

KernPaeP – A Web-Based Pediatric Palliative Documentation System for Home Care

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Abstract. KernPaeP is a new web-based on- and offline documentation system, which has been developed for pediatric palliative care-teams supporting patient documentation and communication among health care professionals. It provides a reliable system making fast and secure home care documentation possible. KernPaeP is accessible online by registered users using any web-browser. Home care teams use an offline version of KernPaeP running on a netbook for patient documentation on site. Identifying and medical patient data are strictly separated and stored on two database servers. The system offers a stable, enhanced two-way algorithm for synchronization between the offline component and the central database servers. KernPaeP is implemented meeting highest security standards while still maintaining high usability. The web-based documentation system allows ubiquitous and immediate access to patient data. Sumptuous paper work is replaced by secure and comprehensive electronic documentation. KernPaeP helps saving time and improving the quality of documentation. Due to development in close cooperation with pediatric palliative professionals, KernPaeP fulfils the broad needs of home-care documentation. The technique of web-based online and offline documentation is in general applicable for arbitrary home care scenarios.

Keywords. palliative care, ambulatory care, terminal care, nursing records, online system

1. Introduction

In April 2007, the German government approved a law that gives every citizen in Germany the right to receive “specialized palliative care in the community” (in German: “Spezialisierte Ambulante Palliativ Versorgung”, SAPV). So called “Palliative Care Teams” (PCTs) have been established throughout the country, in order to deliver this service. These teams rely on a comprehensive cross-profession joint patient documentation accessible to all PCT members. In order to achieve improvements in patient documentation and quality management, an access-based documentation system, called KernPaeP, has been implemented, tested and used for patient documentation at several hospitals. The access version enables comprehensive documentation in digital form of pediatric palliative patients receiving treatment at home. Although the first system fulfils the needs of pediatric home care documentation,

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it does not support multiple user access, as the system does not provide user administration, audit trail or needed security measurements for ubiquitous but restrictive access. Therefore, after evaluating the hitherto documented data, a web-based documentation system of KernPaeP has been implemented, using advanced mobile information and communication technology (ICT). It provides an on- and offline solution making documentation at site possible. By storing and sharing health information electronically and by providing these information in most cases in real time, clinical communication can be enhanced, number of errors reduced, and doctors giving their diagnosis and treatment assisted. However, the increasing access to medical data through electronic systems, especially over the Internet, brings new risks to the privacy and security of health records. The implementation of KernPaeP demands high requirements regarding security on the one side and usability on the other side [1]. This paper introduces the concept of the new web-based system and the results which have been achieved so far.

2. Methods

2.1. The Online and Offline Architecture

KernPaeP is designed as an on- and offline application accessible via any standard browser. It is based on PHP, JavaScript, and MySQL-databases. The implementation uses a self-designed model-view-controller architecture making it easier to modify either the visual appearance of the application or the underlying business rules. For visual appearance a Smarty template engine is used. Offline access is realized by providing a web server within a VirtualBox. The local web server hosts an adapted version of the online application with a local MySQL database and synchronization algorithm (cf., section 2.4). In order to document and view patient records with the offline system, the client has to select records while online and download them temporarily onto the local database. The offline system is provided to PCT members on netbooks, but in principle runs on any other platform which meets the requirements for a VirtualBox hosting a web server.

2.2. Separation of Patient Identifying and Medical Data Records

In order to meet the demanded security requirements when processing medical data online [2, 3], the implementation of the new KernPaeP system is based on the “generic concept A” from the German Telematics Platform for Medical Research Networks (TMF e.V.) [4]. Identifying and medical data are strictly logically and physically separated. Patient identifying data is stored on the IDAT (identifying data) server. Medical data is stored in the MDAT (medical data) server (cf., Figure 1). MDAT and IDAT components are located at two separate remote sites. The MDAT server additionally stores the ADAT, containing information about physicians (user of the system), associated institutions, access rights and general system data.

IDAT and MDAT data of a patient record are associated through a unique (and bijective) internal pseudonymous patient identification number (PID) [5]. The PID is not visible to the user at any time (thus it is strictly confidential) and not editable. Individual administrators do not have the possibility to consolidate data. Only

authorized users have access to patient data and thus to both IDAT and MDAT. A comprehensive role system regulates the access of all users to the system.

2.3. Merging of Patient-Identifying and Medical Data Records

The consolidation of IDAT and MDAT requires connections to two database servers. Due to the “same origin policy” of modern web-browsers, a direct connection to the two database servers (i.e., web servers) using the online KernPaeP system is not possible [6]. In order to adopt the data consolidation concept [4], identifying and medical data are merged by dynamic inclusion of JavaScriptlets. The process of retrieving information from both servers is illustrated in Figure 1. When a user requests consolidated identifying and medical data, KernPaeP establishes a direct connection between the user and MDAT server. MDAT content is directly delivered to the user. It contains a unique temporary identifier (TempID), which is shared by ADAT/MDAT and IDAT server and relates IDAT data to MDAT data. Still missing IDAT data is marked in the content delivered by the MDAT server. Dynamically generated short JavaScriptlets by the MDAT server are executed automatically on page load. They call a PHP script on the IDAT, which returns dynamically generated JavaScript code with the help of the TempID. The code is executed in the user’s browser and provides the requested IDAT data, which is filled into the previously marked content bringing identifying and medical data together. This described method ensures that identifying and medical data are only merged within the browser of an authorized user.

Working with the offline application, selected data has to be stored beforehand on the local MySQL database. Storing identifying and medical data on the offline system is not critical, since the data is solitary in the ownership of an authorized physician. For security measurements the partition containing the database and program-logic is encrypted in case the netbook with the offline application is stolen or lost.

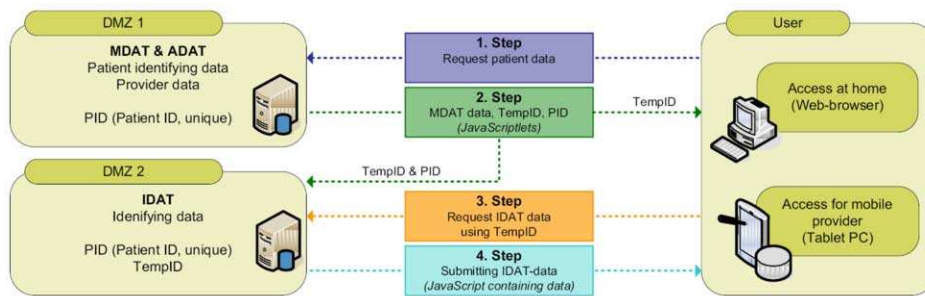


Figure 1. The four steps of data consolidation of IDAT and MDAT. A TempID is created for each individual request, keeping the PID hidden from the user.

2.4. Data Synchronization

Systems using central database storage and offering offline components require stable and solid methods of synchronization. KernPaeP uses the method of enhanced two-way synchronization [7]. Instead of sending a complete patient record from the offline database to the database servers, only data which has been modified after the last synchronization is committed [8]. If a dataset has been modified, it is flagged, signed by the client and stored with respect to the current timestamp. When the selected data is

sent to the central database, conflict resolution is mandatory. Conflicts arise e.g., when changes to the same dataset have been made on both the client and server side. The synchronization algorithm compares each data field of the data committed by mobile clients with the existing ones in the central database. If two data-sets are in conflict, the user is informed when and by whom the conflicting data had been modified. The user has to decide for each conflicting data set which entry is valid. When all conflicts are resolved, the data is stored.

When working on datasets online, data fields are locked dynamically using a two-phase locking mechanism [9]. The lock is applied when the modifying process is started. Lock existence prevents other clients from modifying data which might cause inconsistency. According to the two phase locking protocol, a transaction handles its locks in two distinct, consecutive phases during the duration. In phase 1, locks are acquired and none are released. In phase 2, locks are released and none are acquired. This means that, if a user is working on a specific form, other users have read-only access to the certain form but temporarily no modification rights.

3. Results

The online system has been implemented and tested. Evaluation of these tests have shown that it is important for the documentation system to provide as much predefined option values as possible instead of free text fields. This fastens the process of documentation and makes evaluation of data in a broader context possible. Benefiting of the experience with the first access-based version of KernPaeP, the new web-based version focuses on data, which is really needed and reliable for quality management and supportive for the daily work routine. Tests with PCT members have shown that the acceptance of the software depends on the usability and effectiveness. Comprehensive patient documentation is very time consuming. KernPaeP tries to adapt especially to the workflow of PCT members to fasten the process.

4. Discussion

Web-based online and offline documentation systems help to manage the increasing complexity of health care processes and the resulting huge quantity of information. Implementations of general comprehensive documentation systems face the problem that the variety of data is too broad and too complex. Furthermore, patients do not usually present themselves or their histories in a structured data format, which makes the handling of huge electronic documentation system difficult [10]. In order to avoid these difficulties KernPaeP was especially designed for the specific field of pediatric palliative medicine. It has been developed in close collaboration with home care teams to meet the needs of pediatric palliative documentation. Distinguishing to hitherto systems [11] KernPaeP offers a solution for web-based online and offline documentation. Patient data is centralized stored making fast exchange of information and access to the most current information possible. Offering an offline version KernPaeP does not rely on permanent internet access and is therefore adaptable as mobile documentation system. Using standardized forms and checklists ensure that best practices are followed. Home-care teams using the system will most likely enhance their quality of documentation and have comprehensive patient data always at hand.

5. Conclusion

By implementing a secure system for web-based online and offline documentation, KernPaeP represents a telemedicine application which taps the full potential of modern internet technologies. Offering dependable synchronization methods for online and offline systems, it enables comprehensive and reliable documentation directly at site, e.g., at patient's home. KernPaeP improves communication among health care professionals by offering ubiquitous and immediate access to patient data. In case of emergency a physician could be granted access to medical data online. Expecting an increasing number of nationwide establishments of palliative home care teams, the new system could be used as a nationwide quality assurance instrument. In order to achieve this goal further testing, improvements and research will be applied.

References

- [1] Pharow, P., Blobel, B. (2008) Mobile health requires mobile security – Challenges, solutions, and standardization. In Andersen, S.K., Klein, G.O., Schulz, S., Arts, J., Mazzoleni, M.C. (Eds.) *eHealth Beyond the Horizon – Get IT There. Proceedings of MIE 2008*, IOS Press, Amsterdam, *Studies in Health Technology and Informatics* 136:697–702.
- [2] Prady, S.L., Norris, D., Lester, J.E., Hoch, D.B. (2001) Expanding the guidelines for electronic communication with patients: Application to a specific tool. *Journal of the American Medical Informatics Association* 2001(4):344–348.
- [3] White P. (2002) Legal issues in teleradiology-distant thoughts! *British Journal of Radiology* 75(891):201–206.
- [4] Reng, C.-M., Debold, P., Specker, C., Pommerening, K. (2006) *Generische Lösungen zum Datenschutz für die Forschungsnetze in der Medizin*. Medizinisch Wissenschaftliche Verlagsgesellschaft, Berlin.
- [5] Faldum, A., Pommerening, K. (2005) An optimal code for patient identifiers. *Computer Methods and Programs in Biomedicine* 79:81–88.
- [6] Karlof, C., Shankar, U., Tygar, J.D., Wagner, D. (2007) Dynamic pharming attacks and locked same-origin policies for web browsers. In *Proceedings of the 14th ACM Conference on Computer and Communications Security CCS'07*, ACM, New York, USA, 58–71.
- [7] Haras, C., Sauquet, D., Ameline, P., Jaulent, M.C., Degoulet, P. (2005) Patient data synchronization process in a continuity of care environment. *AMIA Annual Symposium Proceedings 2005*, 296–300.
- [8] Campana, J., Gmelin, M., Schöchlin, J., Bolz, A. (2002) XML-based synchronization of mobile medical devices. *Biomedizinische Technik* (Berlin) 47(Suppl 1, Pt 2):857–859.
- [9] Leu, P.J., Bhargava, B. (1988) Clarification of two phase locking in concurrent transaction processing. *IEEE Transactions on Software Engineering* 14(1):122–125.
- [10] Baron, R.J. (2007) Quality improvement with an electronic health record: Achievable, but not automatic. *Annals of Internal Medicine* 147(8):549–552.
- [11] Chaudhry, B., Wang, J., Wu, S. et al. (2006) Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine* 144(10):742–752.