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# Digital image management project for dermatological health care environments: a new dedicated software and review of the literature

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**Background/purpose:** Because the skin is the only organ completely accessible to visual examination, digital technology has therefore attracted the attention of dermatologists for documenting, monitoring, measuring and classifying morphological manifestations. To describe a digital image management system dedicated to dermatological health care environments and to compare it with other existing softwares for digital image storage.

**Methods:** We designed a reliable hardware structure that could ensure future scaling, because storage needs tend to grow exponentially. For the software, we chose a client-web server application based on a relational database and with a 'minimalist' user interface.

**Results:** We developed a software with a ready-made, adaptable index of skin pathologies. It facilitates classification by pathology, patient and visit, with an advanced search option allowing access to all images according to personalised criteria. The software also offers the possibility of comparing two or more digital images (follow-up). The fact that the archives of years of digital photos acquired and saved on PCs can easily be entered in the program distinguishes it from the others in the market. This option is fundamental for accessing all the photos taken in years of practice in the program without entering them one by one. The program is available to any user connected to the local Intranet and the system may directly be available in the future from the Internet.

**Conclusions:** All clinics and surgeries, especially those that rely on digital images, are obliged to keep up with technological advances. It is therefore hoped that our project will become a model for medical structures intending to rationalise digital and other data according to statutory requirements.

**Key words:** digital images – dermatology – electronic records – medical technology


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MEDICAL IMAGES have always been fundamental for teaching, learning, research and clinical practice (1). Technological advances in the last century enabled the transition from medical illustrations, sometimes exquisite paintings, to analogue photos and recently digital photographs (2–5). In the 1990s, digital technology considerably improved image acquisition and management (6–8). Dermatology used these methods more than many other branches of medicine, because the skin is the only organ completely accessible to visual examination. Thus, digital technology was used by clinicians to document, monitor, measure and classify morphological manifestations. The degree to which digital images are now essential in dermatology is indicated by the fact that today about 85% of dermatologists obtain patient images at least occasionally and about 20% image all patients (9–11). The advantages of digital imaging include storage on digital media, organisation into digital albums, easy post-image capture and processing, reproduction of images without development, annotation with digital text and date tags that facilitate retrieval of stored images, support not subject to deterioration, digital watermarking for copyright and fast easy tele-consultation. As with computers, they were initially used in the administrative sphere of clinical practice, but in the last 10 years clinicians have increasingly been using

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them for other tasks, such as prescribing, referring, ordering tests, receiving test results, seeking assistance with clinical decision making and storing digital images of patients, often in a superficial and not strictly legal manner. In Australia, about 98% of family physicians use a computer (12).

In our clinic, we have been using digital telecameras and photocameras to acquire dermatological images for many years. At first, they were not used routinely and image management was relatively amateur, but after a few years, with about 10,000 digital images acquired each year, more professional image management in line with statutory requirements, including patient privacy, became necessary. We therefore, decided to develop an image management system (hardware and software) to improve the efficacy and efficiency of related services. Our practical requirements were: to import easily all digital/historical images present in the various clinicians' archives (more than 30,000 images); the possibility to discharge images acquired with different digital cameras and telecameras; to store images according to a practical predefined scheme; and to easily select and visualise stored images or groups of images by means of a personalised program.

## Materials and Methods

*Hardware infrastructure*

In Fig. 1 the hardware solution we identified is reported. The aim of this solution was to build an infrastructure that supported the required levels in terms of availability and access speed, with a view to future integration with patient management systems and automatic classification of images. It was necessary to design a reliable structure and to use reliable products that could ensure the above and future scaling, because storage needs tend to grow exponentially, especially in the field of electronic data storage. The main characteristics of the hardware were: 1) *performance*: an Intel Xeon processor with 1 Gb ECC RAM on-board, SCSI interfaces enabling installation of a multichannel RAID controller; 2) *storage capacity*: up to 2 Tb of data in internal cases accessed with 14,146 Gb disks with a 0,1,5 Raid configuration; and 3) *multi disk support*: compatibility with Ultra SCSI 3 and Ultra SCSI 4 Hot-Plug disks to ensure the future of the investment. For fault recovery, we applied on-Line Spare, which allows the possibility of installing hot spare drives. In the case of faults, the drives come into operation automatically and database reconstruction occurs on-line without interruption of service; moreover, the installation of stand-by power supply gave us the possibility of installing Hot-Plug stand-by power supply in the event of interruption of mains power.

*Software*

For the software we chose a client-web server application based on a relational database and with a 'minimalist' user interface. This choice avoids the problem of installation on individual PCs, makes the procedure immediately available to any PC in the Department's Intranet by means

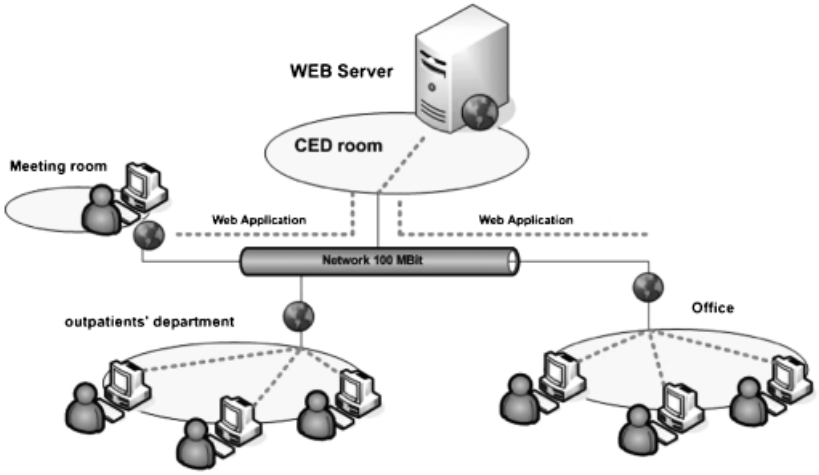


*Fig. 1. Hardware schema project. The main hardware characteristics were, performance: Intel processor xeon, 1 Gb of ECC RAM On-Board, SCSI technology. Storage capacity: up to 2 Tb of data in internal cases accessed with 14,146 Gb disks with a 0,1,5 Raid configuration. Multi-disk support: compatibility with Ultra SCSI 3 and Ultra SCSI 4 Hot-Plug disks.*

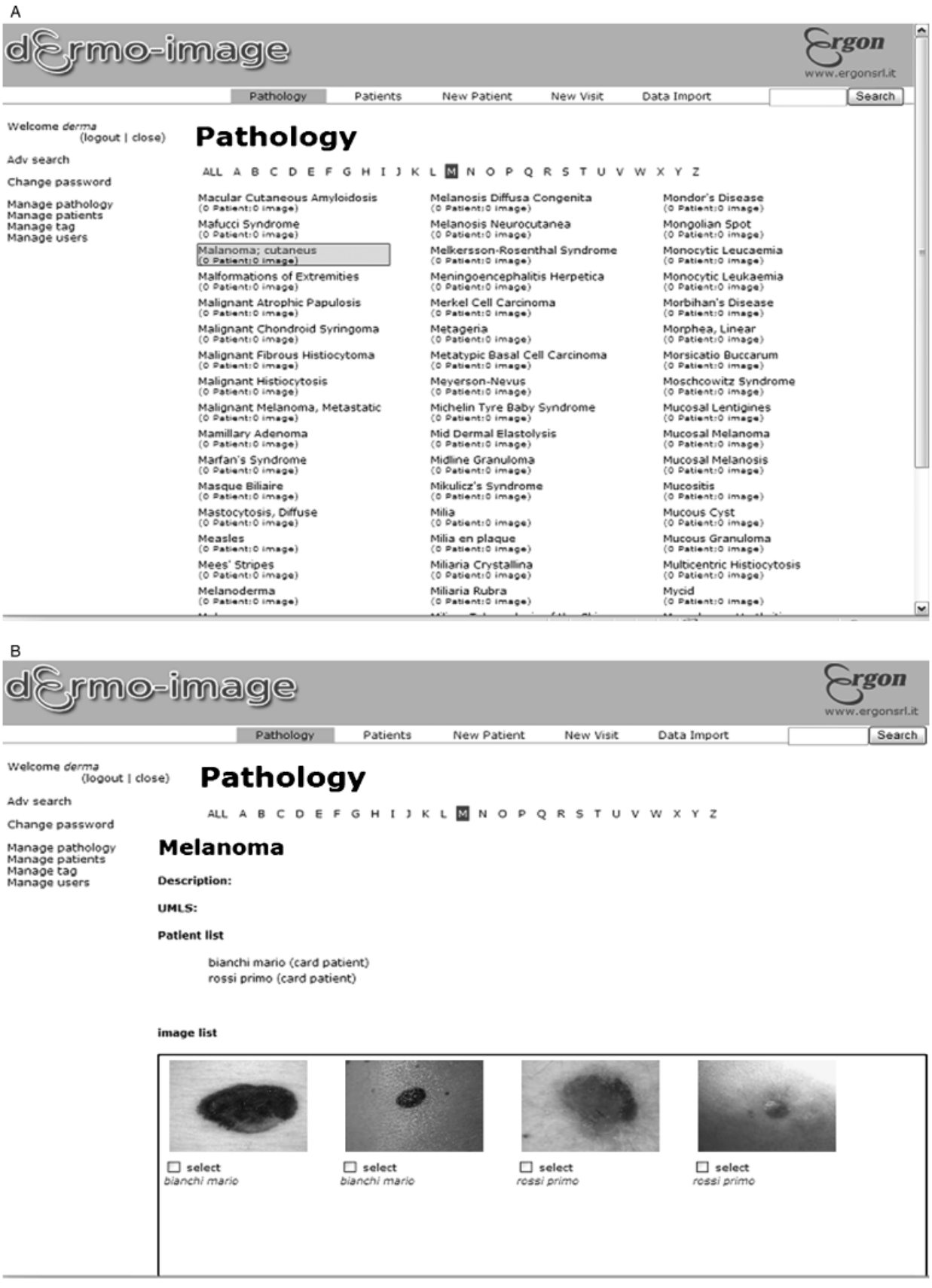


*Fig. 2. New pathologies can be added to the many (>1500) already entered, and existing pathologies can be viewed by selecting them from an alphabetical list; the number of patients and photos is indicated under each pathology (A). By choosing an item from the list, it is possible to access the list of patients with that disease, view their records and the gallery of all photos of the disease and edit the images (B).*

of any Internet browser, can be accessed directly from the Internet in the future and enables central updating of the procedure.

Use of application development tools with the GPL licence also keeps design costs low.

*The application*

The application is divided into the following areas: pathologies, patients, visits, images and search/advanced search. New pathologies can be added to the many (>1500) already entered and existing pathologies can be viewed by selecting them from an alphabetical list. The number of patients and photos is indicated under each pathology. By choosing an item from the list, it is possible to access the list of patients with that disease, view their records and the gallery of all photos of the disease and edit the images (Fig. 2). Patients can be viewed by selecting them from an alphabetical list. By choosing a name, one can view the pathologies or examinations as well as the gallery of all photos and edit the images (Fig. 3). Information about a current visit can be entered in the visits section by selecting patients already entered or entering a new patient and identifying a disease in the pathologies list (new pathologies can only be entered by the administrator to avoid problems of nomenclature). Images are generally downloaded from a digital camera interfaced to the PC, but they can also be recovered from a CD, a hard disk or any web site to which the user has access (Fig. 4). Management of images/photos can be activated during image acquisition or later and enables basic operations for subsequent processing. Each image can be 'published' (made available on the Internet if the option is on, clearly observing the laws on privacy) in order to share it with other users (physicians and others) and/or an on-line encyclopaedia of dermatology can be created. Moreover, photos can be edited, masking the face (definitively) to protect patient privacy, it can be deleted from the archive, labelled with tags (research keys, such as *adult, limb, child, mouth, dermoscopy,* etc., that open updatable lists) to enable easy retrieval at a later date. The tags (Fig. 5) are divided into five points: gender, age, site, type of therapy (medical, physical, surgery) and epiluminescence (yes/no). Finally, images can be edited by adding a description, viewed full screen, rotated by 90° or 180° and saved. Other possibilities are: to save images in a special folder of the web server, simply by clicking (i.e. to create a photo collection to use in an article or for lessons and conferences), shared in videoconferences of two or more users of the same program and compared with another image taken at a different time (follow-up) (Fig. 6). Simple search is active at all stages of the procedure, with a box in which to type key words. The possibility to perform an 'advanced search' was a crucial point for us. The advanced search menu makes it possible to search for visits involving a certain disease in an interval of dates, or photos, related or unre-

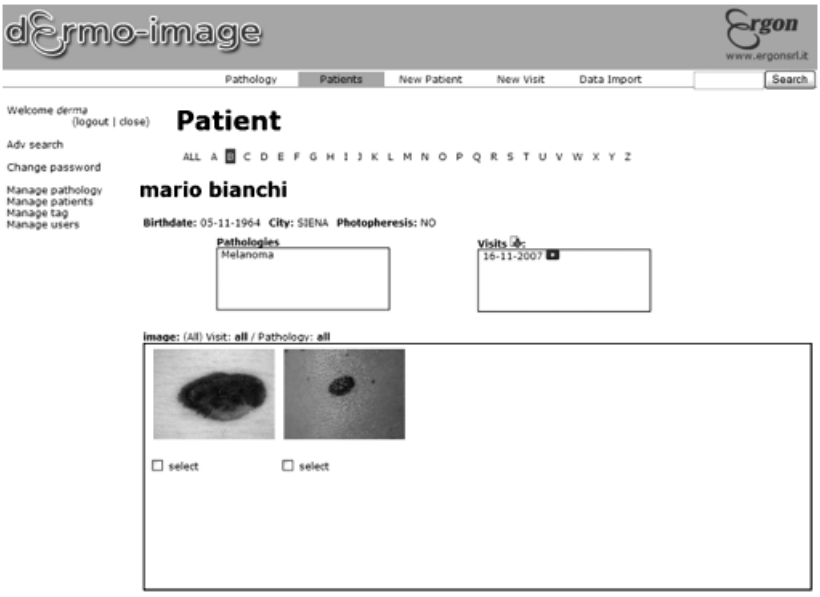


*Fig. 3. Patients can be viewed by selecting them from an alphabetical list; by choosing a specific name, one can view combined pathologies or visits as well as the gallery of all photos.*

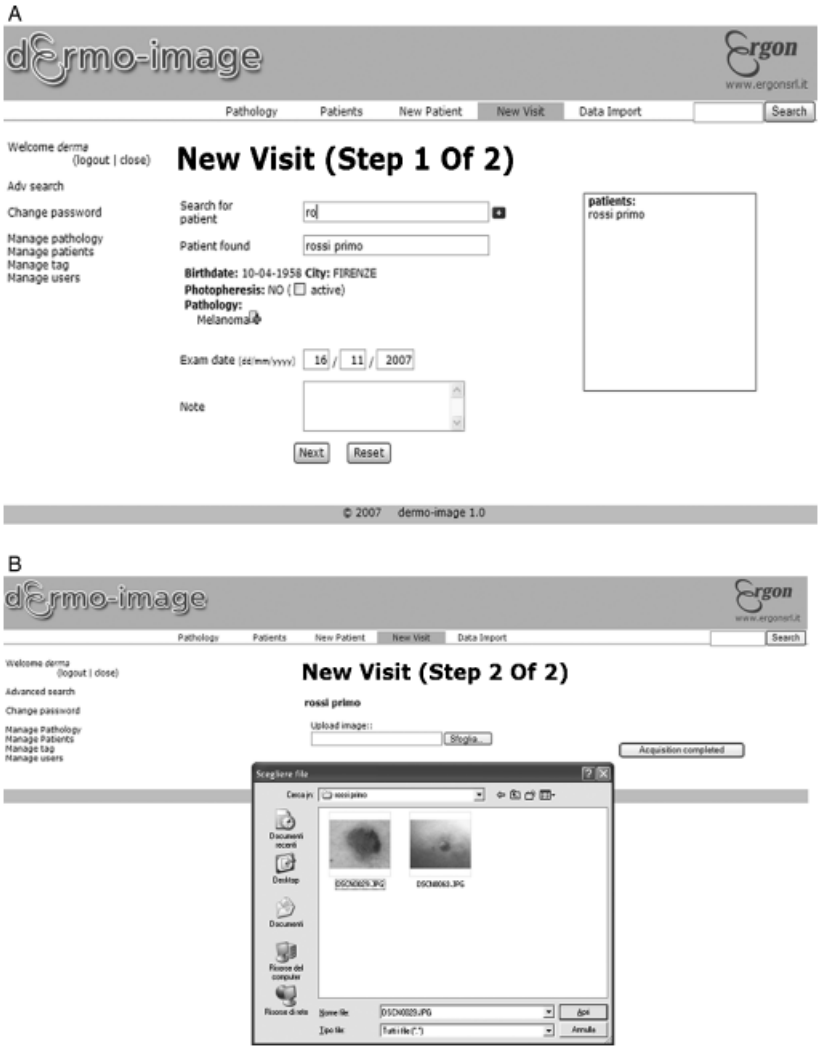


*Fig. 4. Information about a current visit can be entered in the 'visits' section by selecting patients already entered or by entering a new patient and identifying a disease in the pathologies list (A). Images can be downloaded from any digital support (B).*

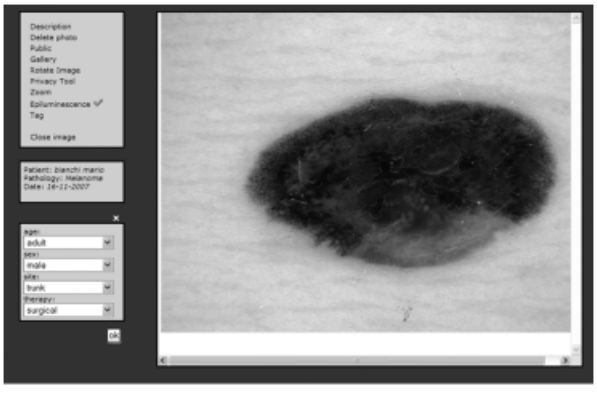


*Fig. 5. Management of images/photos can be activated during image acquisition or later and enables basic operations for subsequent processing. Each image can be 'published' (made available on the Internet if the option is on, clearly observing the laws on privacy) in order to share it with other users (physicians and others) and/or create an on-line encyclopaedia of dermatology. Moreover, photos can be edited, masking the face (definitively) to protect patient privacy, it can be deleted from the archive, labelled with tags (research keys, such as adult, limb, child, mouth, epiluminescence, etc, which open updatable lists) to enable easy retrieval at a later date.*

lated to a certain disease, by selecting available tags (Fig. 7). The application was installed on the principle web server and access is gained by personal user name and password. This enables control of access to the application and regular saving of data in order to ensure it is not lost in the case of hardware failure.

The integrity and security of archives is managed by the Relational Data Base Management System (RDBMS) and operating system. Because the aim of the project was to create a database of patients with univocal dermatology images related to codified pathologies, unique codification is important because this mechanism and Structured Query Language (SQL) are used to rapidly obtain all images of a disease or a group of diseases. Data access policy is managed by the operating system of the web server and by the application itself so as to prevent manipulation by unauthorised users.

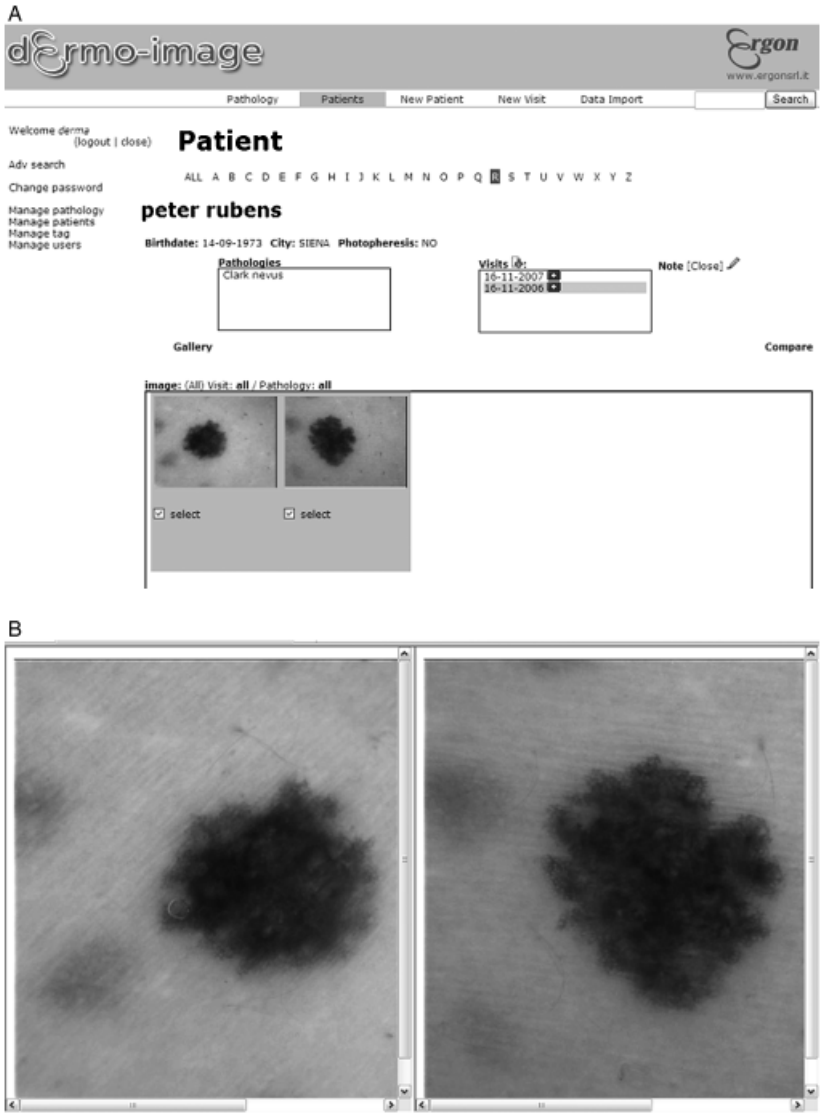


*Fig. 6. Images can be compared with each other (images taken at different time: follow-up) (A, B).*

## Discussion

Information technology is the 'study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware' (13–16). It aims to apply digital systems to the research and development of rational data management (16) and, in our field, is related to the retrieval, storage and optimal use of biomedical information, data banks and all other knowledge useful for solving clinical problems and for teaching and research; in other words, how medical science is created, modelled, distributed and applied by data management techniques. Its advent is linked to that of computer science and digital technology, which enable data to be expressed in digital format and easily processed. In particular, digital technology has led to new image acquisition techniques in general medicine (computerised tomography, NMR)


*Fig. 7. Simple search is active at all stages of the procedure, with a box in which to type key words; it is possible to perform an 'advanced search' for visits involving a certain disease at interval of dates, or for photos, related or unrelated to a certain disease, for therapies or by selecting available tags.*

*TABLE 1. Selected commercially available database software for digital image management*

| Software/contact | Dedicated to medical services | Dedicated specifically to dermatology (preset, updatable index and tags) | Specific tags for image retrieval | Image modification tool | Patient confidentiality (with user name and password protection) | Network compatible (images can be shared via the net) | Import of historic data | Cost |
|---|---|---|---|---|---|---|---|---|
| Windows-based management | No | No | No | No | No | Yes | No | Free |
| Digital photography hobby software | No | No | No | Yes | Variable | Variable | No | $50–$150 |
| PAX it image database<br>http://www.paxit.com<br>Tel: 630 –279 4000 707 N. Iowa Ave.Villa Park IL<br>60181-1510 | Yes | No | Yes | Image stitching and image fusion tools included | Yes | Yes | No | Contact<br>Tel: 630 –279 4000 |
| Digital image management<br>http://www.imagic-imaging.com | Also for medical services | No | Yes | Yes | Yes | Yes | No | Contact<br>info@imagic.ch |
| Cumulus 7<br>http://www.canto.com | Also for medical services | No | Yes | No | Powerful flexible authorisation system | Yes | No | Contact<br>info@canto.com |
| Mirror software<br>http://www.canfieldsci.com/Imaging_Products_Imaging.asp | Yes | No | Yes | Only in $2500 or superior version | Yes | Yes | No | $825<br>*($2.500–$12.500 for superior version†) |
| Imagestore for healthcare<br>http://www.ttlsoftware.com | Yes | Yes | Yes | Yes | Securely access those images from any PC connected to Internet | Yes | No | Contact http://www.ttlsoftware.com/subscriptions.html |
| Dεrmo-Image<br>http://www.ergonsrl.it | Yes | Yes | Yes | Yes | Powerful flexible authorisation system | Yes | Yes | € 990,00 |

*Mirror PhotoFile.

†Mirror PhotoTools, Mirror Rejuvenation, Mirror Simulation, Mirror Suite: softwares for advanced image management and aesthetic simulation.

and dermatology (digital dermoscopy, digital dermoscopy analysis) (17, 18). Because the skin is the only organ completely accessible to visual examination, digital technology has therefore attracted the attention of dermatologists for documenting, monitoring, measuring and classifying morphological manifestations. Digital dermoscopy for the diagnosis of cutaneous neoplasms, especially digital dermoscope analysis, illustrates the degree to which digital images have become essential in dermatology (18, 19).

Technological advances and the increasing number of sophisticated, practical and economical instruments available have provided medicine and dermatology with many new options for acquiring digital images. The ease of acquiring images has led to the development of programs for their acquisition and processing (17). Although these programs can all be used by doctors for amateur management of images, few programs have been designed specifically for medical requirements (Table 1). Only Imagestore for healthcare and Mirror software are suitable for dermatologists, although only the former and the program written by us (Dɛrmo-Image) have a ready-made, adaptable index of skin pathologies. The former enables an overlay of multiple images and fade between them using the compare feature. The search for digital images option is divided according to diagnosis, therapy and anatomical site. Mirror software was developed specifically for medical professionals; the basic management functions of storing, retrieving, viewing and printing images were all designed with the workflow of a medical practice in mind. It has an interesting loupe tool that allows the user to critically examine skin features and target problem areas. Images can be transferred to other programs, such as Word and Power point. Classification by pathology, patient and visit, and an advanced search option enabling access to all images according to personalised criteria is essential. The software considered here (Imagestore for healthcare, Mirror) and Dɛrmo-Image meet these requirements and also offer the possibility of comparing two or more digital images. The fact that the archives of years of digital photos acquired and saved on PCs can easily be entered in the program distinguishes it (Dɛrmo-Image) from the others. By reorganising the folder windows of photos, a huge number of patients with the same disease can be entered in the program with a single key. This option is fundamental for accessing all the photos taken in years of practice in the program without entering them one by one. Dɛrmo-Image also enables data and digital images to be stored according to European law in terms of privacy. The ease with which the various programs are managed is not simple to compare, although the fact that Dɛrmo-Image is a web application makes the software intuitive and simple to use even by users accessing the program for the first time. It also avoids the need to install it on individual PCs. The program is available to any user connected to the local Intranet, and the system can be directly accessed in the future from the Internet.

In conclusion, all clinics and surgeries, especially those that rely on digital images, are obliged to keep up with technological advances. It is therefore hoped that our project will become a model for medical structures intending to rationalise digital and other data according to statutory requirements (20, 21).

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