



A computer-supported management of photographic documentation in plastic surgery - System development and its clinical application



Karol Korczak^{a,*}, Anna Kasielska-Trojan^b, Marian Niedźwiedziński^a, Bogusław Antoszewski^b

^a Department of Computer Science in Economics, University in Łódź, 90-255 Łódź, 3/5 POW Street, Poland

^b Plastic, Reconstructive and Aesthetic Surgery Clinic, Institute of Surgery, Medical University in Łódź, 90-153 Łódź, 22 Kopcińskiego Street, Poland

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ABSTRACT

Photographic documentation is very important for plastic, reconstructive, and especially aesthetic surgery procedures. It can be used to improve patient care as well as to carry out scientific research. The results of our previous studies confirmed a strong demand for Information Technology (IT) systems dedicated to plastic surgery. Unfortunately, most of the solutions of this type are not suited to the actual needs. For this reason we decided to develop a reliable system for photographic documentation storage. The Plastic Reconstructive Esthetic Surgery Photo System (PRESsPhoto) was developed and finally deployed in the Plastic, Reconstructive and Aesthetic Surgery Clinic of the Medical University in Łódź (Poland). Preliminary single-center performance tests proved that the PRESsPhoto system is easy to use and provides, *inter alia*, rapid data search and data entry as well as data security. In the future the PRESsPhoto system should be able to cooperate with Hospital Information Systems (HIS). The process of development and deployment of the PRESsPhoto system is an example of good cooperation between health care providers and the informatics, which resulted in a system that meets the expectations of plastic surgeons.

1. Introduction

Quick access to the still growing collections of medical documentation is one of the reasons that the demand for IT solutions supporting management of such documentation among plastic surgeons in Poland is very high [1]. IT solutions dedicated to plastic surgery are an example of specific software that processes sensitive data occurring in both text and graphical form. Photographic documentation is very important for plastic, reconstructive, and especially aesthetic surgery practice [2,3]. The usefulness of photos depends to a large extent on their quality, which concerns, *inter alia*, their high resolution and standardization [4–8]. In turn, a higher quality of the photographs often is associated with the greater amount of memory needed to store them [9]. Taking into account the fact that during one visit even several dozens of photographs can be taken, management of photographic documentation becomes an essential challenge in plastic surgeons' practice.

Successful deployment of software dedicated to plastic surgeons must comply with the expectations of different groups of users. For example, the same medical record can be processed at the same time by a physician and photographer. In this context, it is very important to

carry out the initial stages of software development life cycle (SDLC) in great detail. In the literature they are often described as: requirements capture, analysis and design [10]. They are the basis for implementation (creating), testing, and finally deployment of software. Cases of inefficient e-Health investments, constantly encountered in practice [11–13], is often equated with the presence of the so-called e-Health paradox [14], reminding us of the need to carry out the initial stages of SDLC.

2. Objectives

The aim of this study was to develop a reliable system for photographic documentation storage, fulfilling the needs and requests of plastic surgeons in terms of software management and safety. We also planned to perform preliminary single-center performance tests.

3. Methods

Requirements analysis is the basis for a proper system development process. In the first step, an on-line survey was conducted among the

* Corresponding author.

E-mail address: karolk@uni.lodz.pl (K. Korczak).

representative sample of members of the Polish Plastic, Reconstructive and Aesthetic Surgery Association to define the requested system features. This group was chosen as it guarantees a high level of clinical practice with photographic documentation. The survey included 86 practicing surgeons, who answered questions concerning many aspects of photographic documentation in their practice and also expressed their requirements about the software. Hence, the main requested features were [1]:

- quick data search (less than 15 min),
- easy to use,
- quick data entry (less than 15 min),
- data security,
- the ability to print the selected photos,
- availability only to the authorized employees,
- particular search criteria: name and surname, clinical diagnosis, the area of the body, sex, status, age and others (type of the surgery or other treatment, personal identity number, the date of photo, the date of surgery, medical record ID).

On the basis of the obtained features the IT system called PRESsPhoto was developed by qualified IT specialists. The PRESsPhoto system was developed in accordance with the waterfall model, which is one of the most popular models in software development. The waterfall model follows the process of software development through the stages of the software development life cycle, from requirements capture, through to analysis, design, implementation (creating) and testing, to deployment of the software. Before beginning the next stage, the previous stage should be completed [15]. The process of system development involved, apart from the software designers, two practicing plastic surgeons from the Plastic, Reconstructive and Aesthetic Surgery Clinic, and Hospital informatics coordinators. It was necessary to deploy a system in clinical practice and to assure the safety of patients' data exchange between the designers and hospital management staff. During the process of software development and improvement, a program of regular meetings was established, which enabled up-to-date system modifications. When the development process was finished (after 4 months), medical staff employed at the clinic were trained on the use of the system and the system was deployed for practical use in the Clinic. It replaced the previously-used method of photographic data archiving (files on a computer hard disk in directories ordered according to the date of the photo, and paper catalogues of a series of printed photos ordered according to the patient diagnosis, in chronological order). After approximately 12 months from its deployment the system was assessed by the medical staff in the following aspects:

1. The time needed to acquaint surgeons and clinical photographer with the system support (data entering, searching, and modifying).
2. The time needed to enter/search particular data.
3. Time after-effect in relation to the previously used technique of photographs archiving.

The time of entering a new patient into the program – by the addition of photographs from a hard disk by the clinical photographer - was measured for ten independent data entries on different days. Analogous time measurements were done for the previously used method (printed cards with photographs). We also measured the time of finding certain photographs for seven doctors, first by using the system and then using paper catalogues. Prior to a statistical analysis of the data, the normality of distribution of the tested variables was examined (using the Kolmogorov–Smirnov test). Comparisons of the time needed to enter/search particular photographs using the system and the time need to perform the same tasks without using the system were done with the dependent samples *t*-test.

4. Results

4.1. Overview of system development

The requirements analysis is one of the most important stages of the life cycle of the system. An appropriate requirements analysis makes it possible to avoid mistakes, misunderstandings, and finally delays in deployment. Problems of this type are a common cause of failure in projects in the field of e-Health [16]. In Poland, an example of such problems can be the frequently occurring delays in the deployment of Electronic Health Records (EHR) [17]. This concerns deployment at the local, regional, and national levels.

During the requirement analysis the project team identified two users' groups of the PRESsPhoto system: physicians and photographers. In turn, the most important functions of the system include: adding a new patient record and photos, search, filtering and management (viewing, editing, completing, printing) of patient records and defining of new categories in the system's dictionary (see Fig. 1).

The users' activities can be divided into: optional («extends»), mandatory («includes») and inherited (arrow without description). Most of the activities in the PRESsPhoto system fall to physicians and photographers. They are responsible for adding patients' records and photos after visits. Via the system they can quickly and easily manage a photographic documentation. An important advantage of the PRESsPhoto system is the user-friendly interface (see Fig. 2).

What's more, physicians can make use, for the purpose of scientific research, of the advanced options to filter the collected data (see Fig. 1) and save the results in a spreadsheet file.

The database is organized in terms of the relational model. It consists of eight tables and the relationships between them. The database can distinguish tables that contain the data about patients, their diagnoses (general and specific) and International Statistical Classification of Diseases and Related Health Problems (ICD10) codes, section and location on the body (general and specific). In the database both identifying (continuous line) and not identifying (dashed line) relationships take place (see Fig. 3). Column names, the value of which have to be filled in while entering a new record, have been written in bold.

The database model ensures the integrity and normalization of data. Another advantage is also the appropriate software functions responsible for the validation of data processed in the system.

A new directory of photographic documentation is created while adding a new patient record. Other directories can be attached on subsequent medical visits (see Fig. 4).

It should be emphasized that the photos taken during the visit are not stored in a database. Because there are usually a very large number of them, this could significantly slow down system performance. Such problems can be often found in HIS. Additional protection is the regular backing up of all the photographic documentation and the contents of the database.

4.2. Software and hardware

The PRESsPhoto system is written in Visual Basic.NET (VB.NET) language. It uses a client-server model. The data is stored in a Microsoft SQL Server database. The system can be used only by authorized users who have set up an account. The system has an easy-to-use graphical user interface (GUI) so it can be easily used by users with basic skills in IT.

The PRESsPhoto system has been installed in one of the medical offices in the Plastic Surgery Out-Patient Clinic. Currently, the system is isolated from the Internet and the hospital internal network. The system is also separated from the HIS. This is related to the lack of appropriate limitations on access to the individual modules of the system HIS. Taking into account the fact that plastic surgery patients are extremely sensitive (their photos are showing faces and whole bodies), access to them should be enabled only to the medical staff of the Clinic. It should be stressed that in the future, after overcoming the restrictions of this type, the

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