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Multimedia Health Records: user-centered design approach for a multimedia uploading service

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Abstract. Multimedia elements add value to text documents by transmitting information difficult to express in words. In healthcare, many professional and services keep this elements in their own repositories. This brings the problem of information fragmentation in different silos which hinder its access to other healthcare professionals. On the other hand patients have clinical data of their own in different formats generated in different healthcare organizations which is not accessible to professionals within our healthcare network. This paper describes the design, development and implementation processes of a service which allows media elements to be loaded in a patient clinical data repository (CDR) either through an electronic health record by professionals (EHR) or through a personal health record (PHR) by patients, in order to avoid fragmentation of the information.

Keywords. Multimedia, Electronic Health Records, Documentation, Health Record, Personal, User-Computer Interface, Medical Informatics

Introduction

Multimedia elements (pictures, audio, and video) add value to text documents by transmitting information difficult to express in words (1). Due to the current proliferation of mobile devices, providers are capable of recording multimedia elements digitally (2), which are often stored in distributed standalone repositories, bringing the problem of information fragmentation in different silos, not accessible to all providers within the healthcare network (3).

This information is useful for healthcare, academic, and teaching tasks, and should be integrated within the clinical data repository (CDR), thus enabling easy and ubiquitous retrieval by healthcare providers at the time they are needed. It is also necessary to have a suitable metadata structure for indexing and represent the stored multimedia content to enable efficient query processing (4).

For this reason, the Department of Health Informatics of Hospital Italiano de Buenos Aires (HIBA) started a project to enable providers and patient to upload this information to the CDR through the Electronic Health Record (EHR) and Personal Health Record (PHR). The aim of this paper is to describe the design, development and implementation of such a service.

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1. Methods

1.1. Setting

Hospital Italiano de Buenos Aires (HIBA) is a non-profit health care academic centre founded in 1853. HIBA has a network of two hospitals with 750 beds, 1000 home care patients and 23 outpatients care centres. On an annually basis, the hospital discharges 50,000 patients and provides 2.8 million outpatient visits. Since 1998 HIBA has implemented a Healthcare Information System (HIS), an in-house project which currently handles all the healthcare related information from data capture to its further analysis (5). The EHR is a fully-implemented web based, problem oriented, patient centred record with customized functionalities depending on the level of care (outpatient, inpatient, emergency care and home care). The CDR integrates information from different sources including multimedia objects such as digital imaging from our institutional PACS (Picture Archive and Communication Systems) (6). Since 2007 the EHR is linked to the PHR giving patients access to health related data (laboratory, diagnosis, preventive information, medications lists), and administrative task.

1.2. User Centered Design

The interface design was conducted by a usability team (2 user-computer interface specialists) along with the clinical informatics team (2 physicians), between February and April 2014. Different prototypes were built through user-centered design (UCD) process. UCD defines iterative cycles, in which user's requirements are obtained by an understanding of use context. The results of this evaluation are used to update the design so that the product produced meets both criteria of usability and business objectives (7). Within this framework, the following work plan was proposed: 1-Contextual Interviews, 2-Participatory Design, 3-Prototyping and Usability Tests.

As the first implementation of the service was planned on the EHR, we conducted the UCD process only in physicians. Users' selection was performed randomly, considering its function. Invitations to participate were made both by email and phone and we programmed the evaluation to take place during business hours.

1.3. Use Statistics

We calculated the total number of items that were uploaded over a period of two and a half months. This elements were differentiated by type (images, PDF, audio, video), user who uploaded it (patients and providers), patient in whose record was stored, and the medical specialty. The results are expressed as numbers and percentages.

2. Results

2.1. User Centered Design

Contextual Interviews: Three EHR users were interviewed by the investigators team (one usability specialist and one medical informatics resident) in their regular workplace (medical offices) using Karen Holtzblatt methodology (8). Medical

specialties involved in this phase were dermatology and neurology. Results were recorded as notes based on the perceptions and impressions of the investigators team.
Participative Design: At this stage, UCD and clinical informatics teams worked in an iterative way, aiming to design a series of prototypes based on observations recorded.
Prototyping *Cycles and Usability Testing:* was conducted to achieve two main usability objectives: users being able to upload multimedia files into a patient's EHR and users been able to retrieve the loaded media in any patient they are taking care.
Interface: Current version of the user interface respect a basic workflow. Files are uploaded as attachments in a progress note. Users must tag each uploaded file with a predefined taxonomy, which includes different types of diagnostic imaging (such as CT, MRI or X-ray), laboratory results, documents (such as discharge summaries and surgery reports), clinical findings, and an open category ("other" media item). Once the progress note is saved, attached files are saved to the CDR. When the EHR shows the progress notes list, users can select notes containing multimedia elements which can be recognized as they are marked with the paperclip icon (figure 1). Elements are previewed as thumbnails and can be viewed in full size by double clicking on them.

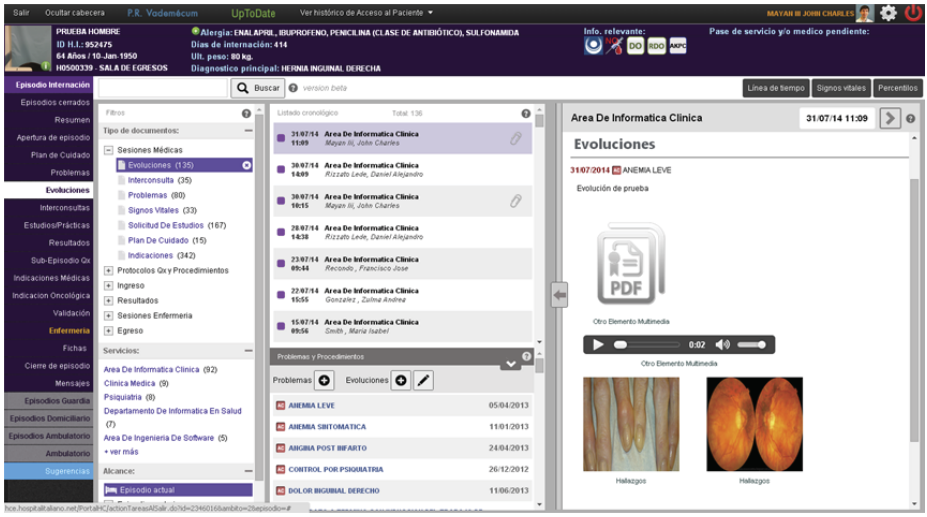

Figure 1. EHR caption showing progress notes containing multimedia elements

2.2. Software architecture

Software architecture can be described as a standalone application running as a service (SAS - Software as a Service), which can be used from any other application in our health information system, and a single repository for multimedia files storage. At the present moment only the EHR and PHR are using this service. This piece of soft-ware was developed on JAVA, JQuery, HTML5 and Javascript and is deployed on a Glassfish 3 application server and multimedia repository is a Linux data file system.

2.3. Usage statistics

Service was first implemented on the EHR in April 2014, 53576 multimedia elements have been loaded since. Most of these elements were images (52226; 97.48%). Other file types uploaded are PDF (1334; 2.49%), video (11; 0.02%); and audio (5; 0.01%).

Files were loaded by 341 users, with an average of 157 elements per user. Most of users were physicians (99%). Elements were loaded in 5316 patients' records, with an average of 10 elements per patient. Users belong to 30 different medical specialities; table 1 shows the first ten medical specialties with most patients with uploaded files.

Table 1. Top ten medical specialties with most patients with uploaded elements in their CDR

Medical Specialty	Number of Patients	%
Ophthalmology	3716	69.9
Otorrinolarignology	609	11.46
Internal Medicine	146	2.75
Home Care	109	2.05
Pediatrics	91	1.71
Primary Care	85	1.6
Gynecology and Obstetrics	83	1.56
Pneumonology	70	1.32
Cardiology	59	1.11
Gastroeneterology	47	0.88

2.3.1. Ophthalmology Issue

Four physicians from ophthalmology department uploaded 47710 files (89%) in 3716 different patients' records. We consider this as an anomaly, and arranged a group interview with them to find out the reason: they had acquired a new optical coherence tomography (OCT) scanner which wasn't yet integrated in our DICOM network either storing files in our institutional PACS. Since ophthalmologist need access to these images, ophthalmology department decided to use this new feature of the EHR.

2.4. PHR

130 patients (0.1% of approximately 177600 PHR users) uploaded 489 multimedia elements from our PHR, in a 30 days period ranged from October to November 2014.

3. Discussion

Traditionally PACS are the multimedia storage systems (9). With the consolidation of the multimedia electronic records, this information fed the CDR of many institutions and PACS were no longer stand-alone systems within the radiology department (6, 10, 11). Imaging workflow usually starts with an imaging order and after diagnostic modalities capture the images, they are stored in the PACS; process ends with the specialist report. When these studies are performed in other institutions patients must carry the printed images or CD to every physician who needs to review them. The advantage of this new model is that, once it's been uploaded to the EHR, allows information distribution to every provider in our network. Any provider within any medical specialty who captures an image or audio or video file of their patients with a cell phone or a portable camera is able to upload it to a patient record avoiding information fragmentation on personal or departmental repositories (12-14). Same way, patients are able to upload their "outside studies" and avoid carrying them.

We found other international experiences of multimedia elements integrated in health information systems, like the Veterans Administrations or the NHS in the UK which allows doctors to capture and share pictures routinely through its information system (15). At the time this paper was written we found no articles describing similar

deployments in Latin America in medical databases such as MEDLINE and LILACS.

Given the diversity of medical specialties and providers that uploaded multimedia files since the system was deployed, and the upward trend in its use, we can state that the project in its first phase has met the objectives set at the beginning. Particularly striking is the large number of elements loaded by the ophthalmology department. As integration of the new equipment as yet to be done, they come upon a temporary solution to avoid an off-line isolated departmental repository and store this information in the CDR. Ignoring ophthalmologists' elements, 5866 elements were uploaded (17.4 elements per provider); in 1600 patients records (3.6 elements per patient).

In the future we plan to study the user satisfaction with a formal methodology, research the use of the taxonomy and ways to improve it, develop specific filters in the EHRs progress note module for multimedia elements, and the possibility to associate these elements to other medical documents such as surgical reports and referral notes.

4. Conclusions

In the present work, we present the experience of the Department of Health Informatics of HIBA in designing and implementing a multimedia elements uploading service trying to solve the problem of fragmentation of this type of information, seeking to improve care, teaching and academic tasks of our providers. We hope that this experience will help other institutions to address similar projects.

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