIK was installed on the physicians' workstation enabling them to access and read the nursing documentation. Overall, we have partially achieved workflow integration.

In summary, important integration aspects, such as data and function integration, are not yet fulfilled by our PIK installation. As we are currently developing a HL7 interface, we hope to achieve data and function integration by the end of the year.

4. DISCUSSION

Good integration into the existing hospital information system is the basis for high-quality information processing and for efficient and high-quality patient care. Besides possessing adequate functionality and high technical quality, new application systems, such as the electronic patient record, should be integrated smoothly into the hospital information system.

For the introduction and integration of PIK, it was helpful to identify various integration aspects necessary for introducing a new computer-based documentation system. While on the one hand we learned that integration aspects are very important for an immediate support of routine clinical processes, we also learned that, despite some integration deficiencies, a good user acceptance can be achieved when the advantages of the system outweigh the disadvantages of an insufficient integration of PIK. For example, we could observe a high user acceptance of PIK due to overall time savings for nursing documentation.

As more and more application systems are introduced into hospital information systems, the integration of these heterogeneous components will be a challenging task of hospital information systems management in this new century. Research should focus on identifying integration aspects and providing integration strategy guidelines for new computer-based information processing tools. This will prevent introduction failures and will lead to an increased quality of clinical information processing.

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