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SKELETAL DYSPLASIAS INFORMATION SYSTEM

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“Be the change you want to see in the world.”

Mahatma Gandhi (1869-1948)

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ABSTRACT

SDIS is an Information System that allows the storage and sharing of personal and clinical data from patients with bone dysplasias, ensuring the confidentiality of the information. It also allows saving information about the Research Groups and Doctors who work there.

Skeletal System is the biological system which main function is the physical support of the body.

Bone dysplasias are a heterogeneous group of diseases characterized by changes in shape, size and formation of bone and/or cartilage.

In 2011, students of Informatics Engineering of University of Coimbra attempted to develop an application with similar goals. The developed application had some failures, being only the basis of this new project.

The new application SDIS adds a set of features to the first implementation attempt.

According to the Client/Server architecture, the developed Information System is composed of a central Database, a DBMS, an interface application that runs in a Web browser, a Web Server and the Client.

The Classic Waterfall Model led to a systematic development of Software, following a strategy of sequential stages of completion.

Initially the application will be used in the three research centers in Portugal. If its use succeeds, we will make the application available to other research groups abroad.

Keywords

“Sharing”, “Confidentiality”, “Security”, “Clinical Information”, “Personal Information”, “HTML”, “PHP”, “MySQL”, “Web Application”, “Software”, “Skeletal Dysplasia”, “Doctor”, Research”

RESUMO

O Sistema de Informação SDIS permite o armazenamento e a partilha de dados clínicos e pessoais de pacientes com displasias ósseas, assegurando a confidencialidade da informação. Permite, ainda, guardar informação acerca dos Grupos de Investigação e dos médicos que aí trabalham.

O Sistema Esquelético é o sistema biológico cuja principal função é o suporte físico do organismo.

As Displasias Ósseas são um grupo heterogéneo de doenças caracterizadas por alterações na forma, no tamanho e na constituição dos ossos e/ou cartilagens.

Em 2011, foi feita uma tentativa de implementação desta aplicação, por alunos de Engenharia Informática da Universidade de Coimbra. Devido a um conjunto de falhas detectadas na mesma, esse trabalho apenas serviu de base ao desenvolvido neste novo projecto.

A aplicação SDIS acrescenta várias funcionalidades às da primeira tentativa de implementação.

De acordo com a arquitetura Cliente/Servidor, o Sistema de informação desenvolvido é composto por uma Base de Dados central, um Sistema gerenciador, uma interface de execução que corre num navegador Web, um Servidor Web e o Cliente da Aplicação.

O Modelo em Cascata clássico conduziu a um desenvolvimento sistemático de Software, seguindo uma estratégia sequencial de conclusão de fases.

Numa primeira fase a aplicação é utilizada nos três Centros de Investigação portugueses. Caso a sua utilização seja um sucesso, será alargada a outros grupos de investigação no estrangeiro.

Palavras-chave

"Partilha", "Confidencialidade", "Segurança", "Informação Clínica", "Dados Pessoais", "HTML", "PHP", "MySQL", "Aplicação Web", "Software", "Displasia Óssea", "Médico", "Investigação"

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LIST OF ACRONYMS

ACIU – Atraso de Crescimento Intra Uterino

Admin – Administrator

CHC – Centro Hospitalar de Coimbra

CSS – Cascading Style Sheets

CT – Computerized Tomography

DBMS – Database Management System

ER – Entity-Relationship

GD – Group Director

GPL – General Public Licence

GruPEDGE – Grupo Português de Estudos de Doenças Genéticas do Esqueleto

IDE - Integrated Development Environment

LA – Líquido Amniótico

MRI – Magnetic Resonance Imaging

PHP – Hipertext Preprocessor

RG – Research Group

SDIS – Skeletal Dysplasias Information System

SPGH – Sociedade Portuguesa de Genética Humana

SPSS – Statistical Package for the Social Sciences

DEFINITIONS

Application – Also known as end-user programs, is a Software tool to perform specific tasks.

Biomedical Engineering – The branch of engineering that aims to develop technologies in the healthcare area.

Clinical Informatics – Clinical Informatics is the field of Informatics that aims to improve healthcare systems by applying them information technologies knowledge.

Information System – Information System is an integrated set of components that aims to collect, save and process data using information technologies.

Software – Software is a computer program that defines the set of instructions to be executed by the physical components of the computer (Hardware).

CHAPTER 1 . INTRODUCTION

1.1 MOTIVATION

Science has transported what we were in the past to the modernity, making us more self-aware of the world we live in.

Research is the way that we, as curious human beings, have found to fill the gaps in our knowledge. It is present in several fields of Science, and is notorious the progress that it has brought in the area of Medicine, especially in the development of new methods of diagnosis and new therapeutics.

In the treatment of rare diseases, which are very uncommon, scientific research plays a key role. Skeletal Dysplasias are a set of rare diseases, about which very little is known.

Currently, there are three Medical Research Centers in Portugal, localized in Coimbra, Lisbon and Porto, where Geneticists are responsible for all of the portuguese patients with Skeletal Dysplasias.

There are several types of Skeletal Dysplasias, each one of them individually rare, with only about fifty cases diagnosed in our country. Thus, due to the very low number of patients, it is very difficult for the researchers to collect enough information to develop new treatments and increase the changes of patients survival.

Besides that, currently the reduced existent information is stored on paper files, which makes its access and use more difficult. Once stored in digital

format, it becomes easier to make statistical studies with this information, using programs such as SPSS® and EXCEL®.

Our client, a Skeletal Dysplasias Researcher/Doctor in Coimbra, believes that sharing information may be extremely helpful to improve the quality of life of these patients and to increase the clinical knowledge about these rare diseases. They defend that similar cases may have similar treatments.

1.2 OBJECTIVES

The main goal of the developed work during this academic year and that now reaches its end was to develop an Information System that allows to share Personal and Clinical Information of Patients with Bone Dysplasias between the three Research Centers in Portugal, ensuring controlled accessibility, as well as patient personal identification confidentiality.

Initially, the SDIS application will be used in these three Portuguese Centers. In case we get a positive user feedback, we consider the possibility of making the application available to other Research Groups abroad.

During this work, it was necessary for the candidate to consolidate some previous concepts and acquire new skills in order to achieve the project's goals:

- Software developing using the Waterfall Model;
- Modelling Database and DBMS;
- Implementation of a Web Based application.

It must be stressed that the candidate is a Biomedical Engineering, not an Informatics Engineering undergraduate. It was the interdisciplinary nature of his project that made it so challenging as much as interesting.

1.3 THESIS OVERVIEW

This thesis is divided in eight chapters.

The present chapter explains the motivation of this project, as well as its main purposes and goals.

The second chapter is subdivided in two parts. In the first part, we briefly describe the Skeletal System and the concept of Bone Dysplasia. The second part refers some of the previous work developed with the same goals, highlighting its strengths and weaknesses.

In the third chapter, we present the developed tool and its Stakeholders and Role. Then, we explain in detail the application's constraints and its functional architecture.

The Software Development process adopted by the candidate was based in the classic Waterfall Model, as explained in the fourth chapter. This chapter also presents the work plan and specifies the material that will be delivered to the client.

The fifth chapter includes a detailed explanation of the developed work in the context of this project. The functional, non-functional and hardware requirements are listed, as well as the application features. In the final part of this chapter, the choice of tools used in the Software implementation is justified.

In chapter six, the conclusions of the work are presented. We also propose some future evolutions for the project.

CHAPTER 2. BACKGROUND

2.1 THEORETICAL BACKGROUND

2.1.1 SKELETAL SYSTEM

Skeletal System is the biological system responsible for the physical support of the organism. The human skeleton is a structure composed approximately by two hundred and six bones, united by joints, and some structures made of cartilage [1].

Bone is a strong type of mineralized conjunctive tissue that is in a constant process of renewing. During this dynamic process, old bones are destroyed and new ones are formed [1].

Cartilage is an elastic type of connective tissue that composes the parts of the skeleton that can't be totally rigid, due to the necessity of body movements [8].

Besides supporting the organism, Skeletal System is responsible for other important functions [1,2]. The major ones are:

- Physical protection of vital structures and organs;
- Mechanical base of the movement;
- Storage of essential minerals, as calcium and magnesium;
- Hematopoietic function - continuous production of new blood cells.

2.1.2 BONE/SKELETAL DYSPLASIAS

Bone Dysplasias, also known as Skeletal Dysplasias, are an heterogeneous group of diseases characterized by alterations in the shape, size and constitution of bones and/or cartilages [3,4,5].

There are about four hundred and fifty-six different conditions of this type, distributed in forty groups defined by molecular, biochemical and/or radiographic criteria. However, there are only about fifty cases diagnosed in our country [3,4,5].

Most of this diseases result in short stature, so the first nomenclature was the term “dwarfism”. However, due to the negative connotation associated to this term, it was substituted by the term “dysplasia” [3,4,5].

In 1977, a group of experts gathered in Paris to propose an International Nomenclature to these diseases. Since then, the nomenclature was revised, dividing the identified diseases into two different groups:

- Osteochondrodysplasias: when there are simultaneous disorders in the development of bone and cartilage;
- Dystoses: characterized by single or combined malformations of individual bones.

More recently, an international group of experts created a new taxonomy, regularly reviewed, based on radiological and clinical features, such as skeletal genetic disorders [4].

2.2 PREVIOUS WORK

For a long time, doctors and researchers working in the field of Skeleton Diseases have felt the need to have a Software tool that supports their work. The main purpose was to store the patients information in digital format, avoiding the problems associated with paper files.

For this reason, in 2008's, during the 12th Meeting of SPGH, a geneticist working on that investigation field and her husband, an Informatics Engineer, presented an idea of an application of this kind.

In this meeting, it was decided how clinical information should be organized, and, thanks to that, a draft interface of a possible application was built.

2.2.1 DRAFT INTERFACE

This draft interface has represented the first big step in the development of the current application SDIS, because it gave a more real outline to what, until then, was just an utopic idea.

The most important contribution of this prototype was to bring the existent ideas into practice. Dr. Patrícia Dias, a member of GruPEDGE, provided it to this project.

However, this draft had some limitations:

- The application wasn't Web based;
- It was designed to save only information about patients, and not about the Research Groups or their doctors;
- It also did not have an authentication system;
- Image store wasn't included;
- It was written in Portuguese;
- It did not offer the possibility of searching on the information stored;
- It wasn't defined an hierarchy of access to the functionalities of the application;
- It did not support information export.

2.2.2 THE FIRST IMPLEMENTATION

The development of the SDIS solution began in the year of 2011, being conducted, at that time, by a group of sixteen Master students in Informatics Engineering at the University of Coimbra, in the curricular unit of Software Projects Management.

Between the months of February and June, those students completed some important tasks, including the writing of the Requirements Document. In the end of the June, they delivered a version of the application to the client. That version of the application had several flaws, recognised by the student developers in the moment they delivered it. Since this was a curricular activity and the course was over, the application remained unused.

In 2011 we faced the challenge to close the project and deliver a working version of the tool. This challenge was accepted with enthusiasm, as we could use the mix of competences of the Biomedical Engineering degree to close the project.

The first task of this Master thesis project was to analyse the developed code in an attempt to correct those failures and add new features to the application.

After a long-lasting and careful analysis of the code, some problems were identified:

- The visual look of the application wasn't the most appropriated in the context, especially the colour scheme chosen;
- The application was designed to save only information about patients, and not about the Research Groups or their doctors;
 - Certain tables in the database were missing;
 - Some missing attributes were detected;
 - The application did not support information export;
 - It was not possible to visualize or search information about the Research groups, Groups Directors or Doctors;

- There was no visualization mode of the patient information;
- There was no possibility of filtering the searched information;
- Administrator, Group Directors and Doctors had the same access privileges;
 - Administrator, Group Directors and Doctors could access all the information about the patients, when only the responsible Doctor should be able to do it, and only about his own patients; this is mandatory legal requirement for medical software.
 - The images were not stored in the database, but in a folder out of the database, in a non-encrypted format;
 - Image features, such as brightness and contrast, could not be modified;
 - It was only possible to save images up to 2Gb, which is a very small file size limit in medical imaging context;
 - A discussion forum was created to associate to the application, but the connection was never made;
 - A mechanism to release messages wasn't created;
 - There was a problem of consistency of the database, because when a Doctor was removed from it, his patients lost his responsible Doctor;
 - Similarly, when a Group Director was removed, his Research Group was left without another responsible.

As can be easily understood, a considerable number of failures was detected, most of them essential to the proper (and basic) use of the application. Given that, we concluded that the best strategy would be to start from scratch. This proposal was presented to the client, which readily agreed.

The Requirements Document was also discussed with the client, concluding that it should also be revised, eliminating some of the old requirements and adding new ones.

From the above it can be said that this was a new project, based on the previous work, which can be valued as useful prototypes to validate some of the requirements.

CHAPTER 3. PROPOSAL OF THE PROJECT

3.1 CONCEPT

This project intends to build an Information System, with an operational database to store information about patients with genetic Skeleton Disorders in a centralized, organized and secure manner.

This application will be available to authorized Doctors, who are currently working at Research Centers dedicated to this type of diseases.

As a research instrument, the application will allow exporting filtered data, which can be analysed with other existent tools, such as SPSS[®] and EXCEL[®].

This application will also be used in the diagnosis process, by making the information accessible to a network of experts.

3.2 STAKEHOLDERS AND ROLES

The database must include information about Research Groups, their Directors and Doctors. It is also extremely important to store the patients' personal and clinical information.

Therefore, there are a set of terms and concepts related to that information management, which will be clarified next [6,7,8,9,10].

RESEARCH GROUP

A Research Group is a group of people who dedicate their professional skills to enrich the knowledge on a particular scientific area. In this context, a Research Group is a set of Doctors in the genetic area devoted to treat patients with skeletal disorders.

ADMINISTRATOR

The Administrator is a user of the application that, as his own name implies, plays an administrative role. He is normally a doctor working in one of the Research Groups, chosen to have the responsibility of managing Research Groups and their Group Directors information, but in this role he or she has not access to the patients clinical data.

GROUP DIRECTOR

Every Research Group already has a Director. Similarly to the Administrator, this Director is a doctor working on the Research Group that he or she is responsible for.

In the application, the Group Director manages Doctors' information, but, again, in this role he or she has not access to the patient's clinical data.

DOCTOR

Doctors are the application users that play the most active role, because they are the ones who contact directly with the patients.

For this reason, Doctors are responsible for the management of their own patients' information.

PATIENT

A patient is an individual who is under the care of a health professional, as a Doctor or a nurse.

Patient's information can be divided in two categories: Personal and Clinical.

1. Personal Information

This type of information includes Patient's personal data, as name, age, gender, address and contacts.

2. Clinical Information

Clinical Information refers to patients' information related to his clinical situation.

In what concerns patients with Bone Dysplasias, Clinical Information is divided in eleven categories: Family Background, Radiology – Bone Abnormalities, Dismorphisms, Somatometry, Phenotype, Pregnancies, Sonographic Findings, Studies, Therapeutics and Images.

2.1 Family Background

This category includes information about patient relatives. Between the relatives, the ones with more clinical relevance for the investigation are their parents and brothers/sisters.

However, since these diseases have a strong hereditary component, it is important to include information about other affected relatives.

2.2 Radiology – Bone Abnormalities

In this category, the characteristics of several bone structures observed in radiology exams are registered. Some structures are analysed in detail (Skull, Clavicle, Blades, Sternum, Ribs, Spine, Pelvis, Hip, Arm, Forearm, Hands, Thigh, Legs and Feet) but there is a field where other alterations can be registered. This category also includes Bone Age, and Bone Density.

During the growing process, the bones size and shape suffer some alterations that can be detected with X-Rays, for example. Bone Age is a measure of the degree of maturation of a child's bones.

Bone Density is an important parameter that measures the density of minerals in bones, using techniques as Bone Densitometry (a special X-Ray exam) and CT scan.

2.3 Dismorphisms

Dismorphisms are abnormalities that are detected on the shape of a biologic structure. In this context, it is important to observe if this type of abnormalities are present in Skull, Face, Eyes, Eyelashes and Eyebrows, Nose, Mouth and Teeth, Jaw, Thorax, Abdomen, Back, Lower Limbs, Upper Limbs, Skin, Nails and Hair, Joints and Genitals of the patients.

2.4 Somatometry

Somatometry is the field of Antropometry dedicated to the several measurements of the patient body parts.

Only some of the possible measurements revealed to be important in the field of Bone Dysplasias. These are: Height, Weight, Occipitofrontal Circumference, Upper Segment, Lower Segment and Span.

2.5 Phenotype

Phenotype is the physical expression of the genetic characteristics of an organism, always influenced by its interaction with the environment.

In this context, it became relevant to observe if the patient has Learning Disabilities, Visual and/or Hearing Impairment and Unusual Voice.

2.6 Pregnancies

If the patient is diagnosed before he is even born, is important to register the Number of Pregnancies and Miscarriages of the mother, the Type of Pregnancy and Mother Background (previous risk behaviours).

2.7 Sonographic Findings

Sonography, also known as Ultrasonography or Ultrasound, is a diagnosis imaging technique that allows having clear visuals of muscles, internal organs and joints. As this technique does not use harmful radiation, it is also used to observe the fetus development in pregnant women.

The Sonographies allow observing some important characteristics of the fetus, such as ACIU, LA, the existence of Fetal Movements, the Nuchal Translucency, the appearance of Skull and Face and if there are any Affected Organs.

2.8 Studies

Patients with skeletal disorders will undergo some studies in an attempt to better understand their particular disease. Each patient can be examined by Molecular, Cytogenetic, Metabolic, Immunohistology, Necropsy or even Other Studies.

After these studies, the result is registered, as well as the identification of the Laboratory involved.

2.9 Therapeutics

After the diagnosis, a therapeutic procedure is applied. In the case of Bone Dysplasias, this procedure can be Medical (drugs, physical therapy treatments) or Cirurgic.

2.10 Complementary Alterations by Organs and Systems

Pathologies in other organs and Systems (Neurological, Cardiovascular, Ophtalmologic, Otorhinolaryngological, Respiratory, Gastrointestinal, Nephrologic, Genital, Hematologic, Imunologic, Joints) may affect the Skeletal System. Those alterations must be also registered.

2.11 Images

The Patient images may be of two types: personal or clinical. This is defined when the image is uploaded to the database. Each image is also identified with a ID (image_id) that is a combination of the Image Type, which includes the medical exam name, and the image order insertion number.

In Bone Dysplasias diagnosis process, medical imaging is a crucial tool. Today, there are several techniques in this field:

Conventional Radiology (X-Ray) [11]

Conventional Radiology is a technique that uses the properties of the X-Rays (ionizing radiation), making them pass through the patient's body in a specific zone. The radiation is then detected on the opposite side of the patient, in a radiographic film or, more recently, in a digital detector.

Different tissues have different densities, which absorb different amounts of radiation, resulting in a different grey level in the obtained image.

Computerized Tomography (CT) [11]

Computerized Tomography is a diagnosis technique based on the same principles that Conventional Radiology.

However, it uses a huge amount of ionizing radiation (about four years of "environment radiation"), resulting in images with much more detail.

Magnetic Resonance Imaging (MRI) [11]

Magnetic Resonance Imaging is a diagnostic technique that takes advantage of the property of Electronic Spin.

The image is obtained by using radio frequency pulses, which are emitted in the interest zone, in order to modify the orientation of protons.

It is a powerful technique since it allows distinguishing benignity and malignancy of a mass, and obtaining an image with a very high resolution, even higher than CT.

3.3 CONSTRAINTS

There are some constraints imposed by certain features of the application. These constraints may be classified in two types, as follows:

- A constraint is named a Hard Constraint (HC) if there are features that can only be used if it is satisfied [12].
- A Soft Constraint (SC) does not need to be satisfied if the features still can be used [13].

Some Hard Constraints were identified:

- HC1: Group Directors and Doctors cannot be created without being associated to a Research Group. Consequently, the Research Group must be created previously.
- HC2: Research Groups and Patients' Files can be removed from the database, but Group Directors and Doctors do not.
- HC3: Group Director is the only user who can add, edit and remove Doctors' information.
- HC4: A Patient must always have a responsible Doctor.
- HC5: If a Doctor leaves the Group, his file isn't removed from the database, but the responsible Group Director must change his Work Status (indicates if he or she is Active/Inactive, i.e., if the he or she still works on the Research Group) to "inactive". The Group Director is also responsible to specify a new Doctor to those Doctors' old patients, by editing those patients' personal (not clinical) files.
- HC6: Patients Personal and Clinical Information must be removed as a whole, which means that Doctors can't remove only the personal data or the family backgrounds, etc. However, images can be removed individually.
- HC7: Personal and Clinical information must always be associated to an existent patient.

- HC8: Each Doctor can only belong to one Research Group, but he can change from one group to another (e.g. a researcher from Coimbra moves to Lisbon).

- HC9: The attributes presented in the application, as combo boxes, have always the possibility “Unknown”, which must be chosen if the information is not yet known. When they are presented as input forms, they may be left empty.

- H10: When a Research Group is removed from the system, the Patients must be distributed by the other Research Groups.

- Others:

- Each Research Group, Group Director, Doctor and Patient must be unique;

- There must be referential integrity between objects, which means that an entity related to other(s) can't be removed (e.g. a Research Group can't be removed if it is associated to Doctors).

The identified Soft Constraints are listed next:

- SC1: the Administrator is the only user who can add, edit and remove information of the Research Groups and Group Directors.

- SC2: If a Group Director leaves the Research Group, the Administrator must edit the Group Director file.

- SC3: Only Doctors can add, edit and remove their own patients from the database, and they can also move a Patient (only under their own medical supervision) to another responsible Doctor.

3.4 SOFTWARE'S ARCHITECTURE

The SDIS application has Client/Server Architecture, a distributed architecture in which every process and computer is a client or server. Servers are computers or processes that provide services. Clients are computers or processes that request services [14].

The architecture of the application was designed in an attempt to visualize the flow of information.

SDIS is composed by a central Database, a DBMS, an Interface running on a Web Browser, a Web Server running in a Server Machine and the Client.

The information is stored in the database, and its management is made by a Database Management System. The interface is presented in a Web Browser, which connects to the Web Server every time a page is requested. The Server Machine running the Web Server receives the request and sends back the requested page.

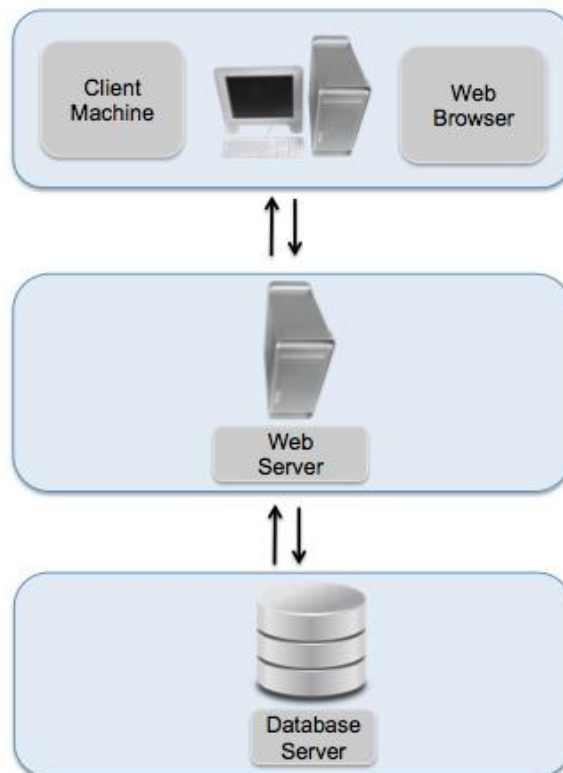


Figure 1: Illustration of the Application's Architecture.

CHAPTER 4. SOFTWARE DEVELOPMENT

4.1 SOFTWARE DEVELOPMENT PROCESS: WATERFALL MODEL

At the starting point of the project planning, the idea was to use the Iterative and Incremental Development Model. However, according to the available resources (one single person), and the fact that the requirements were very stable after the previous attempts, we concluded that the Waterfall Model would better fit the context of the project.

This model implies a systematical development of the Software, following a sequentially ordered phase completion strategy, similarly to a waterfall [29].

4.2 WORK PLAN

The Software Development Work Plan will include the usual phases of the Waterfall Model. The following figure represents the classic Waterfall Scheme [15].

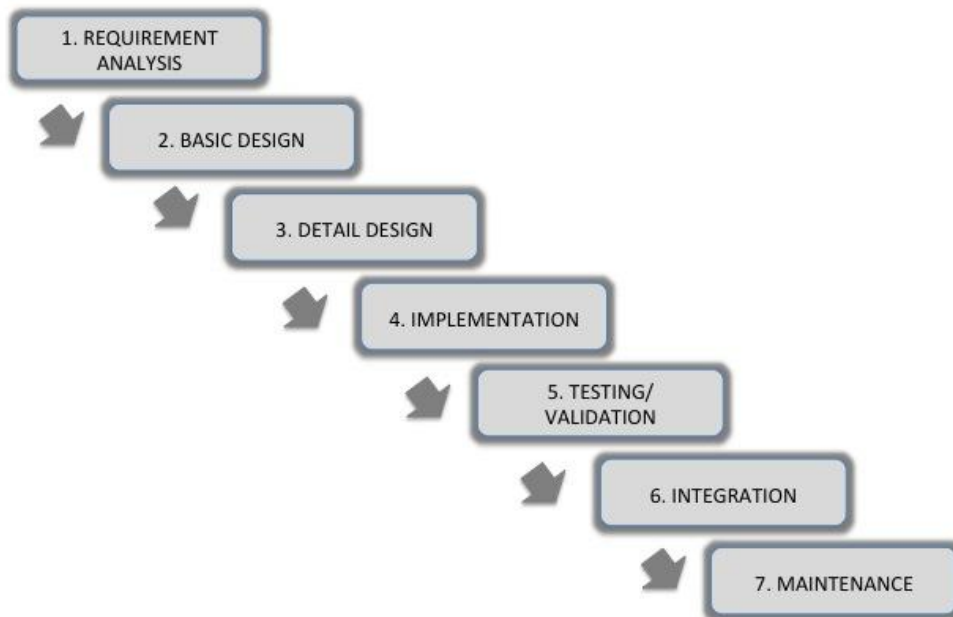


Figure 2: Waterfall Scheme of the Software Development Work Plan.

Next, we present a brief description of each one of each phases [25]. The first five phases are the developer’s responsibility and the remaining two are entrusted to the Informatics Services Team of the CHC.

1. REQUIREMENT ANALYSIS: In this phase, the Requirements Document written during the first implementation attempt was analysed and discussed with the Client. A new Requirements Document was written, including many alterations to the initial ideas.

2. BASIC DESIGN: At this phase, a basic design of the Software application was made on paper.

3. DETAIL DESIGN: Here, we used “Balsamiq Mockups Web”, a design open source tool, to improve the basic design. The result can be seen in Appendix 8.2.

4. IMPLEMENTATION: At this phase, the source code was developed.

5. VERIFICATION/TESTING: After the source code development, the functionalities were tested. The test tables can be seen in Appendix 8.3.

6. INTEGRATION: In Integration phase, Informatics Services Team of the CHC put the application developed in use for the Researchers/Doctors.

7. MAINTENANCE: In the future, to ensure that the application is correctly operating, a periodically maintenance, mostly updates and usage adjustments will be mandatory. This is out of the scope of the current MSc thesis. However, a special care was devoted to the documentation in order to facilitate the future maintenance efforts.

The Gantt Diagram shows the planning of the project's tasks and goals (see Appendix 8.4).

4.3 THE DESTINATION OF SDIS

The Client of this project is the Center of Medical Genetics of the Paediatrics' Hospital of Coimbra, where the Research Group of Bone Dysplasias of Coimbra is located.

During the project, two geneticists of this Research Group, Dr. Ana Beleza and Dr. Pedro Louro, represented the Client.

The final application will be property of the Faculty of Science and Technology of the University of Coimbra, more specifically, property of the Department of Informatics Engineering.

Since the application development is not financed by any entity, it is offered by the Faculty of Science to the Client, more concretely, by Professor Dr. Mário Zenha Relá, supervisor of the project.

As part of this thesis, Professor Dr. Mário Zenha Relá will receive the application source code and the project's documentation, including the user manual.

To the Client will be delivered a copy of the source code, the user and the installation manual.

CHAPTER 5. WORK PERFORMED

5.1 REQUIREMENTS

5.1.1 FUNCTIONAL REQUIREMENTS

The Functional Requirements express the application's functionalities [16].

I. Add, edit, remove and show Research Groups' Information

The Administrator is the only user that can add, edit and remove Research Groups' information. After insertion, deletion or modification, the information can be saved. To save the inserted data, the user must press the "SAVE" button. If a Research Group is removed the Patients must be distributed by the other existent RGs.

Next are listed the sub requirements:

- Register new Research Group:
 - Insert Research Group's Name;
 - Insert Research Group's Phone;
 - Insert Research Group's Address;
 - Insert Research Group's E-mail;
 - Insert Research Group's Fax.

- Edit an existent Research Group's data:
 - Edit Research Group's Name;
 - Edit Research Group's Phone;
 - Edit Research Group's Address;
 - Edit Research Group's E-mail;
 - Edit Research Group's Fax.

- Remove a registered Research Group:
 - Remove from the database all the information of the Research Group chosen.

- Search for Research Group's Information:
 - Receive the information inserted and return the search result. The user chooses the selection criteria.

- Show Research Group's Data in a Page named "Research Group".

II. Add, edit and show Group Directors' Information

Administrator is the only user that can add and edit Group Directors' information.

When the Administrator registers a new Group Director, an identifier (gd_username) is automatically generated by the application. This identifier is a combination of the Research Group initials, the letters "gd" and the insertion order number of the Group Director.

After insertion or modification, the information can be saved. To save or edit the data inserted, the user must press the "SAVE" or "EDIT" button, respectively.

Following, the sub requirements are listed:

- Register new Group Director:
 - Generate Group Director username;
 - Generate Group Director password;
 - Insert Research Group's Name;
 - Insert Group Director's Name;
 - Insert Group Director's Phone;
 - Insert Group Director's E-mail;
 - Insert Group Director's Work Status;

- Edit an existent Group Director's data:
 - Edit Research Group's Name;
 - Edit Group Director's Name;
 - Edit Group Director's Phone;
 - Edit Group Director's E-mail;
 - Edit Group Director's Work Status;

- Search for Group Director's Information:
 - Receive the information inserted and return the search result. The user chooses the selection criteria.

- Show Group Director's data in a page named "Group Director".

III. Add, edit and show Doctors Information

Group Director is the only user that can add and edit Doctor's information.

When a new Doctor is registered, an identifier (`doctor_username`) is automatically generated by the application. This identifier is a combination of the Research Group initials, the word "doctor" and the insertion order number of the Group Director.

After insertion or modification, the information can be saved. To save or edit the data inserted, Group Director must press the “SAVE” or “EDIT” button, respectively.

Following, the sub requirements are listed:

- Register new Doctor:
 - Generate Doctor’s username;
 - Generate Doctor’s password;
 - Insert Doctor’s Name;
 - Insert Doctor’s Phone;
 - Insert Doctor’s E-mail;
 - Insert Doctor’s Work Status;

- Edit an existent Doctor’s data:
 - Edit Research Group’s Name;
 - Edit Group Director’s Name;
 - Edit Group Director’s Phone;
 - Edit Group Director’s E-mail;
 - Edit Group Director’s Work Status;

- Search for Doctor’s Information:
 - Receive the information inserted and return the search result. The user chooses the selection criteria.

- Show Doctor’s data in a page named “Group Director”.

IV. Add, remove, edit and show Patients' Information

Insertion, deletion and edition of patients' information are the main goals of the application.

Only the responsible Doctor can register a new Patient. However, Group Director can modify the Patient's Responsible Doctor field.

When the Doctor registers a new Patient, an identifier (patient_id) is automatically generated by the application. This identifier is a combination of the word "patient", his or her birth date and the insertion order number of the Patient.

When a Clinical Image or Photo is uploaded, an identifier is created, to avoid that the same image is uploaded more than once. That identifier is a combination of the Image Type, which includes the medical exam name, and the Image order insertion number.

The Doctor does not need to worry about the information insertion order, because that is automatically defined by the application.

To edit and remove information, the Doctor must press the "EDIT" and "REMOVE" button, respectively.

After insertion, deletion or modification, the information can be saved. To save the data inserted, the user must press the "NEXT" button in every section, until the "SAVE" button appears in the last section.

Below, the detailed sub requirements are listed:

- Register new Patient:
 - Generate the Patient's identifier (patient_id);
 - Add General Information:
 - Insert Doctor's Name;
 - Insert Patient's Bone Dysplasia (the Diagnosis);
 - Insert Research Group;

- Add Personal Information:
 - Insert Patient's Name;
 - Insert Patient's Date of Birth;
 - Insert Patient's Date of Death;
 - Insert Patient's Gender;
 - Insert Patient's Life Status;
 - Insert Patient's Phone;
 - Insert Patient's E-mail;
 - Insert Patient's Address.

- Add Family Background Information:
 - Insert Mother's Date of Birth;
 - Insert Mother's Date of Death;
 - Insert Mother's Birth Place;
 - Insert Mother's Number of Pregnancies;
 - Insert Mother's Bone Dysplasia;
 - Insert Mother's Stature;
 - Insert Mother's Number of Miscarriages;
 - Insert Father's Date of Birth;
 - Insert Father's Date of Death;
 - Insert Father's Birth Place;
 - Insert Father's Bone Dysplasia;
 - Insert Father's Stature;
 - Insert Number of Brothers;
 - Insert Number of Brothers with Bone Dysplasias;
 - Insert Number of Brothers Alive;
 - Insert Number of Sisters;
 - Insert Number of Sisters with Bone Dysplasias;
 - Insert Number of Sisters Alive;
 - Insert Number of Other Relatives with Bone Dysplasias;
 - Insert Number of Brothers with Other Relatives Kinship;
 - Insert Family Background Observations.

- Add Radiology – Bone Abnormalities Information:
 - Insert Patient’s Bone Age;
 - Insert Patient’s Bone Density;
 - Insert Patient’s General Bone Alterations;
 - Insert Skull’s Alterations;
 - Insert Clavicle’s Alterations;
 - Insert Blades’ Alterations;
 - Insert Hip’s Alterations;
 - Insert Ribs’ Alterations;
 - Insert Spine’s Alterations;
 - Insert Pelvis’ Alterations;
 - Insert Hip’s Alterations;
 - Insert Arm’s Alterations;
 - Insert Forearm’s Alterations;
 - Insert Hands’ Alterations;
 - Insert Thigh’s Alterations;
 - Insert Legs’ Alterations;
 - Insert Feet’s Alterations.

- Add Dismorphisms Information:
 - Insert Skull’s Dismorphisms;
 - Insert Face’s Dismorphisms;
 - Insert Eyes, Eyelashes and Eyebrows’ Dismorphisms;
 - Insert Nose’s Dismorphisms;
 - Insert Mouth and Teeth’s Dismorphisms;
 - Insert Jaw’s Dismorphisms;
 - Insert Neck’s Dismorphisms;
 - Insert Thorax’s Dismorphisms;
 - Insert Abdomen’s Dismorphisms;
 - Insert Back’s Dismorphisms;
 - Insert Lower Limbs’ Dismorphisms;
 - Insert Upper Limbs’ Dismorphisms;

- Insert Skin, Nails and Hair's Dismorphisms;
 - Insert Joints' Dismorphisms;
 - Insert Genitals' Dismorphisms;
 - Insert Dismorphisms' Observations.
- Add Somatometry Information:
 - Insert Patient's Height;
 - Insert Patient's Weight;
 - Insert Patient's Occipitofrontal Circunference;
 - Insert Patient's Height Centil;
 - Insert Patient's Weight Centil;
 - Insert Patient's Occipitofrontal Circunference Centil;
 - Insert Patient's Upper Segment Measure;
 - Insert Patient's Lower Segment Measure;
 - Insert Patient's Occipitofrontal Circunference;
 - Insert Patient's Span;
 - Insert Upper-to-Lower Ratio.
 - Add Phenotype Information:
 - Insert if Patient has Learning Disabilities;
 - Insert if Patient's Learning Disabilities are Proportional;
 - Insert if Patient has Visual Impairment;
 - Insert if Patient has Hearing Impairment;
 - Insert if Patient has Abnormal Voice;
 - Insert Abnormal Voice Observations.
 - Add Pregnancies Information:
 - Insert Number of Pregnancies;
 - Insert Number of Miscarriages;
 - Insert the Type of Pregnancy;
 - Insert Mother Background.

- Add Sonographic Findings Information:
 - Insert if is detected ACIU;
 - Insert the appearance of the LA;
 - Insert Fetal Movements' Characteristics;
 - Insert Nuchal Translucency's Characteristics;
 - Insert Skull and Face's Characteristics;
 - Insert the System of Organs Affected;
 - Insert Sonographic Findings' Observations.

- Add Studies Information:
 - Insert if were made Molecular Studies;
 - Insert Molecular Studies' Result;
 - Insert Molecular Studies' Lab;
 - Insert if were made Cytogenetic Studies;
 - Insert Cytogenetic Studies' Result;
 - Insert Cytogenetic Studies' Lab;
 - Insert if were made Metabolic Studies;
 - Insert Metabolic Studies' Result;
 - Insert Metabolic Studies' Lab;
 - Insert if were made Immunohistology Studies;
 - Insert Immunohistology Studies' Result;
 - Insert Immunohistology Studies' Lab;
 - Insert if were made Necropsy Studies;
 - Insert Necropsy Studies' Result;
 - Insert Necropsy Studies' Lab;
 - Insert if were made Other Studies;
 - Insert Other Studies' Result;
 - Insert Other Studies' Lab.

- Add Therapeutics Information:
 - Insert if The Therapeutic Type;
 - Insert Therapeutic Observations.

- Add Complementar Alterations by Organs and Systems Information;
 - Insert Alterations caused by Neurological System;
 - Insert Alterations caused by Cardiovascular System;
 - Insert Alterations caused by Ophthalmologic System;
 - Insert Alterations caused by Otorhinolaryngological System;
 - Insert Alterations caused by Respiratory System;
 - Insert Alterations caused by Gastrointestinal System;
 - Insert Alterations caused by Nephrologic System;
 - Insert Alterations caused by Genital System;
 - Insert Alterations caused by Hematologic System;
 - Insert Alterations caused by Immunologic System;
 - Insert Alterations caused by Joints System;

- Upload and store Clinical Images and Photos;
 - Must upload an image file;
 - Insert if the image is a Clinical Image or a Photo;
 - Insert the Image Observations.

- Edit an existent Patient data;
 - Edit General Information:
 - Edit Doctor's Name;
 - Edit Patient's Bone Dysplasia (the Diagnosis);
 - Edit Research Group.

- Edit Personal Information:
 - Edit Patient's Name;
 - Edit Patient's Date of Birth;
 - Edit Patient's Date of Death;
 - Edit Patient's Gender;
 - Edit Patient's Life Status;
 - Edit Patient's Phone;
 - Edit Patient's E-mail;
 - Edit Patient's Address.

- Edit Family Background Information:
 - Edit Mother's Date of Birth;
 - Edit Mother's Date of Death;
 - Edit Mother's Birth Place;
 - Edit Mother's Number of Pregnancies;
 - Edit Mother's Bone Dysplasia;
 - Edit Mother's Stature;
 - Edit Mother's Number of Miscarriages;
 - Edit Father's Date of Birth;
 - Edit Father's Date of Death;
 - Edit Father's Birth Place;
 - Edit Father's Bone Dysplasia;
 - Edit Father's Stature;
 - Edit Number of Brothers;
 - Edit Number of Brothers with Bone Dysplasias;
 - Edit Number of Brothers Alive;
 - Edit Number of Sisters;
 - Edit Number of Sisters with Bone Dysplasias;
 - Edit Number of Sisters Alive;
 - Edit Number of Other Relatives with Bone Dysplasias;
 - Edit Number of Brothers with Other Relatives Kinship;
 - Edit Family Background Observations.

- Edit Radiology – Bone Abnormalities Information:
 - Edit Patient’s Bone Age;
 - Edit Patient’s Bone Density;
 - Edit Patient’s General Bone Alterations;
 - Edit Skull’s Alterations;
 - Edit Clavicle’s Alterations;
 - Edit Blades’ Alterations;
 - Edit Hip’s Alterations;
 - Edit Ribs’ Alterations;
 - Edit Spine’s Alterations;
 - Edit Pelvis’ Alterations;
 - Edit Hip’s Alterations;
 - Edit Arm’s Alterations;
 - Edit Forearm’s Alterations;
 - Edit Hands’ Alterations;
 - Edit Thigh’s Alterations;
 - Edit Legs’ Alterations;
 - Edit Feet’s Alterations.

- Edit Dismorphisms Information:
 - Edit Skull’s Dismorphisms;
 - Edit Face’s Dismorphisms;
 - Edit Eyes, Eyelashes and Eyebrows’s Dismorphisms;
 - Edit Nose’s Dismorphisms;
 - Edit Mouth and Teeth’s Dismorphisms;
 - Edit Jaw’s Dismorphisms;
 - Edit Neck’s Dismorphisms;
 - Edit Thorax’s Dismorphisms;
 - Insert Abdomen’s Dismorphisms;
 - Edit Back’s Dismorphisms;
 - Edit Lower Limbs’s Dismorphisms;
 - Edit Upper Limbs’s Dismorphisms;

- Edit Skin, Nails and Hair's Dismorphims;
 - Edit Joints' Dismorphims;
 - Edit Genitals' Dismorphims;
 - Edit Dismorphims' Observations.
- Edit Somatometry Information:
 - Edit Patient's Height;
 - Edit Patient's Weight;
 - Edit Patient's Occipitofrontal Circunference;
 - Edit Patient's Height Centil;
 - Edit Patient's Weight Centil;
 - Edit Patient's Occipitofrontal Circunference Centil;
 - Edit Patient's Upper Segment Measure;
 - Edit Patient's Lower Segment Measure;
 - Edit Patient's Occipitofrontal Circunference;
 - Edit Patient's Span;
 - Edit Upper-to-Lower Ratio.
- Edit Phenotype Information:
 - Edit if Patient has Learning Disabilities;
 - Edit if Patient's Learning Disabilities are Proportional;
 - Edit if Patient has Visual Impairment;
 - Edit if Patient has Hearing Impairment;
 - Edit if Patient has Abnormal Voice;
 - Edit Abnormal Voice Observations.
- Edit Pregnancies Information:
 - Edit Number of Pregnancies;
 - Edit Number of Miscarriages;
 - Edit the Type of Pregnancy;
 - Edit Mother Background.

- Edit Sonographic Findings Information:
 - Edit if is detected ACIU;
 - Edit the appearance of the LA;
 - Edit Fetal Movements' Characteristics;
 - Edit Nuchal Translucency's Characteristics;
 - Edit Skull and Face's Characteristics;
 - Edit the System of Organs Affected;
 - Edit Sonographic Findings' Observations.

- Edit Studies Information:
 - Edit if were made Molecular Studies;
 - Edit Molecular Studies' Result;
 - Edit Molecular Studies' Lab;
 - Edit if were made Cytogenetic Studies;
 - Edit Cytogenetic Studies' Result;
 - Edit Cytogenetic Studies' Lab;
 - Edit if were made Metabolic Studies;
 - Edit Metabolic Studies' Result;
 - Edit Metabolic Studies' Lab;
 - Edit if were made Immunohistology Studies;
 - Edit Immunohistology Studies' Result;
 - Edit Immunohistology Studies' Lab;
 - Edit if were made Necropsy Studies;
 - Edit Necropsy Studies' Result;
 - Edit Necropsy Studies' Lab;
 - Edit if were made Other Studies;
 - Edit Other Studies' Result;
 - Edit Other Studies' Lab.

- Edit Therapeutics Information:
 - Edit The Therapeutic Type;
 - Edit Therapeutic Observations.

- Edit Complementar Alterations by Organs and Systems Information;
 - Edit Alterations caused by Neurological System;
 - Edit Alterations caused by Cardiovascular System;
 - Edit Alterations caused by Ophthalmologic System;
 - Edit Alterations caused by Otorhinolaryngological System;
 - Edit Alterations caused by Respiratory System;
 - Edit Alterations caused by Gastrointestinal System;
 - Edit Alterations caused by Nephrologic System;
 - Edit Alterations caused by Genital System;
 - Edit Alterations caused by Hematologic System;
 - Edit Alterations caused by Immunologic System;
 - Edit Alterations caused by Joints System;

- Edit and stored Clinical Images and Photos information;
 - Substitute the existent image file;
 - Edit if the image Type;
 - Edit the Image Observations;
 - Edit Image characteristics, as brightness and contrast.

- Remove a registered Patient;
 - Remove from the database all the information of the patient chosen.

- Search for Patients' Information:
 - Receive the information inserted and return the search result. The user chooses the selection criteria.

- Show Patient's data in a page named "Patient File";

- Export Patient's Information to several formats (PDF, XLS).
 - Create a PDF or XLS file with the information of the Patient.

V. Contact Doctors by sending an e-mail message

One of the goals of the SDIS application was to facilitate the communication between Medical Specialists, so they could share their knowledge and help each other with their cases.

In order to accomplish that goal, Doctor's page must have an option that allows sending an e-mail message to that Doctor. When the "Send e-mail" button is pressed, an e-mail form is opened, so that the message can be created.

VI. Edit and Show My Account's Information

- Edit My Account:
 - Edit Name;
 - Edit Username;
 - Edit Password.

- Show My Account's data in a page named "My Account".

5.1.2 NON-FUNCTIONAL/ QUALITY REQUIREMENTS

The requirements of this type allow controlling the quality of the Software developed [16].

I. Security Requirements

The confidentiality of the stored data must be preserved. To guarantee this confidentiality in the data transaction between the Client and the Server, the information must be encrypted. The information stored in the database must be encrypted too.

There must be an authentication system in this application. Only registered users will be able to login to the application and use its functionalities.

II. Software Quality Attributes

The application will be developed in English in order to provide a wider usage.

As the users aren't people accustomed to use computer technologies, the interface must be simple, intuitive, with a pleasant visual appearance that motivates them to use it.

The use of text input must be minimized. To achieve that goal, many fields will make use of combo boxes with predefined default values.

5.1.3 HARDWARE REQUIREMENTS

Besides having Software Requirements, the application also presents some Hardware Requirements.

This system will need a central server to support the database and the Web server, and workstations to present the interface [16].

In an initial phase, the server specifications are not relevant because it will only support a small number of users with a very low number of patients [42].

In the future however, the scenario might be different, with a larger number of users and patients. To respond to the needs of that scenario, the server may need to be equipped with enough computing power. If needed it is enough to use a more powerful machine, as the application has no specific hardware dependence.

The server should also have a high-speed Internet connection [16].

5.2 SYSTEM FEATURES

According to the Software Requirements, is possible to list a set of features that the application must have.

This information is summarized next:

1. Research Group information management:
 - 1.1. Register new Research Group;
 - 1.2. Edit an existent Research Group data;
 - 1.3. Remove a registered Research Group;
 - 1.4. Search for Research Groups' information.
 - 1.5. Show Research Groups' Data in a page named "Research Group".

2. Group Director information management:
 - 2.1. Register new Group Director;
 - 2.2. Edit an existent Group Director data;
 - 2.3. Search for Group Directors' information.
 - 2.4. Show Group Directors' Data in a page named "Group Director".

3. Doctor information management:
 - 3.1. Register new Doctor;
 - 3.2. Edit an existent Doctor data;
 - 3.3. Search for Doctors' information.
 - 3.4. Show Doctor's Data in a page named "Doctor".

4. Patient information management:
 - 4.1. Register new Patient:
 - 4.1.1. Add General Information;
 - 4.1.2. Add Personal Information;
 - 4.1.3. Add Family Background Information;
 - 4.1.4. Add Radiology – Bone Abnormalities Information;
 - 4.1.5. Add Dismorphisms Information;
 - 4.1.6. Add Somatometry Information;

- 4.1.7. Add Phenotype Information;
- 4.1.8. Add Pregnancies Information;
- 4.1.9. Add Sonographic Findings Information;
- 4.1.10. Add Studies Information;
- 4.1.11. Add Therapeutics Information;
- 4.1.12. Add Complementar Alterations by Organs and Systems Information;
- 4.1.13. Upload and store Clinical Images;
- 4.1.14. Upload and store Photos.

4.2. Edit an existent Patient data;

- 4.2.1. Edit General Information;
- 4.2.2. Edit Personal Information;
- 4.2.3. Edit Family Background Information;
- 4.2.4. Edit Radiology – Bone Abnormalities Information;
- 4.2.5. Edit Dismorphisms Information;
- 4.2.6. Edit Somatometry Information;
- 4.2.7. Edit Phenotype Information;
- 4.2.8. Edit Pregnancies Information;
- 4.2.9. Edit Sonographic Findings Information;
- 4.2.10. Edit Studies Information;
- 4.2.11. Edit Therapeutics Information;
- 4.2.12. Edit Complementar Alterations by Organs and Systems Information.

4.3. Remove a registered Patient;

4.4. Search for Patients' Information.

4.5. Export Patient's Information to several formats (PDF, XLS).

4.6. Show Patient's Data in a page named "Patient File".

5. Contact a Doctor by sending him an e-mail message.

6. Edit and show My Account's Data.

The three different users of the application have different access permissions to the application functionalities, e.g., they can perform different actions on the application objects. That information is summarized in the table below.

Table 1: Summary of the permissions of access to the application functionalities.

USER/OBJECT	RESEARCH GROUP	GROUP DIRECTOR	DOCTOR	PATIENT
ADMINISTRATOR	1.1, 1.2, 1.3, 1.4, 1.5	2.1, 2.2, 2.3, 2.4	-	-
GROUP DIRECTOR	1.4	2.4	3.1, 3.2, 3.3, 3.4	4.2.1, 4.4, 4.6 ¹
DOCTOR	1.4	2.4	3.4, 5	4.1, 4.2, 4.3, 4.4, 4.5, 4.6

¹ GD can only edit the Doctor field.

5.3 SOFTWARE IMPLEMENTATION

After analysing the application requirements, we concluded that it would be advantageous to develop a Web application.

Clients from other Research Centers, whose available hardware resources is an unknown factor in the context of this project, will use the application. By developing a Web application, problems related to Software compatibility can be avoided, as only a standard browser is needed.

Moreover, considering the strong growth of the mobile platforms market, it is advantageous that the application can run on mobile devices, like Tablets and Smartphones, especially without the need of developing a specific application for that.

Although there was no previous experience in Web application developing, some skills related to databases were already acquired.

The tools used by the students in the first development attempt are the following:

- **Server database:** MySQL
- **Development language:** PHP
- **Database Management Tool:** phpMyAdmin
- **Web Server:** Apache
- **Development Environment:** Netbeans

There was no documentation explaining why these technologies were chosen over other possible ones. However, these were a starting point on the choice of the tools used in this project.

Next, the chosen tools and technologies to develop the Web application will be presented.

I. DATABASE SERVER

In its website, MySQL is presented as “the world’s most popular open source database” [17].

Many advantages were founded in the research process of the best DBMS to use in this project [17, 18, 19, 20, 21, 22, 23]. These are:

- Easy to use;
- High reliability;
- High performance;
- High stability;
- Open source Software – GPL licence;
- High portability and compatibility, working on the most popular Operative Systems;
- Requires little hardware resources;
- Has many stored procedures and functions;
- Multi-task and multiusers.

The use of this DBMS is very common in the development of dynamic Web pages, being used by entities like NASA, HP, Nokia, Sony, Flickr and Facebook. Due to this, there is a lot of available information and documentation [18].

The fact that Dreamweaver can be connected directly with this database server was a decisive factor on its choice.

Since there was no previous experience in working with MySQL, this was a good opportunity to acquire a new skill.

I. DATABASE MANAGEMENT TOOL

Due to the fact that MySQL interface isn't very user-friendly, phpMyadmin was used to manage the database. This is a free Software tool, written in PHP, which facilitates database management, development and administration [24, 25].

II. WEB SERVER

The Apache HTTP Server was chosen to be used as the application Web Server [26].

III. DEVELOPMENT LANGUAGE

PHP is a high-level language designed for Web, which is easy to program and has a similar syntax to C and Java. It is a free tool, easy to install and configure and with a high portability [27, 28].

IV. INTEGRATED DEVELOPMENT ENVIRONMENT (IDE)

Dreamweaver CS5 was the used IDE. This is the only available IDE with a visual edition, and that was the main reason for the choice [29, 30].

V. CLIENT OF THE APPLICATION

In theory, all the current browsers may be used to run the application [18]. The Software tests were made using Safari version 5.1.7 and Google Chrome version 20.0.1132.47.

Nowadays, it is possible to find distribution packages that contain all of the needed tools.

In this project, we used XAMPP version 1.7.3 containing Apache version 2.2.14, MySQL version 5.1.41, PHP version 5.3.1, and phpMyAdmin version 3.2.4 [31].

CHAPTER 6. CONCLUSIONS AND FUTURE WORK

6.1 CONCLUSIONS

The work developed on the project allowed the acquisition of several new technical skills:

- Concepts of Software Projects Management;
- Concepts of Web Application Development;
- Development of MySQL Databases;
- Paper Prototyping implementation;
- Software Testing;
- Implementation of CSS;
- HTML Programming;
- PHP Programming.

It is important to refer that my autonomy, organization and responsibility skills were also improved, in order to complete tasks and accomplish the project's objectives.

We also learned that, sometimes, it is better to start a task from scratch, even with the risk of sacrificing some of the objectives to achieve a good

solution. Even when we work alone, is important to have a critical mind and a realistic point-of-view of the problems in order to be able to find the best solution at each step.

The client must always be heard with attention and, in this particular context, there must be an effort of the developer to speak "their language", so that both parts can communicate as best as possible. Sometimes, the resources available are not the ideal ones, but we must learn to work with what we have.

6.2 FUTURE WORK

According to what has been presented in the previous chapters, we believe that the major objectives have been accomplished.

However, there are some functionalities that weren't included in the available time. Thus, after the end of the project, we will continue the work, with the following tasks:

- Encrypt the information transaction between the client and the Server;
- Add the functionality of editing of Medical Images;
- Create a forum where Doctors using SDIS can discuss patients' diagnosis and treatments, and its integration with the application.

CHAPTER 7. REFERENCES

- [1] Aula de Anatomia: Sistema Ósseo:
<http://www.auladeanatomia.com/osteologia/generalidades.htm#periosteo>
viewed between March and July of 2012
- [2] Pockock, G., & Richards, C. D. *Fisiologia Humana: A Base da Medicina* (2nd ed.). Guanabara Koogan, 2006, 241-262.
- [3] Bone Malformation/Deformity:
http://www.proz.com/kudoz/spanish_to_english/medical_general/4217780-dismorfia_ósea.html viewed between March and July of 2012
- [4] Warman, M. L., Cormier-Daire, V., Hall, C., Krakow, D., LeMerrer, M., Mortier, G., et al. (Dec de 2010). Nosology and Classification of Genetic Disorders. *AM J Med Part A* , 943,944,967,968.
- [5] Chen, H. (s.d.). *Skeletal Dysplasia Clinical Presentation*. viewed at 22 de March of 2012, in Medscape: <http://emedicine.medscape.com/article/943343-clinical>
- [6] What is Bone Age?: <http://www.bonexpert.com/what-is-bone-age> viewed between March and July of 2012

[7] Bone Densitometry: <http://courses.washington.edu/bonephys/opbmd.html> viewed between March and July of 2012

[8] Bone Mineral Density: <http://www.webmd.com/osteoporosis/bone-mineral-density-test> viewed between March and July of 2012

[9] Definition of Somatometry in Medical Dictionary:
<http://medical-dictionary.thefreedictionary.com/somatometry> viewed between March and July of 2012

[10] Genotype and Phenotype:
<http://www.brooklyn.cuny.edu/bc/ahp/BioInfo/GP/Definition.html> viewed between March and July of 2012

[11] Pedroso de Lima, J., Fundamentos de Imagem para Diagnóstico e Terapêutica, Engenharia Biomédica, 2009/2010

[12] Hard Constraints:
<http://vismod.media.mit.edu/tech-reports/TR-451/node5.html> viewed between March and July of 2012

[13] Soft Constraints:
<http://www.constraintsolving.com/tutorials/soft-constraints-tutorial> viewed between March and July of 2012

[14] Client/Server Architecture:
http://www.webopedia.com/TERM/C/client_server_architecture.html viewed between March and July of 2012

[15] Waterfall Model: <http://www.waterfall-model.com/> viewed between March and July of 2012

[16] Henriques, J., Pinto, A., Ramos, V., Marcos D., Requirements Specification, April, 2011

[17] MySQL: The World's Most Popular Open Source Database:

<http://www.mysql.com/>

viewed between March and July of 2012

[18] Introdução ao Desenvolvimento de Aplicações Web Dinâmicas:

<http://www.georgemendonca.com.br/middlecore-introducao-ao-desenvolvimento-de-a>

viewed between March and July of 2012

[19] Licenças BSD e GPL: uma breve comparação:

<http://unixmania.blogspot.pt/2007/04/licenas-bsd-e-gpl-uma-breve-comparao.html> viewed between March and July of 2012

[20] Comparação entre SGBDs:

http://www.inf.unioeste.br/~clodis/BDI/BDI_2007_Modulo7.pdf viewed between March and July of 2012

[21] Comparison of Oracle, MySQL and Postgres DBMS:

http://dcdapp11.cern.ch:8080/dcdb/archive/ttraczyk/db_compare/db_compare.html

viewed between March and July of 2012

[22] PostgreSQL vs MySQL: Which is better?:

<http://www.databasejournal.com/features/postgresql/article.php/3288951/PostgreSQL-vs-MySQL-Which-is-better.htm> viewed between March and July of 2012

[23] ABNEXO: Banco de Dados MySQL:

http://www.abnexo.com.br/banco_dados_mysql.php viewed between March and July of 2012

[24] phpMyAdmin: http://www.phpmyadmin.net/home_page/index.php
viewed between March and July of 2012

[25] Top 10 MySQL GUI Tools:
<http://www.databasejournal.com/features/mysql/article.php/3880961/Top-10-MySQL-GUI-Tools.htm> viewed between March and July of 2012

[26] The Apache HTTP Server Project: <http://httpd.apache.org/>
viewed between March and July of 2012

[27] Serrão, C., & Marques, J. *Programação com 3, 5.3* (2nd Edition ed.). FCA - Editora de Informática, 978-972-722-341-1, 2009.

[28] PHP: Hypertext Preprocessor : <http://au.php.net/> viewed between March and July of 2012

[29] Vantagens do uso de Dreamweaver:
<http://forum.imasters.com.br/topic/279861-vantagens-do-uso-do-dreamweaver/>
viewed between March and July of 2012

[30] Dreamweaver: <http://www.comofazerumsite.com/dreamweaver/index.html>
viewed between March and July of 2012

[31] XAMPP 1.7.3: <http://pplware.sapo.pt/windows/Software/xampp-1-7-3/>
viewed between March and July of 2012

Additional References

- [Valade,J., *“PHP for Dummies”*, Wiley Publishing, Inc, 0-7645-4166-8,2004.
- Desenvolvimento de Aplicações Web:
<http://www.rnp.br/newsgen/9710/n5-3.html#ng-a> viewed between March and July of 2012
- Desenvolvimento de Aplicações para a Web:
<http://www.deei.fct.uaig.pt/~floba/daw/> viewed between March and July of 2012
- Incremental and Iterative Software Development:
<http://www.agilecollab.com/incremental-and-iterative-Software-development> viewed between March and July of 2012
- Web Based Software Solution:
<http://www.netsity.com/webbasedapplication.htm> viewed between March and July of 2012
- What is Clinical Informatics?:
<https://clinicalinformatics.stanford.edu/background.html> viewed between March and July of 2012
- Web Based Software Application:
<http://www.netsity.com/webbasedapplication.htm> viewed between March and July of 2012
- What is a application (application Software):
<http://www.webopedia.com/TERM/A/application.html> viewed between March and July of 2012

- What is a Application Software:
<http://www.techopedia.com/definition/4224/application-Software>
viewed between March and July of 2012
- Information System:
<http://www.britannica.com/EBchecked/topic/287895/information-system>
viewed between March and July of 2012
- W3Schoolss Online Web Tutorials:
<http://www.w3schools.com/>viewed between March and July of 2012
- Balsamiq Mockups: <http://www.balsamiq.com/products/mockups> viewed between March and July of 2012

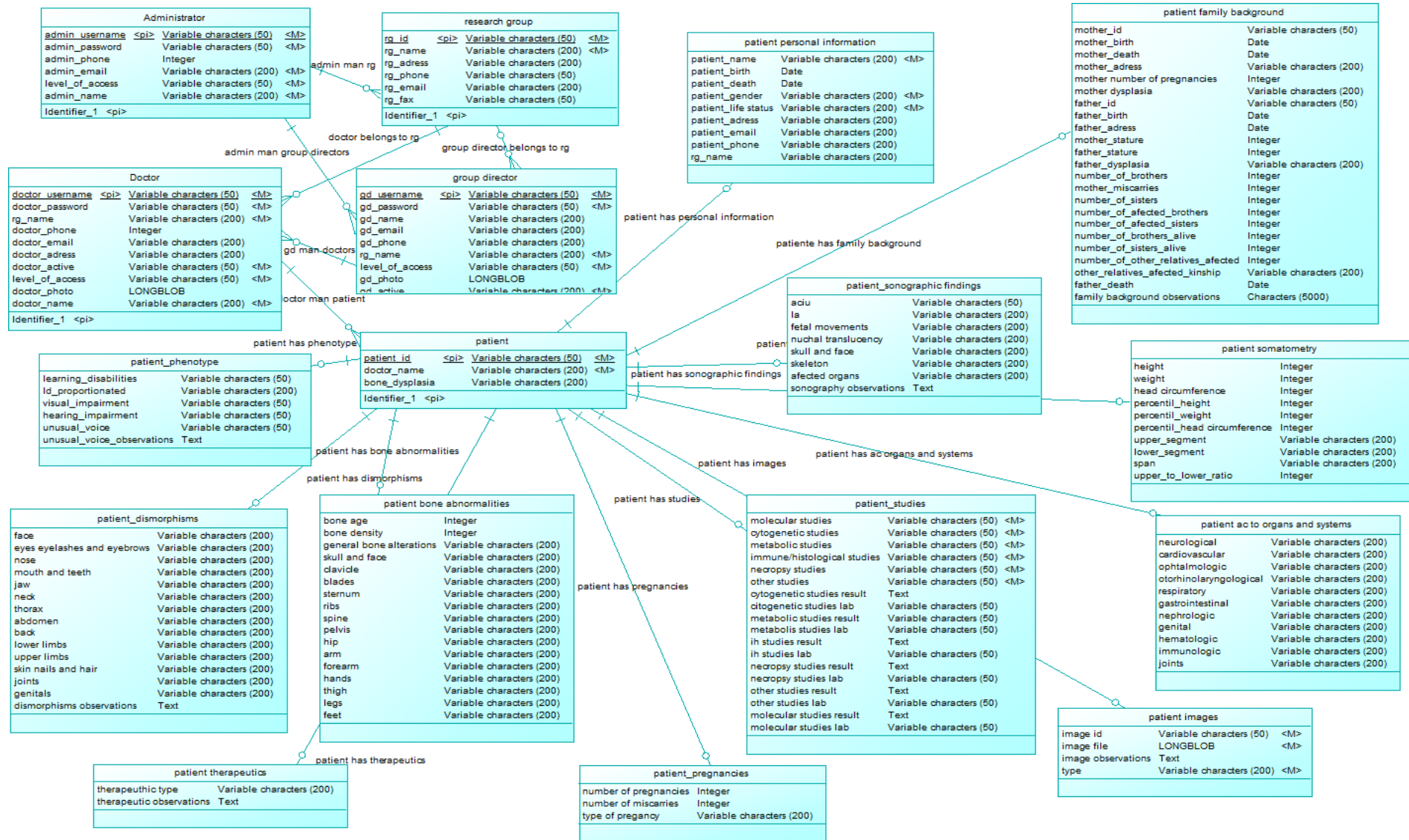
CHAPTER 8. APPENDIXES

8.1 DATABASE DIAGRAMS

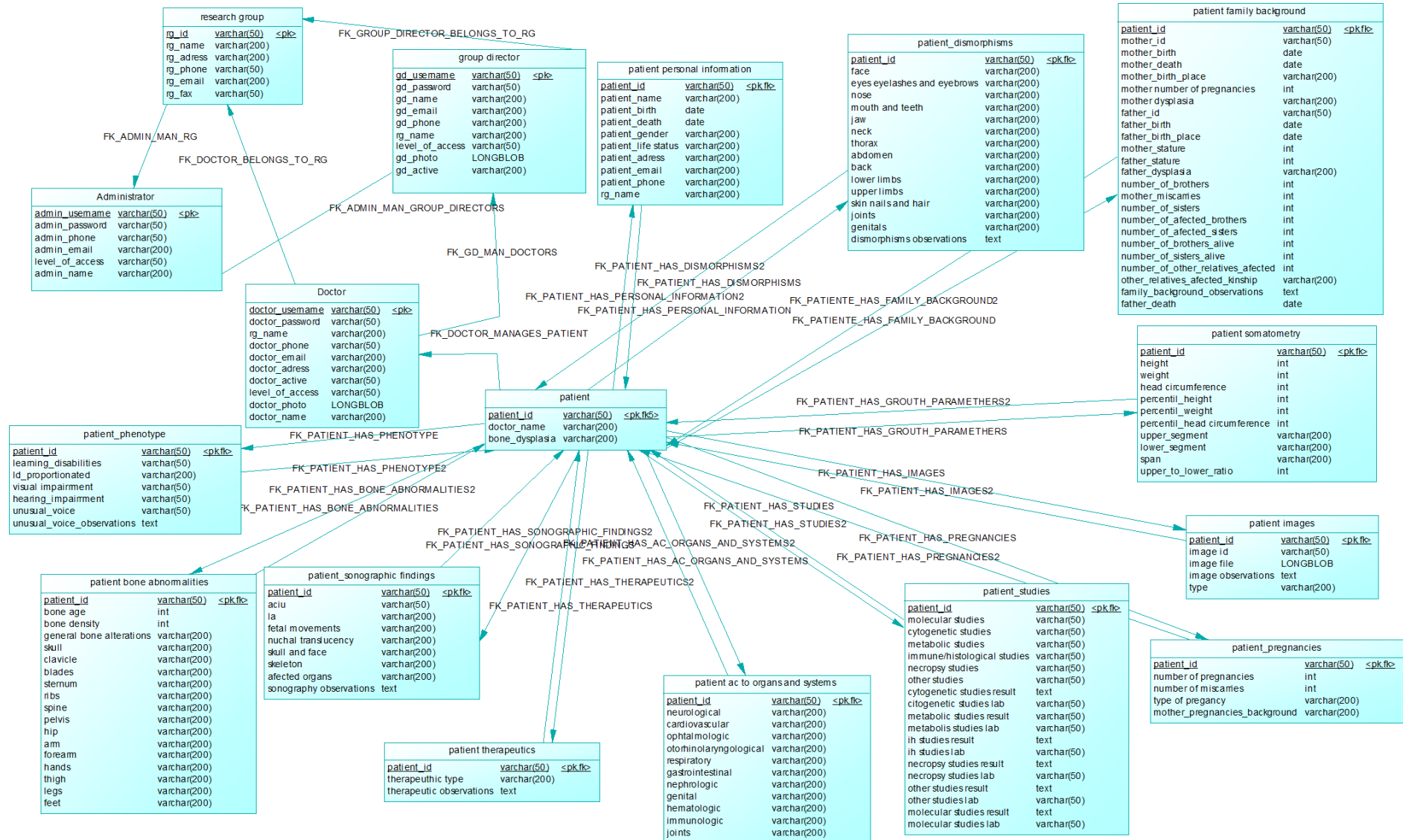
The developed database is organized in seventeen tables with a total of one hundred and seventeen attributes, which of one hundred and forty are Variable Characters type, twenty four are Integers, six are Dates, four are Text type and three are LongBlob variables.

To build the Database Diagrams (ER and Physical) was used Power Designer version 12.5.

8.1.1 ENTITY-RELATION DIAGRAM



8.1.2 PHYSICAL DIAGRAM



8.2 APPLICATION MOCKUPS

In the third phase of the application development, detailed mockups were made.

These mockups can be divided in six categories: Login Page, Main Screen, pages to manage information about the Research Groups, pages to manage information about Group Directors, pages to manage information about Doctors and, finally, pages to manage information about Patients.

Login Page

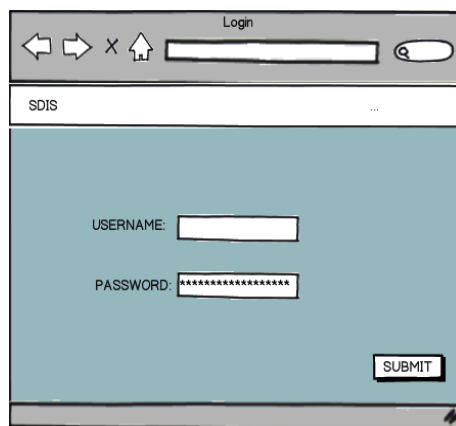


Figure 3: Mockup of the Login Screen.

Main Page

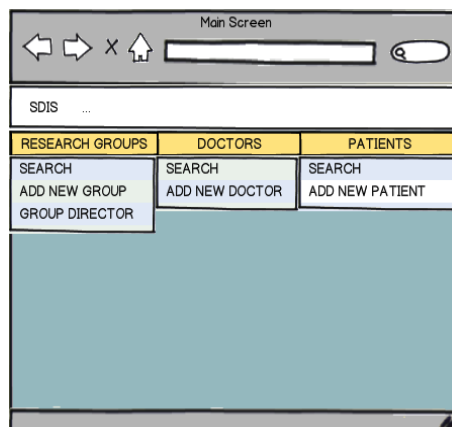


Figure 4: Mockup of the Main Screen including all the possible sub-menus bars.

Pages to manage Research Groups' Information

Research Group

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

ADDRESS:

E-MAIL:

FAX:

PHOTO

4 FEB 2006

EDIT DELETE

(a)

Research Group - Edit

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

ADDRESS:

E-MAIL:

FAX:

PHOTO

Change Picture

4 FEB 2006

SAVE

(b)

Search Group

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

PHONE:

FAX:

NAME:

E-MAIL:

ADDRESS:

SEARCH

(c)

Search Group - New Group

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

PHONE:

FAX:

NAME:

E-MAIL:

ADDRESS:

ADD

(d)

Search Group - Result

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

PHONE:

FAX:

NAME:

E-MAIL:

ADDRESS:

SEARCH

ID	NAME	PHONE	E-MAIL	FAX	ADDRESS

(e)

Figure 5: Mockups of the Research Group's Information Management Pages: (a) Research Group's Page; (b) Research Group - Edit Information Page; (c) Research Group - Search Page; (d) Add New Research Group Page; (e) Search Research Group - Result Page.

Pages to Manage Group Directors' Information

Group Director

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

USERNAME:

E-MAIL:

ACTIVE:

EDIT DELETE

(a)

Group Director - Edit

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

USERNAME:

E-MAIL:

ACTIVE:

Change Picture

SAVE

(b)

Group Director - Search

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

USERNAME:

E-MAIL:

ACTIVE:

SEARCH

(c)

Group Director - Add New

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP:

NAME:

PHONE:

USERNAME:

E-MAIL:

ACTIVE:

Add Picture

SAVE

(d)

Search Group Director - Result

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

ID:

NAME:

PHONE:

USERNAME:

E-MAIL:

ACTIVE:

SEARCH

ID	USERNAME	NAME	E-MAIL	PHONE	ACTIVE

(e)

Figure 6: Mockups of the Group Director's Information Management Pages: (a) Group Director's Page; (b) Group Director - Edit Information Page; (c) Group Director - Search Page; (d) Add New Group Director Page; (e) Search Group Director - Result Page.

Pages to manage Doctors' Information

Doctor

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP:
 NAME:
 PHONE:
 USERNAME:
 E-MAIL:
 ACTIVE:

EDIT DELETE

(a)

Doctor - Edit

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP:
 NAME:
 PHONE:
 USERNAME:
 E-MAIL:
 ACTIVE:

Change Picture

SAVE

(b)

Search Doctor

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP: USERNAME:
 NAME: E-MAIL:
 PHONE: ACTIVE:

SEARCH

(c)

Doctor - Add New

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP:
 NAME:
 PHONE:
 USERNAME:
 E-MAIL:
 ACTIVE:

Add Picture

SAVE

(d)

Search Doctor - Result

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

GROUP: USERNAME:
 NAME: E-MAIL:
 PHONE: ACTIVE:

SEARCH

GROUP	USERNAME	NAME	E-MAIL	PHONE	ACTIVE

(e)

Figure 7: Mockups of the Doctor's Information Management Pages: (a) Doctor's Page; (b) Doctor - Edit Information Page; (c) Doctor - Search Page; (d) Add New Doctor Page; (e) Search Doctor - Result Page.

Pages to manage Patients' Information

The figure shows two side-by-side mockups of a patient information management system. Both pages feature a top navigation bar with 'RESEARCH GROUPS', 'DOCTORS', and 'PATIENTS' tabs. The left page, titled 'Patient - Patient File', includes a search bar and a 'SDIS' dropdown. The right page, titled 'Patient', also has a search bar and 'SDIS' dropdown. The main content is organized into sections: PERSONAL INFORMATION, FAMILY BACKGROUND, SONOGRAPHIC FINDINGS, GROWTH PARAMETERS, STUDIES, THERAPEUTICS, CLINICAL HISTORY, PREGNANCIES, BONE ABNORMALITIES, ADDITIONAL CHANGES TO ORGANS AND SYSTEMS, and IMAGES. Each section contains various input fields, checkboxes, and text areas for data entry. The bottom of each page has a 'SAVE' button, while the left page also has 'DELETE', 'EDIT', 'EXPORT TO EXCEL', and 'SAVE PDF FILE' buttons.

(a)

(b)

Figure 8: Mockups of the Patient's Information Management Pages: (a) Patient's Page; (b) Patient - Edit Information Page.

← → X ↵ Patient - Search

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

PERSONAL INFORMATION

ID: _____ DATE OF BIRTH: _____
 NAME: _____ DATE OF DEATH: _____
 PHONE: _____ GENDER: _____
 E-MAIL: _____ ADDRESS: _____
 DYSPLASIA: _____ LIFE STATUS: _____

FAMILY BACKGROUND

ID: _____ DATE OF BIRTH: _____
 NAME: _____ DATE OF DEATH: _____
 PHONE: _____ GENDER: _____
 E-MAIL: _____ ADDRESS: _____
 DYSPLASIA: _____ LIFE STATUS: _____
 KINSHIP: _____ MOTHER MISCARRIES: _____
 OBSERVATIONS: _____

SONOGRAPHIC FINDINGS

ID: _____ ACIU: _____
 L.A: _____ FETAL MOVEMENTS: _____
 SKULL/FACE: _____ NUCHAL TRANSLUCENCY: _____
 SKELETON: _____ AFFECTED ORGANS: _____
 OBSERVATIONS: _____

GROWTH PARAMETERS

HEIGHT: _____ PERCENTIL: _____
 WEIGHT: _____ PERCENTIL: _____
 HEAD CIRCUMFERENCE: _____ PERCENTIL: _____
 UPPER SEGMENT: _____ LOWER SEGMENT: _____
 SPREAD: _____

STUDIES

MOLECULAR: _____ LAB: _____ RESULT: _____
 CYTOGENIC: _____ LAB: _____ RESULT: _____
 METABOLIC: _____ LAB: _____ RESULT: _____
 IMMUNEMSTOLOGICAL: _____ LAB: _____ RESULT: _____
 NECROPSY: _____ LAB: _____ RESULT: _____
 OTHER: _____ LAB: _____ RESULT: _____

THERAPEUTICS

TYPE: _____
 OBSERVATIONS: _____

CLINICAL HISTORY

DIAGNOSIS: _____
 DESCRIPTION: _____

PREGNANCIES

NUMBER OF PREGNACIES: _____
 NUMBER OF MISCARRIES: _____
 TYPE OF PREGNANCIE: _____

BONE ABNORMALITIES

BONE AGE: _____ BONE DENSITY: _____
 SKULL: _____ BONE ALTERATIONS: _____
 CLAVICLE: _____ BLADES: _____
 STERNUM: _____
 SPINE: _____
 HP: _____
 FOREARM: _____
 THIGH: _____
 FEET: _____

ADDITIONAL CHANGES TO ORGANS AND SYSTEMS

NEUROLOGICAL: _____ OPHTHALMOLOGICAL: _____
 CARDIOVASCULAR: _____ RESPIRATORY: _____
 GASTROINTESTINAL: _____ NEPHROLOGIC: _____
 GENITAL: _____ HEMATOLOGIC: _____
 IMMUNOLOGIC: _____ SKELETAL/JOINTS: _____
 OTORHINCLARYNGOLOGICAL: _____

IMAGES

ID: _____

SEARCH

(a)

← → X ↵ Patient - Add New Patient

SDIS

RESEARCH GROUPS DOCTORS PATIENTS

PERSONAL INFORMATION

ID: _____ DATE OF BIRTH: _____
 NAME: _____ DATE OF DEATH: _____
 PHONE: _____ GENDER: _____
 E-MAIL: _____ ADDRESS: _____
 DYSPLASIA: _____ LIFE STATUS: _____

FAMILY BACKGROUND

ID: _____ DATE OF BIRTH: _____
 NAME: _____ DATE OF DEATH: _____
 PHONE: _____ GENDER: _____
 E-MAIL: _____ ADDRESS: _____
 DYSPLASIA: _____ LIFE STATUS: _____
 KINSHIP: _____ MOTHER MISCARRIES: _____
 OBSERVATIONS: _____

SONOGRAPHIC FINDINGS

ID: _____ ACIU: _____
 L.A: _____ FETAL MOVEMENTS: _____
 SKULL/FACE: _____ NUCHAL TRANSLUCENCY: _____
 SKELETON: _____ AFFECTED ORGANS: _____
 OBSERVATIONS: _____

GROWTH PARAMETERS

HEIGHT: _____ PERCENTIL: _____
 WEIGHT: _____ PERCENTIL: _____
 HEAD CIRCUMFERENCE: _____ PERCENTIL: _____
 UPPER SEGMENT: _____ LOWER SEGMENT: _____
 SPREAD: _____

STUDIES

MOLECULAR: _____ LAB: _____ RESULT: _____
 CYTOGENIC: _____ LAB: _____ RESULT: _____
 METABOLIC: _____ LAB: _____ RESULT: _____
 IMMUNEMSTOLOGICAL: _____ LAB: _____ RESULT: _____
 NECROPSY: _____ LAB: _____ RESULT: _____
 OTHER: _____ LAB: _____ RESULT: _____

THERAPEUTICS

TYPE: _____
 OBSERVATIONS: _____

CLINICAL HISTORY

DIAGNOSIS: _____
 DESCRIPTION: _____

PREGNANCIES

NUMBER OF PREGNACIES: _____
 NUMBER OF MISCARRIES: _____
 TYPE OF PREGNANCIE: _____

BONE ABNORMALITIES

BONE AGE: _____ BONE DENSITY: _____
 SKULL: _____ BONE ALTERATIONS: _____
 CLAVICLE: _____ BLADES: _____
 STERNUM: _____
 SPINE: _____
 HP: _____
 FOREARM: _____
 THIGH: _____
 FEET: _____

ADDITIONAL CHANGES TO ORGANS AND SYSTEMS

NEUROLOGICAL: _____ OPHTHALMOLOGICAL: _____
 CARDIOVASCULAR: _____ RESPIRATORY: _____
 GASTROINTESTINAL: _____ NEPHROLOGIC: _____
 GENITAL: _____ HEMATOLOGIC: _____
 IMMUNOLOGIC: _____ SKELETAL/JOINTS: _____
 OTORHINCLARYNGOLOGICAL: _____

IMAGES

ID: _____

UPLOAD REPORT

UPLOAD FILE

SAVE

(b)

Figure 9: Mockups of the Patient's Information Management Pages: (a) Patient's - Search Page; (b) Add New Patient Page.

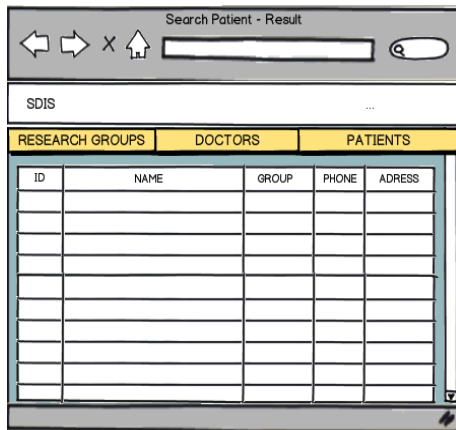


Figure 10: Mockup of the Search Patient - Result Page.

8.3 SOFTWARE TESTS

To evaluate the quality of the developed product, it was necessary to perform a set of tests, specifically designed for SDIS application.

These tests consist, basically, in running the application and searching for Software bugs (errors or others). That set of tests intend to validate/verify if the application:

- Has the components defined on the Design phases;
- Satisfies the requirements that were on the basis of its development;
- Works correctly – each component does what is expected.

8.3.1 TERMINOLOGY

The tests tables contain six columns:

- Test ID: Each test is identified through this field, comprising the number and category of the test.

There are three tests categories according to the user: Administrator (A), Group Director (GD) or Doctor (D).

- Realization Conditions: Indicates the page in which the functionality was tested.

- Inputs: Specifies the tested application fields and the data submitted in each one of them.

- Expected Outputs: Mentions the expected behaviour.

- Result: Indicates if the obtained behaviour was the expected (OK), not the expected (Error) or different from the expected without compromising the analysed functionality (Warn).

8.3.2 SOFTWARE TESTS TABLES

Administrator

Test ID	Tested Functionality	Realization Conditions	Inputs	Expected Outputs	Result
A_1	Choose the user role.	Initial Page	Click on the Administrator Button.	Open Administrator Login Page.	OK
A_2	User Authentication Correct.	Login Page	Insert username and password in their fields and click in "SUBMIT" button.	Open Main Page.	OK
A_3	User Authentication Incorrect.	Login Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return to the Login Page after clicking on OK Button.	OK
A_4	See RG Sub-Menus.	Main Page	Click on "Research Group" option in the horizontal menu bar.	Show the RG Sub-Menus.	OK
A_5	See GD Sub-Menus.	Main Page	Click on "Group Director" option in the horizontal menu bar.	Show the GD Sub-Menus.	OK
A_6	See Search RG Page (presenting a table with all RGs information).	Main Page	Click on "Search" option in the RG Menu.	Open Search RG Page.	OK
A_7	See Add New RG Page.	Main Page	Click on "Add New Group" option in the RG Menu.	Open Add New RG Page.	OK
A_8	See Search GD Page	Main Page	Click on "Search" option in	Open Search GD Page.	OK

	(presenting a table with all GDs information).		the GD Menu.		
A_9	See Add New GD Page.	Main Page	Click on "Add New Group Director" option in the RG Menu.	Open Add New GD Page.	OK
A_10	Filter RG searched information.	Search RG Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the RG(s) that match the query.	OK
A_11	See RG Page.	Search RG Page	Click on the table line of the RG of interest.	Open RG Page with RG name, phone, address, e-mail and fax.	OK
A_12	Filter GD searched information.	Search GD Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the GD(s) that match the query.	OK
A_13	See GD Page.	Search GD Page	Click on the table line of the GD of interest.	Open GD Page with GD name, phone, e-mail, photo, RG and Work Status.	OK
A_14	Add new RG.	Add RG Page	Insert the name, phone, address, e-mail and fax on the fields and click on the "Save" button.	Insert new RG information on the table "research_group" of the Database and returns to the Main Page where is shown the message "New Research Group Added".	OK
A_15	Add new GD.	Add GD Page	Select RG name and GD	Insert new GD information on the	OK

			Work Status., insert GD name, phone and e-mail, select a photo to upload and click on the "Save" button.	table "group_director" of the Database and returns to the Main Page where is shown the message "New Group Director Added".	
A_16	See Edit RG Page.	RG Page	Click on "Edit" button.	Open Edit RG Page.	OK
A_17	Edit RG information.	Edit RG Page	Change the information of one or more fields and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
A_18	See Edit GD Page.	GD Page	Click on "Edit" button.	Open Edit GD Page.	OK
A_19	Edit GD information.	Edit GD Page	Change the information of one or more fields and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
A_20	Delete RG.	RG Page.	Click on the "Remove" button and on the "OK" button of the alert box shown with the message "Are you shore that you want to remove this Research Group?".	Remove RG from de Database and returns to the Main Page where is shown the message "RG Removed"..	OK
A_21	See My Account Page.	All Pages accessed by Administrator.	Click on "My Account" option.	Open My Account Page.	OK
A_22	Edit My Account information.	Edit My Account Page	Change the information of one or more fields (including password) and click on	Update the fields altered on the Database and returns to the Main Page where is shown the	OK

			"Save" button.	message "Alterations Saved".	
A_23	Show an error message if old password is incorrect or new password and confirmation password does not match.	Edit My Account Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return and return to the Edit My Account Page after clicking on OK Button.	OK
A_24	Logout.	All Pages accessed by Administrator.	Click on "Logout" option.	Return to the Initial Page. Delete the data inserted by he user in authentication process.	OK

Group Director

Test ID	Tested Functionality	Realization Conditions	Inputs	Expected Outputs	Result
GD_1	Choose the user role.	Initial Page	Click on the GD Button.	Open GD Login Page.	OK
GD_2	User Authentication Correct.	Login Page	Insert username and password in their fields and click in "SUBMIT" button.	Open Main Page.	OK
GD_3	User Authentication Incorrect.	Login Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return to the Login Page after clicking on OK Button.	OK
GD_4	See RG Sub-Menu.	Main Page	Click on "Research Group" option in the horizontal menu bar.	Show the RG Sub-Menu.	OK
GD_5	See GD Sub-Menu.	Main Page	Click on "Group Director" option in the horizontal menu bar.	Show the GD Sub-Menu.	OK
GD_6	See Doctor Sub-Menus.	Main Page	Click on "Doctor" option in the horizontal menu bar.	Show the Doctor Sub-Menus.	OK
GD_7	See Patient Sub-Menu.	Main Page	Click on "Patient" option in the horizontal menu bar.	Show the Patient Sub-Menu.	OK
GD_8	See Search RG Page (presenting a table with all RGs information).	Main Page	Click on "Search" option in the RG Menu.	Open Search RG Page.	OK
GD_9	See Search GD Page (presenting a table with all GDs information).	Main Page	Click on "Search" option in the GD Menu.	Open Search GD Page.	OK

GD_10	See Search Doctor Page (presenting a table with all Doctors information).	Main Page	Click on "Search" option in the Doctor Menu.	Open Search Doctor Page.	OK
GD_11	See Search Patient Page (presenting a table with all Patients name, identifier and responsible Doctor).	Main Page	Click on "Search" option in the Patient Menu.	Open Search Patient Page.	OK
GD_12	Filter RG searched information.	Search RG Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the RG(s) that match the query.	OK
GD_13	Filter GD searched information.	Search GD Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the GD(s) that match the query.	OK
GD_14	Filter Doctor searched information.	Search Doctor Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the Doctor(s) that match the query.	OK
GD_15	Filter Patient searched information.	Search Patient Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the Patient(s) that match the query.	OK

GD_16	See RG Page.	Search RG Page	Click on the table line of the RG of interest.	Open RG Page with RG name, phone, address, e-mail and fax.	OK
GD_17	See GD Page.	Search GD Page	Click on the table line of the GD of interest.	Open GD Page with GD name, phone, e-mail, photo, RG and Work Status.	OK
GD_18	See Doctor Page.	Search Doctor Page	Click on the table line of the Doctor of interest.	Open Doctor Page with Doctor name, phone, e-mail, photo, RG and Work Status.	OK
GD_19	See Patient Page.	Search Patient Page	Click on the table line of the Patient of interest.	Open Patient Page with his identifier, name and responsible Doctor.	OK
GD_20	See Edit Doctor Page.	Doctor Page	Click on "Edit" button.	Open Edit Doctor Page.	OK
GD_21	See Edit Patient Page.	Search Patient Page	Click on "Edit" button.	Open Edit Patient Page (with only Patient's name, identifier and responsible Doctor).	OK
GD_22	Edit Doctor information.	Edit Doctor Page	Change the information of one or more fields and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
GD_23	Edit Patient Information - Doctor field.	Edit Patient Page (with only Patient's name, identifier and responsible Doctor)	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
GD_24	Add new Doctor.	Add Doctor Page	Select RG name and Doctor Work Status, insert Doctor name, phone and e-mail, select a photo to upload and	Insert new Doctor information on the table "Doctor" of the Database and returns to the Main Page where is shown the message	OK

			click on the "Save" button.	"New Doctor Added".	
GD_25	See My Account Page.	All Pages accessed by Group Director.	Click on "My Account" option.	Open My Account Page.	OK
GD_26	Edit My Account information.	Edit My Account Page	Change the information of one or more fields (including password) and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
GD_27	Show an error message if old password is incorrect or new password and confirmation password does not match.	Edit My Account Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return and return to the Edit My Account Page after clicking on OK Button.	OK
GD_28	Logout.	All Pages accessed by Group Director.	Click on "Logout" option.	Return to the Initial Page. Delete the data inserted by he user in authentication process.	OK

Doctor

Test ID	Tested Functionality	Realization Conditions	Inputs	Expected Outputs	Result
D_1	Choose the user role.	Initial Page	Click on the GD Button.	Open GD Login Page.	OK
D_2	User Authentication Correct.	Login Page	Insert username and password in their fields and click in "SUBMIT" button.	Open Main Page.	OK
D_3	User Authentication Incorrect.	Login Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return to the Login Page after clicking on OK Button.	OK
D_4	See RG Sub-Menu.	Main Page	Click on "Research Group" option in the horizontal menu bar.	Show the RG Sub-Menu.	OK
D_5	See GD Sub-Menu.	Main Page	Click on "Group Director" option in the horizontal menu bar.	Show the GD Sub-Menu.	OK
D_6	See Doctor Sub-Menu.	Main Page	Click on "Doctor" option in the horizontal menu bar.	Show the Doctor Sub-Menu.	OK
D_7	See Patient Sub-Menus.	Main Page	Click on "Patient" option in the horizontal menu bar.	Show the Patient Sub-Menus.	OK
D_8	See Search RG Page (presenting a table with all RGs information).	Main Page	Click on "Search" option in the RG Menu.	Open Search RG Page.	OK
D_9	See Search GD Page (presenting a table with all GDs information).	Main Page	Click on "Search" option in the GD Menu.	Open Search GD Page.	OK

D_10	See Search Doctor Page (presenting a table with all Doctors information).	Main Page	Click on "Search" option in the Doctor Menu.	Open Search Doctor Page.	OK
D_11	See Search Patient Page (presenting a table with the Doctor's Patients name, identifier and).	Main Page	Click on "Search" option in the Patient Menu.	Open Search Patient Page.	OK
D_12	Filter RG searched information.	Search RG Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the RGs that match the query.	OK
D_13	Filter GD searched information.	Search GD Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the GD(s) that match the query.	OK
D_14	Filter Doctor searched information.	Search Doctor Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the Doctor(s) that match the query.	OK
D_15	Filter Patient searched information.	Search Patient Page	Select the attribute to filter information, enter the information in the input field and click on "Search" button.	List on a table the Patients that match the query.	OK

D_16	See RG Page.	Search RG Page	Click on the table line of the RG of interest.	Open RG Page with RG name, phone, address, e-mail and fax.	OK
D_17	See GD Page.	Search GD Page	Click on the table line of the GD of interest.	Open GD Page with GD name, phone, e-mail, photo, RG and Work Status.	OK
D_18	See Doctor Page.	Search Doctor Page	Click on the table line of the Doctor of interest.	Open Doctor Page with Doctor name, phone, e-mail, photo, RG and Work Status.	OK
D_19	See Patient Page.	Search Patient Page	Click on the table line of the Patient of interest.	Open Patient File Page containing General Information, Personal Information, Family Background, Radiology – Bone Abnormalities, Dismorphisms, Somatometry, Phenotype, Pregnancies, Sonographic Findings, Studies, Therapeutics, Complementar Alterations by Organs and Systems and photo.	OK
D_20	See Patient Clinical Images.	Patient File Page	Click on the “View Images” button.	Open Patient Images Page with a table where are listed the Patient Clinical Images.	OK
D_21	See a particular Clinical Image.	Patient Images Page	Click on the table line of the image of interest.	Open the image in a individual window browser.	OK
D_22	See Edit Doctor Page.	Doctor Page	Click on “Edit” button.	Open Edit Doctor Page.	OK
D_25	See Edit Patient General Information Page.	Patient File Page	Click on “Edit” button.	Open Edit Patient General Information Page.	OK
D_26	See Edit Patient Personal	Patient File Page	Click on “Edit” button.	Open Edit Patient Personal	OK

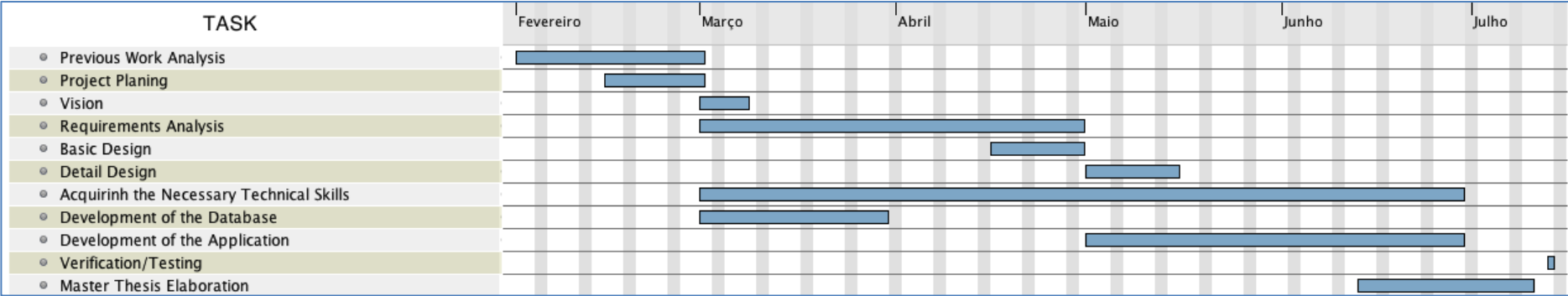
	Information Page.			Information Page.	
D_27	See Edit Patient Family Background Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Family Background Page.	OK
D_28	See Edit Patient Radiology – Bone Abnormalities Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Radiology – Bone Abnormalities Page	OK
D_29	See Edit Patient Dismorphisms Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Dismorphisms Page.	OK
D_30	See Edit Patient Somatometry Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Somatometry Page.	OK
D_31	See Edit Patient Phenotype Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Phenotype.	OK
D_32	See Edit Patient Pregnancies Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Pregnancies Page.	OK
D_33	See Edit Patient Studies Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Studies Page.	OK
D_34	See Edit Patient Therapeutics Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Therapeutics Page.	OK
D_35	See Edit Patient Complementar Alterations by Organs and Systems Page.	Patient File Page	Click on "Edit" button.	Open Edit Patient Complementar Alterations by Organs and Systems Page.	OK
D_36	See Edit Patient Images Page.	Patient Images Page	Click on "Edit" button.	Open Edit Patient Images Page.	OK
D_37	Edit Doctor information.	Edit Doctor Page	Change the information of one or more fields and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_39	Edit Patient General Information.	Edit Patient File Page	Change the information of Doctor field and click on	Update the Doctor field on the Database and returns to the Main	OK

			"Save" button.	Page where is shown the message "Alterations Saved".	
D_40	Edit Patient Personal Information.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_41	Edit Patient Family Background.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_42	Edit Patient Radiology – Bone Abnormalities.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_43	Edit Patient Dismorphisms.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_44	Edit Patient Somatometry.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_45	Edit Patient Phenotype.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_46	Edit Patient Pregnancies.	Edit Patient File Page	Change the information of	Update the Doctor field on the	OK

			Doctor field and click on "Save" button.	Database and returns to the Main Page where is shown the message "Alterations Saved".	
D_47	Edit Patient Studies.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_48	Edit Patient Therapeutics.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_49	Edit Patient Complementary Alterations by Organs and Systems.	Edit Patient File Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_50	Edit Patient Images.	Edit Patient Images Page	Change the information of Doctor field and click on "Save" button.	Update the Doctor field on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_51	Delete Patient.	Patient File Page	Click on the "Remove" button and on the "OK" button of the alert box shown with the message "Are you shore that you want to remove this Patient?".	Remove Patient from de Database and returns to the Main Page where is shown the message "Patient Removed".	OK
D_52	Delete a particular Clinical	Patient Images Page	Click on the "Remove"	Remove image from de Database	OK

	Image.		button and on the "OK" button of the alert box shown with the message "Are you shore that you want to remove this Image?".	and returns to the Main Page where is shown the message "Image Removed".	
D_53	See My Account Page.	All Pages accessed by Group Director.	Click on "My Account" option.	Open My Account Page.	OK
D_54	Edit My Account information.	Edit My Account Page	Change the information of one or more fields (including password) and click on "Save" button.	Update the fields altered on the Database and returns to the Main Page where is shown the message "Alterations Saved".	OK
D_55	Show an error message if old password is incorrect or new password and confirmation password does not match.	Edit My Account Page	Insert username and password in their fields and click in "SUBMIT" button,	Open an Alert box and return and return to the Edit My Account Page after clicking on OK Button.	OK
D_56	Export Patient information to PDF.	Patient File Page	Click on "Save PDF" button.	Create a PDF file with Patients Information.	OK
D_57	Export Patient information to XLS.	Patient File Page	Click on "Save XLS" button.	Create a XLS file with Patients Information.	Error
D_58	Contact a Doctor by e-mail.	Doctor Page	Click on "Send e-mail" button.	Open an e-mail form to write an e-mail message.	OK
D_59	Logout.	All Pages accessed by Doctor	Click on "Logout" option.	Return to the Initial Page. Delete the data inserted by he user in authentication process.	OK

8.4 GANTT DIAGRAM



8.5 USER MANUAL

Administrator

Select User Type

In the Initial Page of the application, the user must choose his level of access. Thus, Administrator must click on the “Administrator” button.

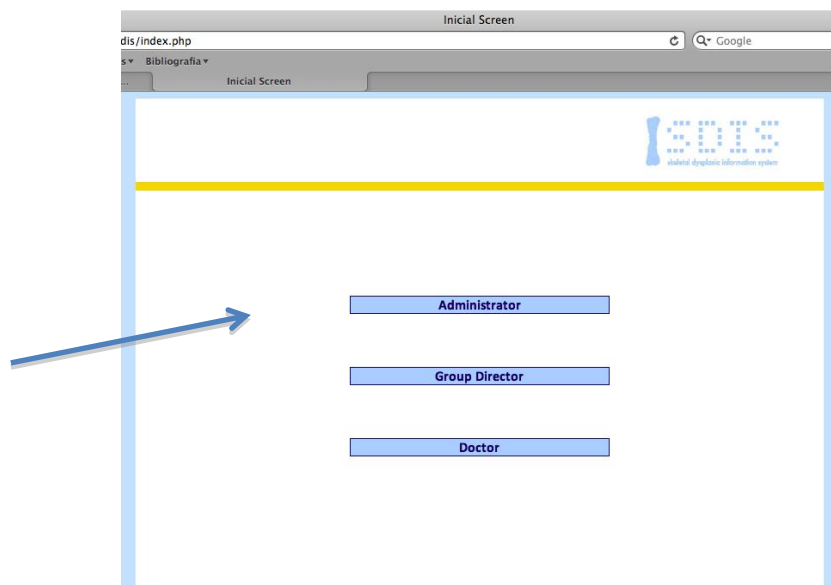


Figure 11: initial Page.

Login

To access the application’s functionalities, it is necessary to do the login. In the Login Page the user Insert his username and password on the “Username” and “Password” fields. After de insertion it is necessary to click on “SUBMIT” button.

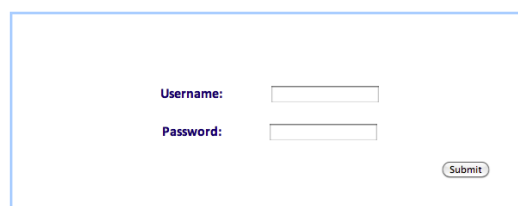
A screenshot of a login form. It contains two input fields: "Username:" and "Password:". To the right of the "Password:" field is a "Submit" button.

Figure 12: User Authentication.

Research Group information management

Register new Research Group

To register a new Research Group in the system, Administrator must select the option “Research Group” of the horizontal menu bar and, then, the option “Add New Research Group”.

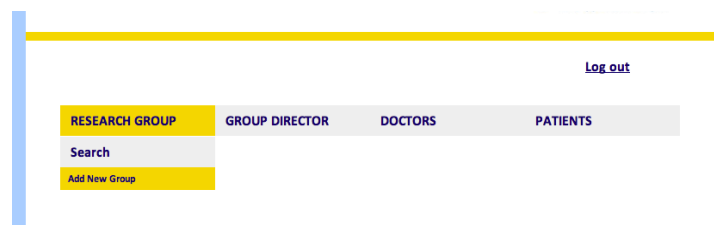


Figure 13: Choose "Add New Research Group" option.

A page is opened with the fields where the information must be inserted.
After insertion, the “SAVE” button must be pressed to save the information.

Search for Research Groups' information

To search Research Group's Information, Administrator must select the option “Research Group” of the horizontal menu bar and, then, the option “Search”.

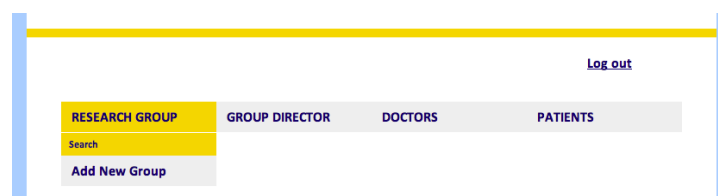


Figure 14: Choose "Search" Research Group option.

The Research Group Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- ID;
- Name;
- Phone;
- E-mail;
- Fax.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and “SEARCH” button must be pressed.

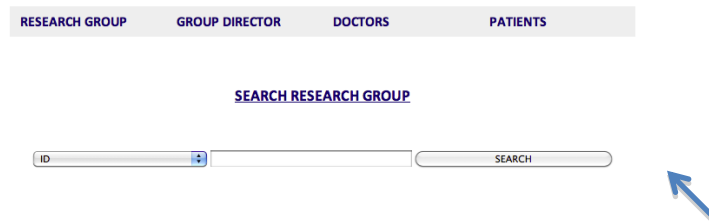


Figure 15: Filter information.

A new table appears on the screen, but has only the information of the Research Groups that matches the query.

To see the page of one particular Research Group, it is necessary to click on the line of the table corresponding to that Research Group.

Edit an existent Research Group data

Once in a Research Group Page, is possible to edit some of its information. To do that, it is only necessary to click on the “EDIT” button.

After that, a page to edit the information is opened. There it is possible to change the saved data. To save the ne data press “SAVE” button.

Remove a registered Research Group

The Research Group Page also has the possibility to remove that Research Group from the System, only by pressing “REMOVE” button.

This action need to be confirmed clicking “OK” in the box opened with the question “Are you sure you want to remove this Research Group?”.

Group Director information management

Register new Group Director

To register a new Group Director in the system, Administrator must select the option “Group Director” of the horizontal menu bar and, then, the option “Add New Group Director”.

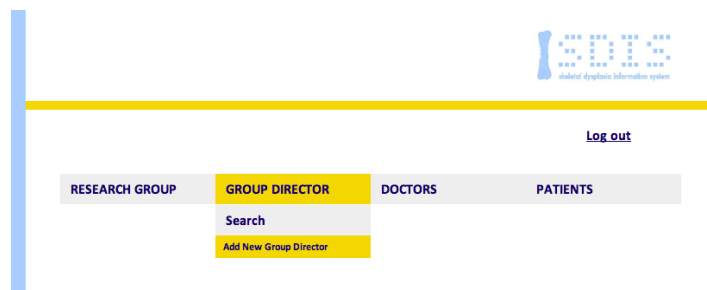


Figure 16: Choose "Add New Group Director" option.

A page is opened with the fields where the information needed must be inserted.

After insertion, the “SAVE” button must be pressed to save the information.

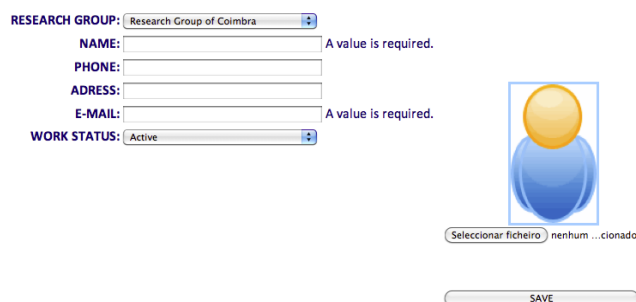


Figure 17: Save Group Director information.

Search for Group Directors' information

To search Group Director's Information, Administrator must select the option "Group Director" of the horizontal menu bar and, then, the option "Search".

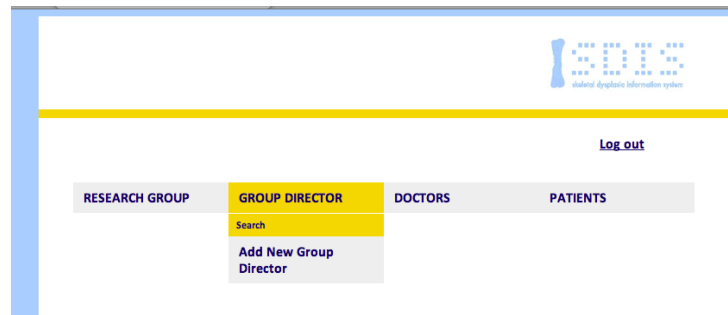


Figure 18: Choose "Search" option.

The Group Director Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- Username;
- Name;
- Phone;
- E-mail;
- Research Group Name.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and "SEARCH" button must be pressed.

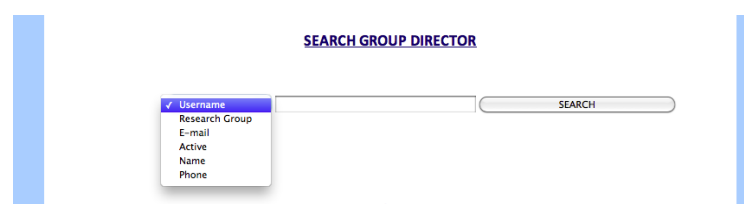


Figure 19: Choose the field to filter de searched information.

A new table appears on the screen, but has only the information of the Group Directors that matches the query.

To see the page of one particular Group Director, it is necessary to click on the line of the table corresponding to that Group Director.

Edit an existent Group Director data

Once in a Group Director Page, is possible to edit some of its information. To do that, it is only necessary to click on the “EDIT” button.

After that, a page to edit the information is opened. There it is possible to change the saved data. To save the new data, press “SAVE” button.

Group Director

Select User Type

In the Initial Page of the application, the user must choose his level of access. Thus, Group Director must click on the “Group Director” button.

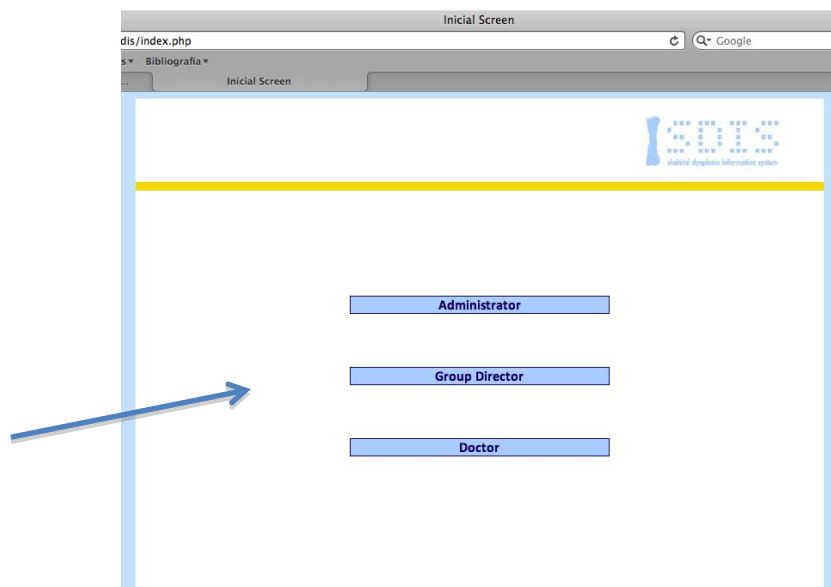


Figure 20: Choose de user role.

Login

To access the application’s functionalities, it is necessary to do the login. In the Login Page the user Insert his username and password on the “Username” and “Password” fields. After de insertion it is necessary to click on “SUBMIT” button.

A screenshot of a login form. It contains two input fields: "Username:" and "Password:". To the right of the "Password:" field is a "Submit" button.

Figure 21: Authentication.

Search for Research Groups' information

To search Research Group's Information, user must select the option "Research Group" of the horizontal menu bar and, then, the option "Search".

The Research Group Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- ID;
- Name;
- Phone;
- E-mail;
- Fax.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and "SEARCH" button must be pressed.

A new table appears on the screen, but has only the information of the Research Groups that matches the query.

To see the page of one particular Research Group, it is necessary to click on the line of the table corresponding to that Research Group.

Search for Group Directors' information

To search Group Director's Information, user must select the option "Group Director" of the horizontal menu bar and, then, the option "Search".

The Group Director Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- Username;
- Name;
- Phone;
- E-mail;
- Research Group Name.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and “SEARCH” button must be pressed.

A new table appears on the screen, but has only the information of the Group Directors that matches the query.

To see the page of one particular Group Director, it is necessary to click on the line of the table corresponding to that Group Director.

Doctor information management

Register new Doctor

To register a new Doctor in the system, Group Director must select the option “Doctor” of the horizontal menu bar and, then, the option “Add New Doctor”.

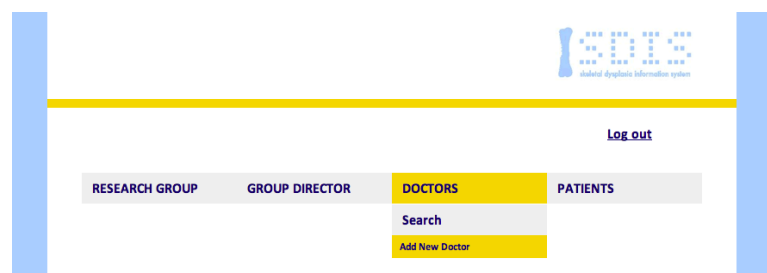


Figure 22: Choose the "Add New Doctor" option.

A page is opened with the fields where the information must be inserted.

After insertion, the “SAVE” button must be pressed to save the information.

RESEARCH GROUP GROUP DIRECTOR DOCTORS PATIENTS

ADD NEW DOCTOR

RESEARCH GROUP:

NAME: A value is required.

PHONE:

ADDRESS:

E-MAIL: A value is required.

WORK STATUS:

Selecionar ficheiro nenhum ...cionado

SAVE

Figure 23: Save Doctor Information.

Search for Doctors' information

To search Doctor's Information, Group Director must select the option “Doctor” of the horizontal menu bar and, then, the option “Search”.

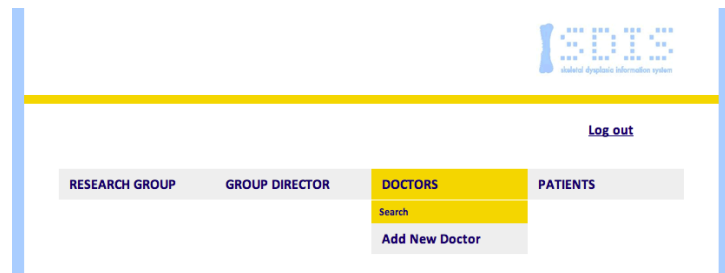


Figure 24: Choose the "Search" Doctor option.

The Doctor Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- Username;
- Name;
- Phone;
- E-mail;
- Work Status;
- Research Group Name.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and “SEARCH” button must be pressed.

A new table appears on the screen, but has only the information of the Doctors that matches the query.

To see the page of one particular Doctor, it is necessary to click on the line of the table corresponding to that Doctor.

Edit an existent Doctor data

Once in a Doctor Page, is possible to edit some of its information. To do that, it is only necessary to click on the “EDIT” button.

After that, a page to edit the information is opened. There it is possible to change the saved data. To save the new data, press “SAVE” button.

Edit an existent Patient Responsible Doctor

When a Doctor leaves the Research Group another Doctor must be responsible for its former patients. Group Director must specify a new doctor to those patients.

To do that, he must select the option “Patient” of the horizontal menu bar and, then, the option “Search”.

The Patient Search Page is opened with a table containing the Name, ID and Doctor Name of all the Patients. That result needs to be filtered by Doctor Name.

A new table appears on the screen, but has only the information of the Patients of that Doctor.

Each Patient File, only containing Patient’s Name, ID and his Doctor Name, must be opened and the Doctor Name field must be edited.

To save the alteration, press “SAVE” button.

Doctor

Select User Type

In the Initial Page of the application, the user must choose his level of access. Thus, Doctor must click on the “Doctor” button.

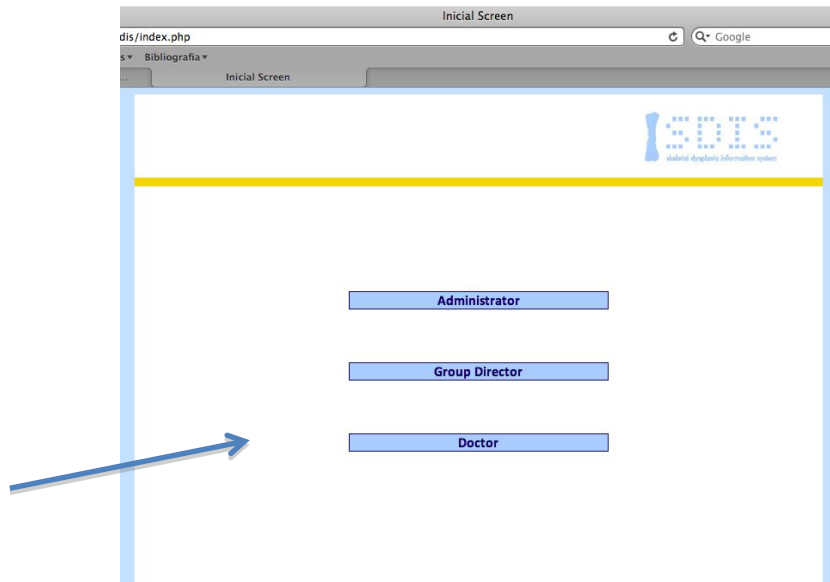


Figure 25: Choose the Doctor role.

Login

To access the application’s functionalities, it is necessary to do the login. In the Login Page the user Insert his username and password on the “Username” and “Password” fields. After de insertion it is necessary to click on “SUBMIT” button.

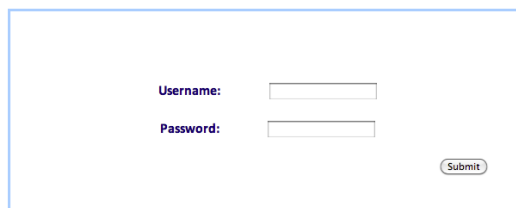
A screenshot of a login form enclosed in a blue border. It contains two input fields: "Username:" and "Password:". To the right of the "Password:" field is a "Submit" button.

Figure 26: Authentication.

Search for Research Groups' information

To search Research Group's Information, user must select the option "Research Group" of the horizontal menu bar and, then, the option "Search".

The Research Group Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- ID;
- Name;
- Phone;
- E-mail;
- Fax.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and "SEARCH" button must be pressed.

A new table appears on the screen, but has only the information of the Research Groups that matches the query.

To see the page of one particular Research Group, it is necessary to click on the line of the table corresponding to that Research Group.

Search for Group Directors' information

To search Group Director's Information, user must select the option "Group Director" of the horizontal menu bar and, then, the option "Search".

The Group Director Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- Username;
- Name;
- Phone;
- E-mail;
- Research Group Name.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and “SEARCH” button must be pressed.

A new table appears on the screen, but has only the information of the Group Directors that matches the query.

To see the page of one particular Group Director, it is necessary to click on the line of the table corresponding to that Group Director.

Search for Doctors' information

To search Doctor's Information, Group Director must select the option "Doctor" of the horizontal menu bar and, then, the option "Search".

The Doctor Search Page is opened with a table containing the information of all the Research Groups in the system, one in each line.

That result can be filtered by:

- Username;
- Name;
- Phone;
- E-mail;
- Work Status;
- Research Group Name.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and "SEARCH" button must be pressed.

A new table appears on the screen, but has only the information of the Doctors that matches the query.

To see the page of one particular Doctor, it is necessary to click on the line of the table corresponding to that Doctor.

Patient information management

Register new Patient

To register a new Patient in the system, Doctor must select the option “Patient” of the horizontal menu bar and, then, the option “Add New Patient”.

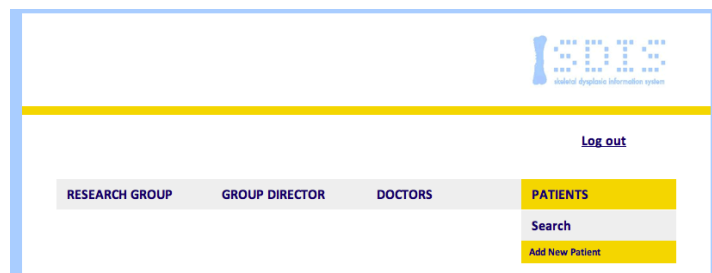


Figure 27: Choose the "Add New Patient" option.

A page is opened with the first of thirteen tabs where the information must be inserted. To move forward in the tabs must press “NEXT” button.

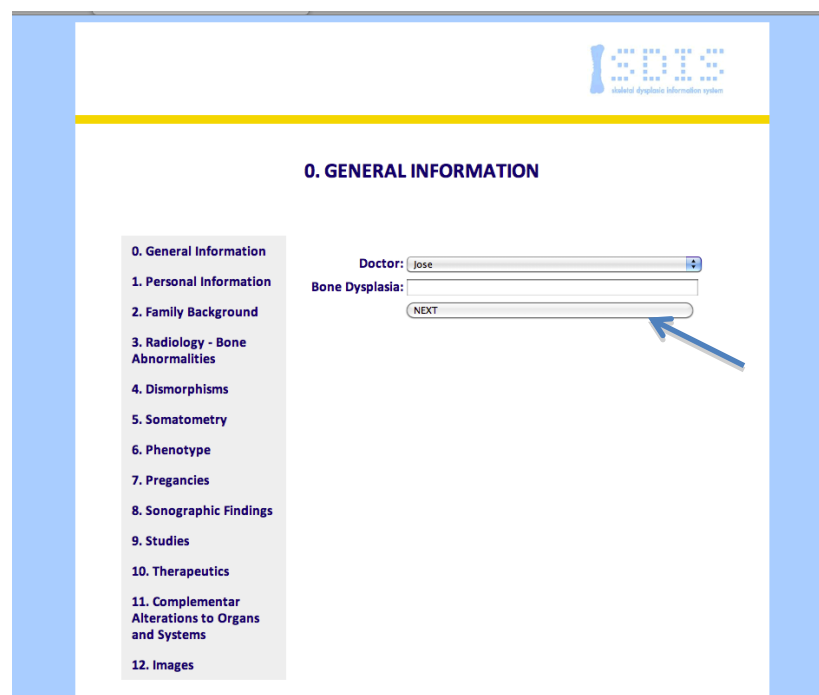


Figure 28: First Screen to add the Patient's Information.

After insertion, the “SAVE” of the last tab button must be pressed to save the information.

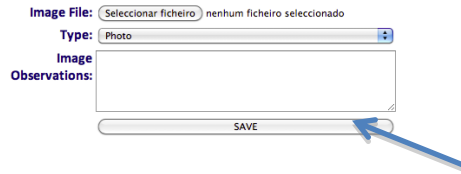


Figure 29: Last screen where the button "SAVE" must be pressed to save the inserted information int the set of the thirteen tabs.

Search for Patients' Information

To search Patient's Information, Doctor must select the option “Patient” of the horizontal menu bar and, then, the option “Search”.

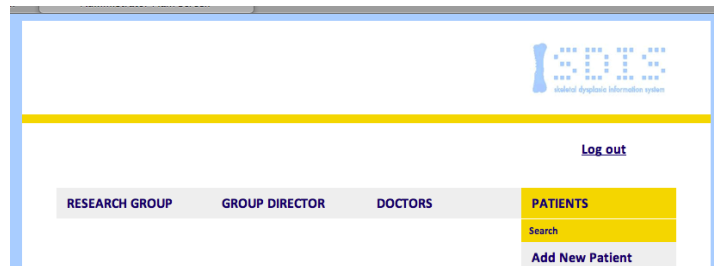


Figure 30: Choose the "Search" Patient option.

The Patient Search Page is opened with a table containing the information of all the Patients of that Doctor already in the system, one in each line.

That result can be filtered by:

- ID;
- Name;
- Gender;
- Life Status;
- Dysplasia;
- Phone;
- E-mail.

That element must be selected on the combo box then, the information corresponding must be inserted in the field on the right of the combo box and “SEARCH” button must be pressed.

A new table appears on the screen, but has only the information of the Patients that matches the query.

To see the page of one particular Patient, it is necessary to click on the line of the table corresponding to that Doctor.

Edit an existent Patient data

Once in a Patient File Page, is possible to edit some of its information. To do that, it is only necessary to click on the “EDIT” button above the boxes containing:

- **General Information;**
- **Personal Information;**
- **Family Background Information;**
- **Radiology – Bone Abnormalities Information;**
- **Dismorphisms Information;**
- **Somatometry Information;**
- **Phenotype Information;**
- **Pregnancies Information;**
- **Sonographic Findings Information;**
- **Studies Information;**
- **Therapeutics Information;**
- **Complementary Alterations by Organs and Systems Information.**

After that, a page to edit each type of information is opened. There it is possible to change the saved data. To save the new data, press "SAVE" button.

Remove a registered Patient

The Patient File Page also has the possibility to remove that Patient from the System, only by pressing "REMOVE" button.

This action need to be confirmed clicking "OK" in the box opened with the question "Are you sure you want to remove this Research Group?".

Export Patient's Information to several formats (PDF, XLS)

Pressing "SAVE AS PDF" or "SAVE AS XLS" allows to export the Patient File Information to the PDF or XLS format.

The directory where that files will be saved must be defined by the user.

Contact a Doctor by sending him an e-mail message

Doctor page has the option "Send e-mail" that open an e-mail form already with that Doctor e-mail address.

Edit and show My Account's Data

To open My Account Page he user must click on the "My Account" option.

Once in a My Account Page, is possible to edit some of its information. To do that, it is only necessary to click on the "EDIT" button.

After that, a page where is possible to change the saved data is opened. To save the new data, press "SAVE" button.