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Integrating Dermoscopic Images into PACS Using DICOM and Modality Worklist

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Abstract. Dermatology is one of the medical fields outside the radiology service that uses image acquisition and analysis in its daily medical practice, mostly through digital dermoscopy imaging modality. The acquisition, transfer, and storage of dermatology images has become an important issue to resolve. We aimed to describe our experience in integrating dermoscopic images into PACS using DICOM as a guide for the health informatics and dermatology community. During 2022 we integrated the video dermoscopy equipment through a strategic plan with an 8-step procedure. We used the DICOM standard with Modality Worklist and Storage commitment. Three systems were involved (video dermoscopy software, the EHR, and PACS). We identified critical steps and faced many challenges, such as the lack of a final model of DICOM standard for dermatology images.

Keywords. Dermoscopic images, PACS, DICOM, medical equipment integration, imaging.

1. Introduction

The use of photography in the medical field has grown considerably. Although image acquisition and analysis were initially limited to radiology, an increasing number of medical specialties are using medical imaging for screening, diagnosis, treatment, and follow-up purposes [1].

Given the usefulness of this medical data, it is necessary to develop circuits and tools that would allow the communication of the different image acquisition equipment in healthcare institutions with a centralized server capable of storing this information in an orderly manner for each patient and practice. The digital image archive is known as Picture Archiving and Communication Systems (PACS). Although its use is a reality for radiology services in computerized hospitals [2], this is not the case in other medical

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fields, where images are still stored in local directories or on the equipment's servers, resulting in errors due to manual data loading, effort and time.

The PACS uses a standard called Digital Imaging and Communication in Medicine (DICOM) to exchange medical images with the Health Information System (HIS) and a modality worklist that automatically transfers patient data from the HIS to the imaging modality. Thus, when the images are sent to the PACS, they match the corresponding patient and study records and are incorporated into the patient's Electronic Health Record (EHR) [3].

Dermatology uses visual analysis in order to differentiate skin lesions. Possible imaging modalities are clinical photography, dermoscopy, and confocal microscopy [4]. Dermoscopy is one of the most widely used techniques for a wide range of diseases, especially skin cancer, due to its high sensitivity [5]. To our knowledge, the equipment for performing dermoscopy is not usually integrated into the HIS and PACS. The need for multiple resources and the lack of imaging standards are the main factors contributing to this situation [6].

In this article, we aimed to describe our experience in integrating dermoscopic images into PACS using DICOM and Modality Worklist as a guide.

2. Methods

Hospital Italiano de Buenos Aires (HIBA) is a community-based tertiary care hospital located in Buenos Aires, Argentina. HIBA is a HIMSS Level 7+ organization with an in-house developed HIS. It has a web-based, problem-oriented, patient-centered EHR; a terminology server referenced to SNOMED CT; a PACS integrated since 2008 [7], and an integrated personal health record (PHR).

HIBA has a Dermatology Department which provides the latest treatments for all forms of skin conditions. Experienced dermatologists are part of the dermatoscopy section. Around 3,200 Dermoscopy studies (DS) are performed per year. The FotoFinder® vexia system (FotoFinder Systems Gmbh, Bad Birnbach, Germany) is used for video dermoscopy. It has a full HD video camera with a range of magnification from 20× to 140× and uses polarized and non-polarized light for dermoscopy, trichoscopy, and capillaroscopy.

We created an interdisciplinary team of biomedical engineers, health informaticians, and dermatologists. We developed a strategic plan with an 8-step procedure to carry out this integration project.

3. Results

We carried out the integration of the video dermoscope into the PACS in 2022. Since 2019, 439,203 images from 6,803 patients have been registered at the time of the solution's implementation. To achieve the stated objective, it was necessary to define and conduct an 8-step procedure detailed in Table 1.

Table 1. Procedure to achieve the video dermoscopy system integration into the PACS.

Step	Description	Results
Data Collection and Analysis	Survey of DS and HIBA HIS about workflow, hardware and software.	The main findings were: (I) usage of two video dermoscopes working independently of the HIS, (II) manual patient information entry, (III) clinical and dermoscopic images storage in the video dermoscopy system database server, (IV) images exported as pdf file and then attached to the DS medical report, and (V) file upload to the patient's EHR and PHR.
Feasibility Analysis	Interoperability assessment between the equipment and the HIS with known standards (HL7, DICOM).	DICOM standard integration model selection, including the implementation of a modality worklist and the storage of the images with well-defined metadata into the PACS.
Architecture design	Requirement definition for the integration of three systems: video dermoscopy software, EHR and PACS.	Then main stages defined were: (I) creation of a new worklist item based on the study appointment information, (II) image acquisition and storage, and (III) image retrieval and visualization.
Development and Testing	Creation of functionalities needed to meet defined requirements.	Development of the EHR-PACS interface and assessment of communication modules between EHR, PACS, and the video dermoscopy software.
Database Analysis and Correction	Database inspection and cross-check with the HIS records using an in-house developed application.	Mismatches and errors were grouped into categories based on the nature of the conflict. Cases were analyzed in depth with experts from the Dermatology Department to correct them. There were 1.4% moderate errors (duplicated patients) and 1.6% critical errors (mismatched id and patient data).
Contingency Plan	Design, documentation, and implementation of a plan in case of an eventual downtime of the HIS.	To avoid interrupting the performance of studies, a help desk circuit was defined to request the temporary deactivation of PACS integration.
User Training	Design a detailed hands-on training plan to engage end users in the new DS workflow.	Training sessions were conducted by clinical informatics, and guides and instructions were provided to users.
Pilot Test	Planning and implementation of a small-scale study to test integration performance.	Monitoring and recording of results during the first four weeks. Verification of compliance with established requirements.

DICOM: Digital Imaging and Communication in Medicine, DS: Dermoscopy Study, EHR: Electronic Health Record, HIBA: Hospital Italiano de Buenos Aires, HIS: Health Information Systems, PACS: Picture Archiving and Communication System, PHR: Personal Health Record

Concerning the solution defined in the "***Architecture Design"*** (Figure 1), it should be noted that the creation of worklist items is possible through an internal EHR procedure that sends DICOM messages to the PACS. Subsequently, the video dermoscopy system can query the item and allow the acquisition of images linked to it, while an additional vendor tool is responsible for sending the complete study to the PACS. Finally, a PACS DICOM viewer is available from the EHR and PHR, allowing both professionals and patients to access the corresponding images studies.

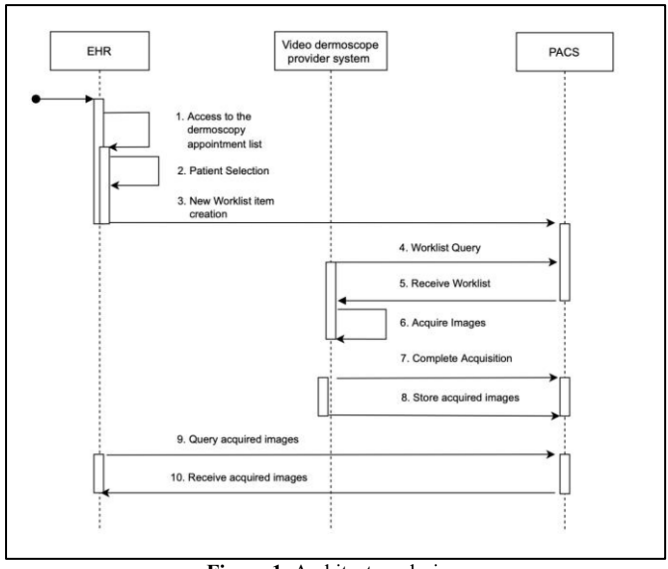

Figure 1. Architecture design.

4. Discussion

Despite the increasing use of digital skin imaging, the acquisition, transfer, and secure storage of these data remain challenging for dermatologists and healthcare institutions. In this regard, Taberner et al [8], reported in 2010 that only 10% of Spanish dermatologists used EHR and PACS as a repository of dermatologic images. Although some applications have been developed in recent years to safeguard this imaging modality, the proposed solutions only focus on dicomizing and sending images to the PACS [8,9]. In this sense, they require downloading the images to a personal computer and then uploading them to the application, making the specialist's workflow more difficult. For this reason, we decided to go further and integrate the video dermoscopy system (hardware and software) into our PACS using DICOM and Modality Worklist.

Regarding the modality worklist, it's a key component to maintain a high level of data integrity and the benefits of using it were described years ago by Gale et al. [10]. On the other hand, while the DICOM standard is widely accepted and used in radiology, it's still a pending issue to resolve in dermatology [6,11]. The Working Group 19 (WG19) of the DICOM consortium has explored ways in which this standard can be used for dermatology and also identified metadata elements that are important for dermoscopy images [12]. Although the standard is still under development, a transformation is being driven by new technologies, such as Artificial Intelligence, which will encourage the use of DICOM in dermatology [13].

There is some concern about the privacy and confidentiality of dermatologic images [14], which is why information systems need to ensure the security of personal data. Our HIS provides a high level of security as it complies with the Health Insurance Portability and Accountability Act (HIPAA). It has access control based on the user's role and privileges.

5. Conclusions

In this article, we describe our experience following an eight-step procedure to achieve the video dermoscopy equipment integration into PACS using the DICOM standard. The most critical steps we faced to ensure the desired interoperability and achieve successful integration were “Data Collection and Analysis” and “Feasibility Analysis”. When we started this project, there was not enough evidence on how to integrate this medical equipment, so we considered it important to share a guide for the health informatics and dermatology community. Furthermore, we believe it is important to encourage the transition from “Radiology” PACS into a multi-departmental system. In this way, other medical fields can take advantage of it.

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