

## Web application for the integration of bone age calculation in RIS/PACS

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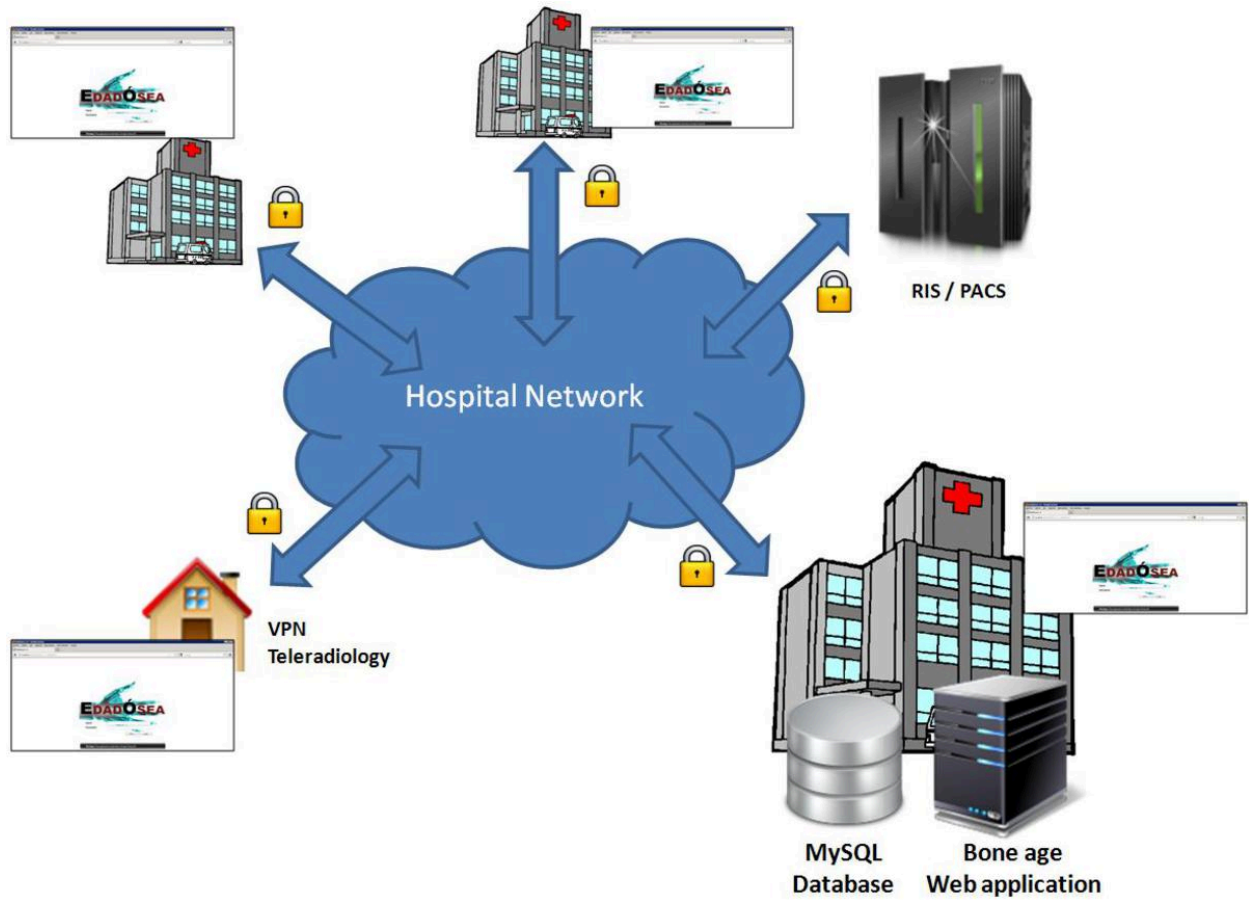
## Purpose

Radiology departments have different workflows associated to different studies. With the release of the RIS/PACS systems, images and reports were efficiently centralized, ensuring data availability and integrity and minimizing costs. However, most RIS/PACS systems don't take into account radiological processes which may need the aid of a third-party software tool (such as bone age calculation), so it is not always easy to incorporate the output of an external software-based analysis into the PACS.

Moreover, desktop software tools are difficult to manage in heterogeneous networks, such as that of a big hospital or a group of hospitals. In this scenario, web-based tools have gained popularity as they comply with all the security and access necessities (figure 1).

The purpose of this work is to develop a multi-user web application that allows a semi-automatic calculation of bone age integrating all the necessary workflows and methods with the hospital PACS.

Images for this section:



**Fig. 1:** Example of a network shared by different hospitals and users. The web application is stored in a single server and it is accessible to all users.

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## Methods and Materials

The web application was developed using the framework Java Google Web Toolkit for the interface, a MySQL database and Dcm4chee for DICOM connectivity with the PACS. These technologies are all free and open-source, so they can be extended to match each user needs without problems. They were also chosen because they have proved to be robust in different operative system and Java version environments.

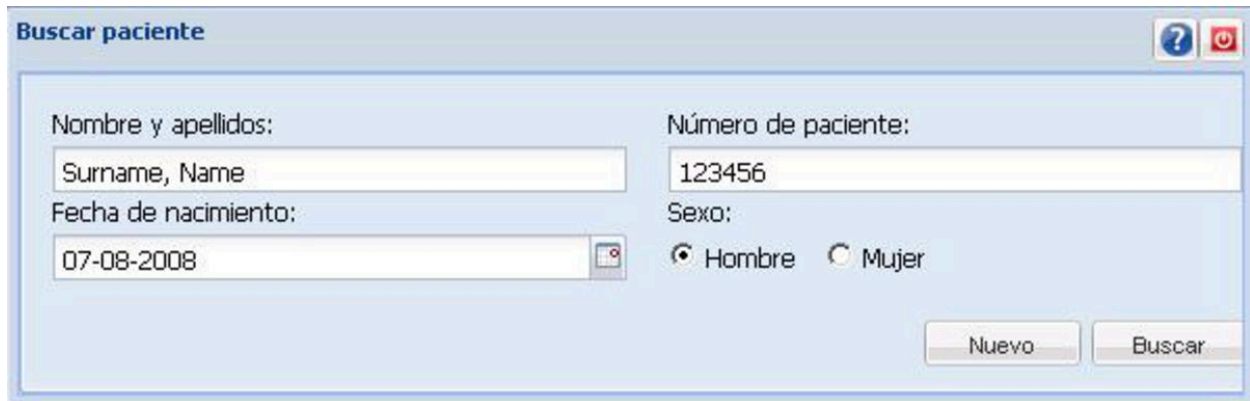
The application has access control so that only authorized users can use it. These users are defined by an administrator.

The application allows query/retrieve functions to import patient's radiographies from the PACS (figure 2). DICOM tags help generating a tree directory with the name, date and X-ray images of the study. It also provides information about previous studies and reports from the patient (figure 3).

The user can choose different semi-automatic bone age calculation methods (Greulich-Pyle, Tanner-Whitehouse or Sempé). It then asks for the corresponding user inputs, minimizing the number of interactions for each method.

The results are presented as a report comprising patient data and the corresponding bone age information (bone age, maturation, bone-by-bone scores and position in the normality graph). This report is dicomized and associated to the original radiograph in the PACS (figure 4). Finally all the results are stored in the MySQL database for research purposes.

**Images for this section:**



The image shows a software dialog box titled "Buscar paciente" (Search patient). It contains several input fields and buttons. The fields are: "Nombre y apellidos:" (Name and surnames) with the text "Surname, Name"; "Número de paciente:" (Patient number) with the text "123456"; "Fecha de nacimiento:" (Date of birth) with the text "07-08-2008"; and "Sexo:" (Sex) with radio buttons for "Hombre" (Male) and "Mujer" (Female). There are two buttons at the bottom right: "Nuevo" (New) and "Buscar" (Search). The dialog box has a standard Windows-style title bar with a question mark icon and a close button.

**Fig. 2:** Query/Retrieve dialog box used to search patients in the PACS

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**Buscar paciente**

Nombre y apellidos:

Número de paciente:

Fecha de nacimiento:

Sexo:  Hombre  Mujer

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Paciente:

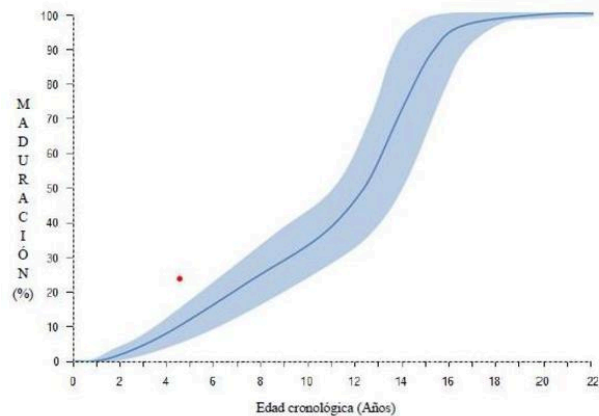
Descripción	Fecha	Informe
Estudio	07-12-2012	
Serie	07-12-2012	
Radiografía de: Mano izquierda	05-12-2012	

Tipo de análisis:  Sempè  Tanner-Whitehouse  Greulich y Pyle

**Fig. 3:** Results of the query to the PACS. There is a list of patients matching the search criteria and a list of the studies and reports for each patient.

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DATOS DEL PACIENTE		DATOS DEL ESTUDIO	
Nombre:		Fecha del informe:	07-12-2012
Fecha de la radiografía:	05-12-2012	Maduración: Huesos cortos	36.0%, Huesos largos
Fecha de nacimiento:	07-08-2008		Maduración total: 23.8%
Edad cronológica:	4 Año(s), 3 Mes(es), 27 Día(s)	Edad ósea:	7 Año(s), 1 Mes(es), 18 Día(s)



HUESO	VARIABLE	VALOR
Grande	R	30.0
Ganchoso	R	40.0
Pyramidal	R	50.0
Piriforme	P	5.0
Semilunar	P	10.0
Escafoides	P	15.0
Trapezio	P	15.0
Trapezoide	P	15.0
<b>Total de huesos cortos:</b>		<b>180.0</b>
Epifisis distal del Radio	P	5.0
Epifisis distal del Cubito	P	15.0
Epifisis proximal del primer Metacarpiano	P	3.0
Epifisis proximal de la primera Falange del Pulgar	P	3.0
Sesamoides del Pulgar	P	5.0
Epifisis proximal de la segunda Falange del Pulgar	P	3.0
Epifisis distal del tercer Metacarpiano	P	3.0
Epifisis proximal de la primera Falange del Medio	P	3.0
Epifisis distal del quinto Metacarpiano	P	3.0
Epifisis proximal de la segunda Falange del Medio	P	3.0
Epifisis proximal de la primera Falange del Meñique	P	3.0
Epifisis proximal de la tercera Falange del medio	P	3.0
Epifisis proximal de la segunda Falange del Meñique	P	3.0
Epifisis proximal de la tercera Falange del Meñique	P	3.0
<b>Total de huesos largos:</b>		<b>58.0</b>

Maduración de huesos cortos: 36.0 %  
 Maduración de huesos largos: 11.6 %

**Fig. 4:** Example of a report showing the bone age calculation results.

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## Results

The application allowed access from any hospital computer, regardless of the Java version or operative system. Connectivity with the PACS ensured that bone age reports were associated to the corresponding X-ray image, ensuring robust follow-up for longitudinal studies.

Radiologists found the tool very useful, as they could access it from any computer without limitations.



## Conclusion

The presented web application has improved the radiological workflow associated to the calculation of bone age, providing quantitative results, optimizing radiologist's effort and ensuring data consistency and integrity.

## References

Serinelli S et al. Accuracy of three age determination X-ray methods on the left hand-wrist: A systematic review and meta-analysis. *Legal Medicine* 2011;13:120-133.

## Personal Information

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