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Systematic Review of Telemedicine Projects in Colombia

Carlos Rey Moreno

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Contents

1 Introduction

Saving the life of another human being is an inherent characteristic of mankind. Since time began, man has helped his fellow man when he was in trouble. Society has progressed from binding the bites of wild animals with herbs and wild plants and we now have a very advanced civilisation which uses state of the art technology to help others, in both immediate aid and in preventative medicine.

Progress in technology and telecommunication has introduced major changes in the way health services are provided. Care can now be delivered directly regardless of distance and time, through what is known as ***'telemedicine'***. This concept refers to a medical discipline where two or more implicated agents, which are geographically apart, communicate. These agents could be a doctor and a patient, a doctor and another doctor, or a doctor, a patient, information and data related to both [50]. Telemedicine, as a praxis which uses information and communication technologies (ICT) to improve health care processes, began many years ago, when NASA tracked astronaut's vital signs by remote control in the 1950's [56].

Deployment of telemedicine systems may be expensive. They require specialised hardware such as robotised microscopes, digital stethoscopes, digitaliser cards or videocameras and related software that allows the user to control them in a friendly way. Many years ago finding these devices was not an easy task, nowadays, through advances in ICT, they have become more popular, making them more accessible.

Despite technological difficulties and some resistance from many patients and professionals to the shift in the traditional paradigm of health attention, telemedicine has been demonstrated to have a great impact on health. It avoids unnecessary journeys for patients to the specialised attention centre, reducing costs and risks associated with movement, not only of patients, but of health care professionals as well. It also diminishes hospitalisation periods, facilitates information exchange

among institutions and promotes continuous capacitation of health care professionals. Furthermore, it contributes to the improvement, in attention and diagnosis, of patients living in isolated and remote places [75].

Within the globalisation process, developing countries are increasingly adopting this technology. In Latin America they are used in an attempt to reduce social inequalities and improve accessibility to the health system for people living in less developed and distant areas [50]. This is because, in Latin America health care professionals are concentrated mainly in urban areas, where all levels of health care assistance are also located. At the same time, geographically isolated areas, where a bigger portion of the vulnerable population is located, are attended by health care professionals who require support and guidance when dealing with difficult cases [76]. Therefore, telemedicine is expected to bring many benefits to the health care system in Latin American countries.

However, telemedicine projects depend greatly on the means and available resources. In many Latin American countries, communications are poorly developed, hindering access to the aforementioned depressed areas. Furthermore, power infrastructure is mainly concentrated on urban areas and the isolated areas seldom have power supply of any kind. In addition to this, ICT penetration and usage is very low, particularly within the health sector, thus, making it very difficult for telemedicine programs to succeed [100].

Within this context, if introducing new technologies in complex health care systems, such as those described above, it is not planned and carried out carefully, the system can deteriorate as a whole, and the outcome will be very far from those stated at the beginning of the project [92]. One of the main causes of the failure of many telemedicine projects occurs when development is centered more on the technology used instead of beneficiary and health care professional needs [92]. As indicated in a report about telemedicine, one faces the paradox of having a technological solution looking for a health problem to solve [31]. Even so, there are very few studies which evaluate telemedicine projects carried out in Latin American countries and even less which evaluate their appropriateness and capacity to solve health care problems in certain areas or regions. These evaluations contribute with real information on how to maximise resources for the projects to succeed, which may help the continuity of similar initiatives.

Therefore, it is important to review all the telemedicine projects carried out until now in Latin America, in order to learn their virtues and failures. This will make future telemedicine projects aware of what difficulties may they find, which outcomes may they expect or whose support they may

count on.

1.1 Problem Formulation

In order to reach a better understanding on telemedicine initiatives in Latin America, this document will be written around the following problem formulation:

Are there successful experiences regarding telemedicine projects in Latin America which are recommended for replication in other areas of the region?

1.2 Document Outline

To answer the problem formulation, this document will be outlined as follows:

This chapter will end with a description of the research design used in this document. Justification of decisions made in order to fulfill the standards for systematic reviews will be given. It will also explain the decisions made for the selection of Colombia, as the country to be analysed in this document.

In Chapter 2, the search and assessment strategy of the systematic review report will be introduced. The search strategy contains a description of the steps taken to review all the telemedicine projects carried out in the selected country, it specifies the exclusion and inclusion criteria of projects, and it indicates the criteria for choosing a key expert who will determine whether a project actually exists. The assessment strategy provides the tools used to categorise the projects: it will describe which indicators are going to be considered important when analysing data found and it will explain a nine-level categorisation which will serve to classify the level of evidence of those data. This will let the reader have an idea of the strategies used when applying them to the next chapter.

Chapter 3 will present the results of the systematic review, showing all the telemedicine initiatives carried out in Colombia. After that, Chapter 4 will present an analysis of the projects, considering the indicators described in the previous chapter, and classifying data regarding them according to the evidence encountered.

In Chapter 5 all the ideas outlined in the previous chapter will be collected and summed up in recommendations for future telemedicine projects carried out in Latin American countries.

Four appendixes has been also added to this document. Appendix A will introduce the context where the telemedicine projects take place. It will describe the health care system of Colombia, it will present its telecommunication infrastructure for developing telemedicine projects and it will identify the laws that regulate telemedicine practice. In addition to this, a reference framework will be presented, defining all the telemedicine terms which will be used along the document. In Appendix **??**, all the interviews with the responsibles of the telemedicine initiatives found will be presented. Appendix C will show the contact information of the people interviewed. Finally in Appendix D, a translation in English of the names of the institutions mentioned in this document is provided.

1.3 Research Design

The project is built around a systematic review design. The Centre of Research and Dissemination (CRD) describes it as a scientific tool which provides information by *"identifying, appraising and summarizing the results of otherwise unmanageable quantities of research"* [18][1]. To do so, systematic reviews focus on the localisation and analysis of conducted studies, sometimes with conflicting findings, to generate objective conclusions based on the evaluation and synthesis of the existing evidence.

For a review to be conducted professionally, the first step should be to establish whether it is required, by searching for historical and ongoing reviews on the same topic [32]. Two studies with a similar purpose were found: [115] and [72]. The first is a study conducted jointly by the International Telecommunication Union (ITU) and the Pan American Health Organization (PHO) published in December 2003. Despite publishing a book and an interactive CD-ROM with very useful information on investment in telecommunications and health, its contents are not related to those stated in the objectives. It lacks detailed information on specific projects and there is no identification of positive or negative practice. Furthermore, as it was published in 2003, most of the information collected will be from at least one year prior to publication, so other telemedicine projects may have been carried out since then. Similarly, the second review identified was conducted in 2001 by the Organismo Andino de Salud (ORAS) jointly with PHO. So, although it contains very useful information and identifies many telemedicine projects carried out in the Andean region, an update of it's contents is needed. This update is important since telecommunication and health techniques have changed greatly in the

[1] Phase 0, p. 4.

last ten years and therefore different recommendations for telemedicine practice may appear when conducting this systematic review.

The quality of a systematic review is directly related to the use of methods which minimise bias. This can be achieved by being *"systematic both in the identification and evaluation of materials, objective in its interpretation and reproducible in the conclusions"* [32][2].

In this document, identification of telemedicine projects will be carried out through an intricate methodology described in Section 2.1. This includes all the steps which will be followed in the process, from the search of relevant articles in specialist journals, to the contact of key experts on the topic for verifying findings. Similarly, evaluation of all materials found will be done systematically. The process will follow a protocol, described in Section 2.2. It will classify materials according to key indicators which will be then measured according to their level of scientific evidence. Thus, both the process of identification and the evaluation carried out in this thesis guarantees a high degree of specification.

Although the majority of indicators are carefully described and the level of scientific evidence in the studies where they are found is categorized in a nine-level table, leading to high objectivity on the decisions made, some factors of subjectivity may appear which I have to be aware of. In professional systematic reviews there are a team of experts in charge of the evaluation of the studies to minimise bias [18], however, in this document all the decisions were made by one reviewer alone. To combat this weakness great effort has been made in the definition of the indicators and evidence levels. Another factor of subjectivity revolves around the qualitative assessment of some projects. When evaluating feasibility and impact of telemedicine projects in developing countries, some factors, such as empowerment, are difficult to measure. Nevertheless they have to be considered since they offer insight into social and emotional changes. According to the CRD, this is not to be considered a weakness, because *"there is a potential from qualitative research to enhance the quality and salience of systematic reviews"* [18][3].

Reproducibility in the conclusions deals with a key concept of research design: reliability. A research is reliable if one follows the same procedures described in this document and always arrives at the same conclusion. Therefore, a very detailed description of the methods, justifying all the decisions made will help to reproduce the conclusions reached in this review. As it was pointed out

[2] p.4

[3] Phase 2, p. 5.

above, both search and assessment strategies are explained in depth in their respective sections. For example, in the search strategy a list of the publications where studies could have been identified has been shown, and search filters used to recall them specified. Furthermore, including and excluding criteria of materials have been enumerated, in order to achieve the goal of replicability: *"minimise errors and biases in a study"* [126][4].

However, according to Lewin, a study *"can be reliable (always generate the same result) but not valid (not measure the intended concept)"* [73][5]. In order to lend validity to answers to the research question, two main concepts have to be taken into account: internal and external validity. Internal validity refers to data analysis of the project and causal relationships need to be established, while external validity refers to generalisation of the results obtained in a study.

In this review a high level of internal validity is needed to support the recommendations made on good and bad practices within telemedicine projects. However, the internal validity of this review is highly related to the one of the assessed studies. Although it is reasonable to establish a causal relationship between positive indicators, such as impact on patient health and telemedicine project intervention, it is impossible for the reviewer to assert whether intervening variables taken into account within each study were all the variables at play. Hence, I acknowledge a certain level of bias on the recommendations since they are based on the internal validity of the retrieved studies. However, this bias has been minimised using different steps. Recommendations for supporting any practice followed in a telemedicine project were made by using the nine-level categorisation according to the level of scientific evidence. Thus, those results which were obtained by means of exhaustive analysis, such as meta-analysis and therefore, with a high degree of internal validity, were given more weight when making recommendations, than for example descriptive studies, which do not allow any recommendation to be made. The other mechanism used to minimise bias was to contact people of the telemedicine project assessed in order to interview them and recall any key information missing from the studies. So, despite a certain bias has to be acknowledged regarding the internal validity of the results obtained through this study, measures have been taken to minimise it.

Since the scope of this review (assessing all the telemedicine projects carried out in Latin America) is very broad, and the time framework to carry out this work is very short, one Latin American country has been selected as model example in order to be able to relate the findings to the rest of the countries.

[4] p. 37.
[5] p 216.

This will be difficult to do since no country is equal to another and neither is a telemedicine project. However, there are some elements such as scarcity of specialists, limited resources, geographical difficulties with internal communications, lack of telecommunication infrastructure in large areas of the country and big inequalities between urban and rural health services, which are common to many Latin American countries [72].

The country selected is Colombia. It has been chosen because since Latin American countries started attending international telemedicine and telehealth in 2001, such as the Annual Meeting of the American Telemedicine Association or the International Conference of the International Society of Telemedicine, Colombia, together with Brazil, has always attended [118]. Brazil was not chosen because the difference in the language would have brought about difficulties when looking for projects. This last decision can also be considered a weakness of the analysis of which I have to be aware of. Furthermore, as stated in [115][6] *"Colombia can be considered without any doubt one of locomotors of telemedicine in the region"*, due to its dynamism at different levels: public, private and academic sectors. Then, although other countries may have more and better projects carried out recently, Colombia has older experiences, which can be analysed once the projects have finished and their outcomes can be assessed, thus providing a bigger number of elements for analysis. Therefore, the recommendations from the review of telemedicine projects carried out in Colombia could be applied to the rest of Latin American countries, ensuring a high degree of external validity.

[6] CD-ROM accompanying the book. In the section General Information in the chapter about Colombia.

2 Methodology

In this chapter both the search and the assessment strategies used in this study are described in detail.

2.1 Search Strategy

The process of retrieving projects is one of the most important phases of this study. In order to use reliable sources, it would be advisable to use only scientific electronic databases, such as LILACS or MEDLINE, which recall articles from indexed journals. However, it is widely known that there is a lack of articles published in developing countries. According to Fisher's World Almanac [124], countries classified as industrialised (those with a high Human Development Index (HDI)[1]) produce 97% of the telemedicine publications and the other countries just 3%. According to the Journal of Telemedicine and Telecare [90], after analysing all the indexed articles in MEDLINE from January 1964 to July 2003, the following comments were noted:

- There is a high level of correlation between the publications per number of inhabitants and the Gross National Product of a country (r=0,69; P=0,0001).
- There is a high level of correlation between the publications per number of inhabitants and the number of Personal Computers per 1000 inhabitants of a country (r=0,73; P=0,0001).
- There is negative correlation between the publications per number of inhabitants and the HDI of a country (r=-0,60; P=0,0001).

[1] http://hdr.undp.org/en/statistics/indices/

- There is a high number of articles (63%) from industrialised English speaking countries (United States of America, United Kingdom and Australia)

Thus, searching for telemedicine projects only in indexed journals from scientific electronic databases may lead to bias in their identification process. It is possible that articles referring to telemedicine projects in Latin America may not have been published in English speaking indexed journals.

Therefore, other non indexed documents, such as articles which are referenced in quoted projects as well as other scientific databases, have been considered to enable a wider search for telemedicine projects. However, as stated in an article in The Economist, *"publishers generally prefer research that has a positive result"* [4][2], so it is likely that many negative experiences have not been published, leading to another bias when highlighting bad practice.

Taking everything into account, it is necessary to look for information somewhere else. It was decided that the World Wide Web (*www*) would be used for this complementary task, after acknowledging all its advantages and disadvantages. On the one hand, many non-indexed journals can be accessed through the *www.* Besides, many institutions use the *www* for the diffusion of information regarding their projects, since it is faster, easier and cheaper. The *www* also offers the possibility of making contact with the authors of the project, which could further the search for accurate information.

On the other hand, there are many irrelevant websites and related articles that have to be reviewed, whilst looking for relevant material, which can then be inadvertently missed. To solve these problems, a search algorithm proposed by Diego Moñino in [37] will be used. Another problem posed by the *www* is the difficulty in contrasting the findings. This would lead to a lack of reliability in the sources, however, this methodology will only be used for identifying the projects. Later in the project, authors will be contacted to verify the information quoted.

The last step is to be sure that the affirmations made in this study are correct, hence, an expert from either the Ministry of Communications or the Minitry of health will be contacted to confirm every hit.

[2] p. 2

2.1.1 Scientific Information Sources

A systematic review of the articles published until May 2008 in international indexed scientific journals specialised in telemedicine has been undertaken. To do this, the following electronic resources have been used:

- **Telemedicine Information Exchange (TIE)**. *"An unbiased and all-inclusive platform for information on telemedicine and telehealth"* [110].
- **MEDLINE**. It is a component of the North American National Library of Medicine, which contains references to more than 17 millions articles published in biomedic journals and newspapers [79].
- **LILACS**. This is a component of the Virtual Library of Health of the PHO. It aims at facilitating the collection, selection, description and indexing of health articles written in Spanish or Portuguese [74].
- **IEEExplore**. This delivers *"full text access to the world's highest quality technical literature in electrical engineering, computer science, and electronics"* [64]. In particular, it is worth mentioning the Journal of Telemedicine and Telecare, the Telemedicine Journal and e-Health and the International Journal of Medical Informatics.
- **Cochrane Library**. This contains high quality, independent evidence from systematic reviews, clinical trials, which informs health care decision makers [22].
- **Current Contents**. This is an electronic database which provides single source key information from journal books and Web literature [34].
- **Cumulative Index of Nursing and Allied Health Literature (CINAHL)**: This is a comprehensive and versatile guide to the literature of nursing and subsequent allied health information [21].
- **CUIDEN**. It includes the scientific production of the iberoamerican nursing specialities [33].

Non indexed documents have been also considered. First of all references found in the consulted articles have been reviewed. Furthermore, key articles have been retrieved using the "related articles"

tool of MEDLINE [79]. The Centre for Reviews and Dissemination (CRD) has also been consulted. The centre *"undertakes high quality systematic reviews that evaluate the effects of health and social care intervention and the delivery and organisation of health care"* [17]. Using the Cochrane Library, the reports of the Iberoamerican Agency of Health Technologies, the list of publications of the Health Technology Assessment (HTA) and the Economic Evaluation Database of National Health Service of the UK (NHS EED), which contains a list of articles about economic evaluation of interventions in health assistance, have been also consulted [22]. The Scientific Electronic Library Online (Scielo) has been also reviewed, the library allows access to the literature of the scientific community of Latin America and the Caribbean [104].

In addition to this, abstracts of the proceedings of the American Telemedicine Association (ATA) [2] and the International Society for Telemedicine (ISFT) [66] have been considered. Finally, articles found on the website of the Royal College of General Practitioners (RCGP) [101] and the Association of Telehealth Service Providers (ATSP) [8] have been reviewed.

2.1.1.1 Search Criteria

In order to search for the articles in the sources indicated above, the following key words and their equivalents in Spanish have been used:

1. Colombia and telemedicine
2. Colombian and telemedicine
3. Colombia and telehealth
4. Colombian and telehealth
5. Colombia and ehealth
6. Colombian and ehealth
7. Colombia and e-health
8. Colombian and e-health

These very broad searching criteria are required because, as previously indicated, there are very few published articles from the developing countries.

2.1.1.2 Inclusion and Exclusion Criteria

Inclusion Criteria: Articles describing telemedicine projects, programmes, and systems installed in Colombia and research activities carried out there.

Type of studies: systematic reviews, large and small sample randomized controlled trials, non-randomized controlled prospective studies, cohort studies, case studies, non-controlled trials and descriptive studies.

In this categorisation meta-analysis and show very good evidence, controlled and small sample randomized controlled trials and nonrandomized controlled prospective studies (multicentric) show good evidence, observational studies (analytic and transversal) show fair evidence, and descriptive studies and non-controlled trials show poor evidence.

Exclusion criteria: Articles that are not written in English or Spanish.

2.1.2 Search Engines

Besides the use of scientific electronic databases, the use of search engines has been considered. The goal is to retrieve useful information about telemedicine projects, programmes and systems not included in specialised journals and websites. Furthermore, this method will be used to retrieve contact information about people related to the telemedicine in each country. Possible contacts are defined as those people related to:

- a whole telemedicine project or programme.
- a project or programme containing telemedicine activities.
- a change in the health management process which uses ICT in an innovative way.
- studies about telemedicine.
- telemedicine education, articles or experiences.

According to an extensive analysis of the different search engines carried out by Moñino in [37], Google was chosen as the engine which has more quality links and documents to offer. However, when using this kind of search engine, the number of references obtained increases because key words offer more flexibility. Therefore, for a faster and more efficient search it is necessary to put the possible combinations in order and proceed from the more restrictive to the more generic.

The list of key words used in this study[3] and its order of use is as follows:

1. “telemedicine in Colombia”
2. “telemedicine project” Colombia site:.org OR site:.co
3. “telemedicine project” Colombia
4. telemedicine project Colombia site:.org OR site:.co
5. telemedicine project Colombia
6. “telemedicine congress” Colombia
7. telemedicine congress Colombia site:.org OR site:.co
8. telemedicine congress Colombia
9. “health minister” telemedicine Colombia site:.co OR site:.gob
10. minister medicine|health telemedicine Colombia site:.co OR site:.gob
11. “health minister” telemedicine Colombia
12. “health minister” Colombia
13. “faculty of medicine” telemedicine Colombia
14. university OR faculty telemedicine Colombia site:.org OR site:.co
15. university OR faculty telemedicine Colombia

When using any combination of these key words the following basic rules will be followed:

- In each consultation a maximum of 10 references will be consulted. When reviewing any of them, it will never go deeper than 4 levels of navigation.
- If in the 4 first references the same information is repeated, without contributing any new telemedicine project or contact, a filter to the reiterative information will be used (In Google using the option “-”)

[3] As the selected country is composed mainly by Spanish speakers, the key words will be the Spanish translation of the indicated ones.

- If after one consultation less than 5 pages are retrieved and from them it is impossible to recall 4 different telemedicine projects or contacts, the next combination of key words will be used.

Once the search process for Colombia has finished, the process of contacting the people relevant to the study begins. Since previous experience with email contacts revealed that many people do not like to spend time answering written surveys, the telephone is the tool used in this study. Therefore, if there is information about a project but there is no reference to the author, then a further search is done.

Each time a new project is added to the list, a new search is carried out by entering its name as key word "and Colombia", and first ten hits are considered. This way a better insight about a project was acquired before carrying out any interview.

When there is reliable information that a contact is related to a telemedicine project, a first phone contact will be established to discard those projects or programs which were never carried out. Once a list of the real telemedicine projects undertaken in a country is created, a second round of calls establishes contact with the author of each project. In this second conversation, deeper project information is requested, including any available evaluation of the project. If, on the other hand, the contact is not directly related to a telemedicine project, information about projects and key people will be requested.

2.1.3 Criteria for Expert Selection

As it has been mentioned an expert from either the Ministry of Communications or from the Ministry of health will be contacted for corroborating the findings. Expert will be selected from contacts provided by people interviewed. The only constrain for his or her election is that he/she can not be related with any of the projects analysed.

2.2 Assessment Strategy

Projects detected through the search strategy described in the previous section will be classified according to the indicators detailed in the next section. After classification, information found will be assessed according to the nine-level categorisation presented in last section of this chapter.

2.2.1 Classification of projects according to indicators

The introduction of telemedicine systems requires precise planning. The impact of that introduction depends greatly on the way it has been carried out. Before introducing a technology it is of paramount importance to carry out feasibility studies in order to assess the needs of the user and thereby deploy the correct and most effective technology to match the requirement. Furthermore, once the project has commenced, it is necessary to obtain measurements of the real effects caused by the introduction of the selected telemedicine system. Both feasibility and impact data of the projects recalled have been retrieved according to the indicators described in the following section. These indicators have been selected from [77], a reference book in Latin America for evaluating telemedicine systems.

2.2.1.1 Feasibility Indicators

Within the projects found, information related to the technical feasibility of the telemedicine system used has been retrieved. This information could be related to the technical effectiveness of the system, and to reliability, shown as security in a system and to ease of use. Furthermore, information related to institutional feasibility when introducing a telemedicine system, shown as acceptance and satisfaction from people involved, has also been recovered. Finally, within the economic feasibility subsection, evidence about economic sustainability of the telemedicine projects selected has been retrieved. Table 2.1 presents a reference of the feasibility indicators considered.

Table 2.1: Feasibility Indicators

Feasibility	Technical	(1) Effectiveness
		(2) Reliability
		(3) Ease of use
	Institutional	(4) Acceptance
	Economic	(5) Sustainability

Technical Feasibility Indicators

(1) Effectiveness. This indicator will show whether technical features of a telemedicine system are enough for providing the health service they are designed to support. Articles or data which include comparisons between data obtained through telemedicine systems and those obtained through "traditional" methods have been recalled. Articles relating to whether or not the quality of the video conference or telephony systems were good enough to allow communication between people or devices involved in the telemedicine activity have also been selected.

(2) Reliability. In this document this term is related to two different variables: robustness and security of the system. The robustness of a system means that the ratio of system breakdown per time unit is low. In this case, in articles or data referring to a number of failures, the mean times (eg. reparation mean time), have been retrieved. Security of the system refers to the avoidance of undesired side effects caused by the use of a telemedicine system, therefore data or articles including results about the security of the system, such as technical barriers to the introduction of impossible data have been also recovered. To consider this indicator evaluated it is necessary to state within the information found that no failure has occurred.

(3) Ease of use. This indicator makes reference to the simplicity of handling the telemedicine system introduced and its adaptation to the daily work in the institutions where it has been deployed. A key factor for improving the ease of use of a system is the design of appropriate initial training courses and follow-up refresher courses to allow the beneficiaries to use the system correctly. Therefore both data related to the user's opinion of the simplicity of using the system and information referring to the training strategies have been considered. The opinion of non-contact managers or supervisors has not been recorded.

Institutional Feasibility Indicators

(4) Acceptance. One of the major problems when trying to guarantee the continuity of telemedicine projects comes from the assertion of institutional will. On many occasions support from health authorities for introducing a telemedicine system is not obtained, which gives no value to the technical feasibility evaluation, since the project cannot go forward. In others, the problem is similar when health workers or patients are not willing to use the system introduced. So it is important to recall all data showing evidence that patients, health workers and health authorities were satisfied or at least

accepted the introduction of the telemedicine system. Furthermore, articles or information related to the expansion of a project to other institutions or areas, and those concerning opposition to the adoption or continuation of the system have been considered.

Economic feasibility Indicators

(5) Sustainability. Sometimes studies regarding economic feasibility and economic impact of a project are easily confused. In this document, while economic impact seeks to include all results comparing cost and benefit for any of the agents involved, sustainability seeks to group all data concerning evidence that a telemedicine system that has been deployed, can be maintained by the health institution without an excessive economic effort. Therefore, studies or information regarding installation and operation costs of a communication system or maintenance costs of the devices installed have been taken into account.

2.2.1.2 Impact Indicators

In this section the emphasis is given to the external impact of the introduction of a telemedicine system. Information related to the impact on the clinical process, patient health and accessibility to a higher quality health care system have all been considered. Furthermore, evaluations of the cost-benefit ratio which show the economic impact on the different agents involved have been recalled. All indicators considered within this section are presented in Table 2.2.

Table 2.2: Impact Indicators

Impact	On the clinical process	(6) Improvement of diagnostic capacity
		(7) Improvement in the organisation
	On the patient health	(8) Utility
	On the accessibility	(9) Variation on the feeling of isolation
		(10) Higher quality health care system
	Economic	(11) Effects on the health care centre
		12) Effects on the national health care system

Impact on the clinical process indicators

(6) Improvement of the diagnosis capacity. This indicator is intended to measure whether a relationship exists between using a telemedicine system and improving the quality in diagnosis, for instance, whether the introduction of the telemedicine system has allowed a more precise diagnosis. If the evidence found shows that a system has improved diagnostic precision, it is considered that this indicator has been evaluated.

(7) Improvement of the organisation process. The introduction of a new system always brings changes in the way an institution is organised, for instance the introduction of a real time teleconsultation application may modify doctors schedules. Data referring to a change in the way technical and human resources are allocated have also been considered.

Impact on the patient health indicators

(8) Utility. When analysing the impact of a system on the patient health, not only do dramatic changes on the mortality rates have to be considered, but also changes in the patient's mental and emotional welfare, anything which means an improvement of her or his quality of life. Therefore, data which shows a reduction in the mortality rate and data which shows a reduction in patient waiting time are both considered.

Impact on the accessibility indicators

(9) Variations on the feeling of isolation. Due to the scarcity of resources, in many developing countries there is a trend to leave rural areas and migrate to urban areas. This trend includes health care workers who have usually carried out their studies in big cities and feel isolated when working in rural villages. Thus rural areas, which already have limited resources for health provision, face a high rotation of health care workers. Furthermore, patients living in isolated areas are not able to access all levels of health care and they often feel isolated from the national health care system. In this document, data or articles referring to a reduction in the feeling of isolation for patients and health care workers have been taken into account. This also includes access to tele-education courses for health care workers or better access to health information for the population living in remote areas.

(10) Accessibility to a higher quality health care system. Telemedicine systems are usually used for teleconsultation, thus supporting health care workers attending in remote areas. So patients

Table 2.3: Degree of evidence of the studies

Level of evidence	Degree of evidence	Study design
1	Very good	Meta-analysis.
2	Very good	Large sample randomized controlled trials.
3	Good	Small sample randomized controlled trials
4	Good	Nonrandomized controlled prospective studies (multicentric).
5	Fair	Nonrandomized controlled prospective studies (monocentric).
6	Fair	Cohort studies.
7	Fair	Case and control studies.
8	Poor	Non-controlled clinical series, descriptive studies.
9	Poor	Anecdotes or case reports.

do not have to go to higher level health institutions to be assessed and he or she is directly attended by a specialist through a telemedicine system, who can also access the medical history of the patient simultaneously. Furthermore, telemedicine can improve protocol for emergency cases. In this document, data showing that new disciplines have been extended to remote areas or the protocol for emergencies has been improved, has been considered.

Economic Impact Indicators

(11) Effects on the health care centre. It is important to consider the economic impact of a telemedicine project to such a small unit as the health care centre. This is because sometimes a project can cause a revolution on a higher level if a telemedicine system creates a huge impact. Therefore data concerning costs of the installation of a communication system compared with benefits it brings are considered within this indicator.

(12) Effects on the national health care system. With this indicator this document intends to take into account studies or data referring to the economic impact of improving coverage through telemedicine at a national level.

Table 2.4: Recommendations for the adoption or not adoption of an evaluated technology

Level of evidence	Degree of evidence	Recommendations for the adoption or non adoption of an evaluated technology
1	Very good	Correct scientific evidence exists
2	Very good	
3	Good	Sufficient scientific evidence exists
4	Good	
5	Normal	
6	Normal	
7	Normal	
8	Poor	Insufficient scientific evidence exists
9	Poor	

2.2.2 Assessment of projects

Evaluation of the degree of scientific evidence of the data and articles found has been carried out through the nine-level categorisation detailed in [69]. In this categorisation meta-analysis and large sample randomized controlled trials show very good evidence, controlled and small sample randomized controlled trials and nonrandomized controlled prospective studies (multicentric) show good evidence, observational studies (analytic and transversal) show fair evidence, and descriptive studies and non-controlled trials show poor evidence. In Table 2.3 a summary of the degree of evidence of the different studies is presented.

2.2.3 Criteria for the presentation of results

A degree of evidence was established in order to make recommendations considering all data and articles found. Thus, an article with good evidence (level three in the table described before) offers the correct scientific evidence for recommending or not recommending the use of a certain telemedicine system. This degree of evidence has been obtained from [70]. In Table 2.4 a summary of the recommendations which can be made according to the degree of evidence of the different studies is presented.

3 Results

Due to limitations on the number of pages of the document, it has not been possible to include information related to the context where the projects have been carried out. In order to get a better understanding of such a context, it is strongly recommended to read Appendix A, which describes it in detail. Furthermore, it includes a description of the technical terms used in the following sections.

3.1 Places where Materials for Description have been Recalled

Through the search process carried out in international indexed scientific journals, the following results have been obtained[1]:

1. Colombia and telemedicine (11 matches)
2. Colombian and telemedicine (3 matches)
3. Colombia and telehealth (0 matches)
4. Colombian and telehealth (0 matches)
5. Colombia and ehealth (99 matches)
6. Colombian and ehealth (1 match)
7. Colombia and e-health (1 match)
8. Colombian and e-health (0 matches)

[1] This combinations were also introduced in Spanish. The results showed are the sum of both languages.

Contrary to what can be expected, according to what has been said in Section 2.1, several articles were retrieved. However, many of them are coincidences of the same article. Thus, all the eleven articles recalled using combination of words No. 1, contained all the valid references, since 98 out of the 99 articles retrieved when using combination No. 5 were due to a failure of a database searching machine[2] and the rest of them belong to those found when introducing combination No. 1.

Within this collection of articles a review similar to the one presented in this document was found [72]. It contains many references to different projects which allowed identification of many telemedicine initiatives carried out in Colombia: Vision Technology Group project, the *Centro de Telemedicina-Universidad Nacional* project in Leticia and the islands of San Andrés and Providencia, the telemedicine activities carried out by *Grupo de Investigación en Telesalud (GIT)-Universidad de Caldas*, the *Red de Telemedicina de Antioquía* designed by *Equipo Interdisciplinario de Telemedicina (EIT)-Universidad Pontificia Bolivariana*, the telemedicine project developed by Ecopetrol (Colombian Petroleum Company) and the teleradiology services provided by Cardiobip Ltd in the late nineties. An article about ethics [78] mentioned Resolution No. 1448 and another one was actually Resolution 2184 [82], obtaining a good glimpse about telemedicine legal issues. [122] was not accessible[3] and [91] was impossible to recall physically, since it was only published on paper. [15] makes reference to the first telemedicine initiative developed by the *Centro de Telemedicina-Universidad Nacional*; an identification of telemedicine needs in the department of Amazonas, which was the seed for other telemedicine project carried out by the Centro in the same area. Indeed, [3] references a successful dermatology case solved through a telemedicine system installed by the Centro in the department of Amazonas. [100] describes the telemedicine activities carried out by Subprogram EHAS – Colombia, concretely in the department of Cauca. This article also mentioned Ecopetrol, San Andres and Providencia and *GIT-Universidad de Caldas* projects cited above. Furthermore [11], it is also cited in its references section. It is an article which presents multiple results of the teleradiology project carried out by Vision Technology Group. [116] shows results of a teleconsultation application developed by the *Fundación Santa Fe de Bogotá* called Doctor Chat. This application aims at providing a tool for all Colombian citizens to ask their medical doubts to an specialist. Last two articles retrieved referred to *Centro de Telemedicina de Colombia* and its telemedicine initiatives:

[2]The searching engine also takes into account when the word salud appears preceded by a word ending in e. However, in September 4th 2008 this problem was solved and 1 result was retrieved.

[3]I could only retrieve articles from journals accessible in the AAU library online system.

one for helping displaced people caused by the Colombian internal conflict, [119], and another one for creating, jointly with Grupo Destino, a simulator with medical education purposes, [121]. These last two articles also served for identifying *Programa de Investigación y Desarrollo en Redes de Acceso Universal para la teleducación y la telemedicina*, predecessor of *Red Piloto de Teleasistencia Sanitaria (ReTAS)*, both of which have been developed by *Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones (GNTT)-Universidad del Cauca*.

Web searching was also fruitful and eight more articles were retrieved due to this process. First two ones, [117] and [120], make also reference to Centro de Telemedicina de Colombia, describing in more detail the telemedicine activities carried out by them. [16] presents results of the project design by EIT-Universidad Pontificia Bolivariana mentioned before, describing in detail all the applications developed within the project framework. Other article about *Centro de Telemedicina-Universidad Nacional* was also found; in this case, [14] makes reference to the methods they use for transferring medical images. [7] presents a dissertation from the coordinator of GIT-Universidad de Caldas about the role of the group within the University. [46] shows the results of an economic comparison between Vision Technology Group services and traditional ones. Two more articles, [102] and [103], were retrieved, both are about the T@lemed program, a telemedicine project carried out in Brazil and Colombia financed by the European Commission. In addition to the articles, another important document for identifying telemedicine initiatives in Colombia was retrieved, [115]. It is a systematic review similar to the one presented in this document carried out by ITU, which in my opinion does not fulfill its purpose, since no recommendations are made. Nevertheless, it refers to several telemedicine projects, thus providing very important information about some projects already identified and bout four new ones: researches carried out by *Grupo de Investigación en Telemedicina (GITEM)-Universidad Distrital Francisco Jose de Caldas*, the activities of *Grupo de Ingeniería Biomédica (GIB)-Universidad de los Andes*, government's Connectivity Agenda and software Galeno developed within the Leticia and San Andrés project described before. Web searching also served for retrieving [9], which mentions Dr. García telemedicine activities, and for finding Caprecom and *Fundación Cardiovascular de Colombia* (FCV) websites, which contain a lot of useful information about telemedicine in the country.

In addition to the telemedicine articles and initiatives described above, others were found thank to the interviews with the contacts from those projects. For instance, due to *Programa de Investigación y Desarrollo en Redes de Acceso Universal para la teleducación y la telemedicina*, Oscar

Calderón was contacted. He provided me with very useful information, including contacts within the Universidad del Cauca[4], which let me identify the ReTAS and *Red Telemática para la prestación de servicios de Telemedicina y Telesalud*, carried out by GNTT-Universidad del Cauca and *Facultad de Ingeniería Electrónica-Universidad del Cauca*, respectively. Furthermore, he sent me a link to the First National Meeting on Telemedicine[5], were key information about already found projects could be retrieved and many other ones identified, such as telemedicine intentions of the Governor's Office at department of Guaviare, the teleradiology pilot project designed by *Grupo de Investigación en Bioingeniería (GIB)-Universidad EAFIT*, the telemedicine activities carried out by SaludCoop, the results of the teleradiology project deployed by the *Hospital Universitario La Samaritana* in the nineties, and activities of the *Asociación Colombiana Medicina, Informática y Telesalud*.

Other articles and projects were also retrieved due to the interviewing process. Contacts with the FCV served for recalling three articles, [89] [87] and [88]. The first one makes a comparison between traditional methods and modern ones using telemedicine for providing cardiology services; the second one describes *Programa Galaxia*, a wide telemedicine project carried out in department of Santander; and the third one presents a dissertation on the psychopathology of telemedicine. Contacts with GIB-Universidad EAFIT were also fruitful and another paper was recalled, [55]; it describes a teleradiology project carried out in Cali and shows tests made to evaluate its performance. In addition to this, three more telemedicine initiatives could be identified: a project designed by *Facultad de Medicina-Universidad de Antioquía*, referred by Velez[6], the telemedicine activities of Esoft Ltd, referred by Kopec[7], and researches by *Grupo de Investigación en Ingeniería Clínica* (GINIC) within HUS by Torres[8]. References to already identified projects were also made by other contacts; all of them will be summarized after describing each telemedicine initiative presents in the next section. Furthermore, contact information about each institution, including its website, and telephone, email and position of the person contacted within each institution is available in Appendix C.

In addition to this, contacts with the expert selected, Dr. Martha Giraldo Executive Director of Renata, to corroborate findings, provided the name of another institution, ITMS. Contacts with them allow retrieving one last article, [44], regarding a comparison between a tele-electrocardiograph and

[4]Contacts with GNTT -Universidad del Cauca. email 2.

[5]Contacts with GNTT -Universidad del Cauca. email 2.

[6]Contacts with *Centro de Telemedicina de Colombia*, email No. 5.

[7]Contacts with Hospital Universitario la Samaritana, email No. 5.

[8]Contacts with Hospital Universitario la Samaritana, email No. 2.

traditional methods.

Therefore, a total of 25 articles regarding telemedicine in Colombia were retrieved along with information about 24 different institutions carrying out telemedicine projects in the country. These are:

Ministerio de la Protección Social-Caprecom

Grupo de Investigación en Telesalud (GIT)-Universidad de Caldas

Centro de Telemedicina-Universidad Nacional

Fundación CardioVascular de Colombia

Subprogram EHAS – Colombia

Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones (GNTT) -Universidad del Cauca

Facultad de Ingeniería Electrónica-Universidad del Cauca

Telemed

Fundación Santa Fe de Bogotá

SaludCoop

Grupo de Investigación en Bioingeniería (GIB)-Universidad EAFIT

Centro de Telemedicina de Colombia

Hospital Universitario La Samaritana

Ecopetrol

Vision Technology Group

Cardiobip Ltd

Grupo de Investigación en Telemedicina (GITEM)-Universidad Distrital Francisco José de Caldas

Grupo de Ingeniería Biomédica (GIB)-Universidad de los Andes

Facultad de Medicina-Universidad de Antioquía

Equipo Interdisciplinario de Telemedicina (EIT) - de la Universidad Pontificia Bolivariana

Asociación Colombiana de Informática Médica y Telesalud

Esoft Ltd

Dr. Díaz

ITMS-Colombia

Information in detail about the projects carried out by this 24 institutions will be presented in detail in the following section. It will include all the information retrieved, both through Internet and

by interviews, regarding indicators presented in Section 2.2.1. It has been decided to make reference to institutions instead to individual projects since it is easier to present results this way. Within each institution, each individual project will be described in detail providing information related to the aforementioned indicators.

As it can be noticed, institutions and projects names appear in Spanish instead of in English. This decision has been taken for respecting their real names. All names in Spanish in italics appear translated in Appendix D.

3.2 Description of Telemedicine Initiatives Recalled

3.2.1 Ministerio de la Protección Social-Caprecom

In 2007 through Agreement No. 357, the CNSSS from the *Ministerio de la Protección Social* allocated 10 billion COP from FOSyGA to the *Eventos Catastróficos y Accidentes de Tráfico* (ECAT) account for the improvement of the national emergencies network. This Agreement had two components: provision of medical devices, communication devices, and communication infrastructure for transferring patients in a critical state, and implementing health services on a telemedicine basis in the departments of Amazonas, Caquetá, Guaviare, Guainia, Vichada, Vaupés, Chocó y San Andrés y Providencia. 20% of this budget was used for the first component while 80% served two parts: a) provision of emergency, reanimation, and intensive and intermediate care devices; and b) support services, in this case those provided through telemedicine [30]. Furthermore, through Agreement No 378, financing have been granted for 2008 with the allocation of 3.5 billion COP for strengthening this project [29]. Departments were chosen according to an intense revision carried out by *Grupo de Atención en Emergencias y Desastres*, which identified them as those department lacking of key services for emergency attention such as intensive and intermediate care [30].

Ministerio de la Protección Social entrusted the implementation of this project to Caprecom, a public EPS[9], which in turn, through a public tender, entrusted it to three reference centres: *Fundación Cardiovascular de Colombia* (FCV), *Centro de Telemedicina-Universidad Nacional* and GIT-Universidad de Caldas[10]. These centres make use of the infrastructures provided by the Compartel Program which grant connectivity. Therefore, *Ministerio de la Protección Social* is in charge of guar-

[9]Contacts with Ministerio de la Protección Social-Caprecom, email No. 8.

[10]Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 10.

anteeing provision of devices, contracting centres of reference, training of health care professionals and continuous technical and scientific support, but it is not in charge of services *per se*[11].

Nowadays, the project is running in 11 IPS under intermediate care basis and in 58 under basic telemedicine basis[12]. Basic telemedicine consists of attention through specialised teleconsultation in the following services: cardiology, neurology, pediatrics, internal medicine, gynecology, urology, otorrynolaryngology, dermatology, clinic of pain, infectology, telelectrocardiography and teleradiology for ambulatory patients [81]. In these cases, the remote doctor consults via Internet the specialist located at the reference centre, who analyzes the case and sends back his/her opinion by the same means. On the other hand, intermediate care has been design for patients in a critical state, who can be monitored continuously by specialists located at the reference centre. In the first six months of operation, 3026 patients under basic telemedicine basis and 245 under intermediate care have been attended. In the first case, mean response time from the reference centre has been 2 hours[13]. However, *Ministerio de la Protección Social* does not count with any other evaluation[14].

Mrs. Hoyos, from *Grupo de Atención Emergencias y Desastres*, emphasizes that health care provision on a telemedicine basis intends at improving access to health care services, quality and opportunity in the attention, whereas decreasing, at the same time, direct and social costs associated to it. However, telemedicine does not substitute specialised personal attention at any time, but allow those living in remote areas to have access to these services[15].

3.2.2 GIT-Universidad de Caldas

GIT-Universidad de Caldas is a research group of the *Facultad de las Ciencias de la Salud* of the Universidad de Caldas created in 2001 with Colciencias financing [23]. Since then, it has developed several telemedicine projects which will be described below.

Teledermatology project

In 2002 the centre began providing dermatology services on a telemedicine basis for allowing people living in remote areas of the department of Caldas to get access to dermatology consultation

[11] Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 8.
[12] Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 10.
[13] Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 8.
[14] Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 5.
[15] Contacts with *Ministerio de la Protección Social*-Caprecom, email No. 5.

Table 3.1: Cases Attended by the teledermatology project in each institution every year from 2002

Institution	2002	2003	2004	2005	2006	2007	2008
Hospital San Vicente de Paul - Anserma				5			
Centro de salud Assbasalud	70	2					
Hospital Felipe Suarez - Salamina						58	71
Hospital Infantil Universitario	63	1					
Hospital San Félix - La Dorada	8	36	208	227	384	364	224
Hospital San Antonio - Manzanares			5	1			
Hospital San Cayetano - Marquetalia		1					
Hospital San José - Samaná					1	6	9
Hospital San José de Aguadas	2	65	120	227	194	155	65
Hospital San Juan de Dios - Pensilvania				1			
Hospital San Jose de Neira				6	10	31	2
ESE Hospital Santa Teresita - Pacora				43			
Hospital San Vicente de Paul -				3	18	4	
Hospital Norcasia				1			
Hospital San Juan de Dios - Riosucio		22	13				
Hospital San Rafael - Risaralda				1			

without having to physically travel to the Manizales, capital of the department [62]. This project belongs to an agreement between the Universidad de Caldas and the Territorial Direction for health of the department of Caldas, for providing these services to 25 municipalities[16].

In Table 3.1, these health care centres are detailed, together with number of patients attended by each of them every year[17]. Some of them counts with broadband infrastructure, and some of them use traditional telephone lines, but in all cases cost-efficient solutions have been used due to the lack of economic resources of the area[18]. To do so, GIT counts with its own web platform, which complies with all the requirements imposed by the *Ministerio de la Protección Social*, where

[16]Contacts with GIT-Universidad de Caldas, email No. 5.

[17]Document attached in Contacts with GIT-Universidad de Caldas, email No. 5

[18]Document attached in Contacts with GIT-Universidad de Caldas, email No. 7

management of cases occurs. Remote institutions access the system and add the appropriate images, then, specialists from the reference centre attend the cases under a store and forward basis. In addition to this, telephone support is also provided for defining technical and operative issues[19]. The mean response time is 48 hours[20].

However, as it can be seen in Table 3.1, in very few establishments the service has been continuous through the years. In deed, nowadays, service is only provided in 5 health care centres. According to Dr. Arbelaez, coordinator of the group, this is due to human factors, since the rotation of health care professionals is very high, and, thus, those who received training leave the institution in the short run. Occasionally, it is also due to the lack of commitment of health centres managers. Furthermore, he mentions a second factor: GIT did not provide continuous visit for support and following-up due to the lack of financing for this task, since centres were difficult to access, hence expensive to reach[21]. Even so, the program is a reference both nationally and internationally [7]. Until June 9th 2008, 2727 cases had been attended, entailing the transfer of 12322 medical images. Thanks to these results, several agreements are ready to be signed for the extension of this project to other municipalities of the department[22].

Teleradiology project

In the same municipalities GIT provides teledermatology services, it is developing a project for teleconsultation in radiology. Nowadays, comparison between traditional and virtual reading tools is being carried out in 100 adults and 50 children, but no other data are available about this project [62].

Virtual education project

In addition to the projects described above, GIT has been doing a great effort in virtual education in the last years. Through a research project financed by PHO, it aims at comparing efficacy of a virtual method developed by the group for education in Integrated Management of Childhood Illness (AIEPI, in Spanish) methodology with face-to-face traditional methods. The analysis of the later has been already carried out, but the former it is pending [62], so no results are available yet. Furthermore, all

[19]Document attached in Contacts with GIT-Universidad de Caldas, email No. 7
[20]Document attached in Contacts with GIT-Universidad de Caldas, email No. 5
[21]Document attached in Contacts with GIT-Universidad de Caldas, email No. 7
[22]Document attached in Contacts with GIT-Universidad de Caldas, call No.2

images stored through teledermatology and teleradiology consultations are used for students training at the Universidad de Caldas [7].

Caprecom project

On November 27th 2007, GIT signed a contract with Caprecom through which it was in charge of providing telemedicine services in 20 municipalities from departments of Chocó, Guainia, Putumayo and Vaupés [114]. Then, at the beginning of 2008 contracts were signed with each IPS beneficiary of the project, which are detailed in Table 3.2[23].

In these health care centres, the following specialties are provided: pediatrics, internal medicine, dermatology, gynecology, orthopedy, cardiology, cardiology, infectology, urology and otorrinolaryngology[24]. These services use the same telemedicine platform described in the teledermatology project: remote doctors add medical images, which are analysed later by the specialists located in the reference centre. Nowadays, there is no impact evaluation of these services, but there exist a relation of patients attended by each establishment[25], which is shown in Table 3.2. All together, GIT-Caprecom has attended 532 cases.

GIT-Universidad de Caldas, appears in the two systematic reviews regarding telemedicine projects in Latin America retrieved [72] and [115]. Furthermore, several interviewed persons made reference to it[26].

3.2.3 Centro de Telemedicina-Universidad Nacional

Centro de Telemedicina-Universidad Nacional is an IPS authorized by the CNSSS since in 2004 Resolution No. 2184 came into effect [47], which provides health care services on a telemedicine basis. Among these services are: radiology, cardiology, internal medicine, gynecology, dermatology, infectology, otorrynolaringology, urology, pediatrics and orthopedics. They are provided using an application called Virtual Hospital (from Hospital Virtual) which consisted of three modules: Saruro,

[23]Contacts with GIT-Universidad de Caldas, email No. 5.

[24]Contacts with GIT-Universidad de Caldas, email No. 5.

[25]Contacts with GIT-Universidad de Caldas, email No. 5.

[26]Contacts with *Ministerio de la Protección Social*-Caprecom, call No. 2., contacts with Subprogram EHAS – Colombia, mail No. 2, contacts with *Centro de Telemedicina-Universidad Nacional*, call No.2, contacts with Fundación Santa Fe de Bogotá, email No. 3 and contacts with GIB-Universidad de los Andes, email 2.

Table 3.2: Patients attended by GIT – Caprecom

Department	Municipality	Health Institution	Cases Attended
Chocó	Bahía Solano	Hospital Local Julio Figueroa Villa	43
Chocó	Tado	ESE Hospital San Juan de Tado	26
Chocó	Unguía	Hospital Local de Unguía	17
Chocó	Carmen de Atrato	Hospital San Roque	34
Chocó	Condoto	ESE Hospital San Jose de Condoto	27
Chocó	Istmina	ESE Hospital Eduardo Santos	26
Chocó	Quibdo	Hospital Ismael Roldán	27
Chocó	Acandi	Hospital Lascario Barbosa Avendaño	21
Guainia	San José	Centro de Salud de San José	0
Guainia	San Felipe	Centro de Salud de San Felipe	9
Guainia	Barrancominas	Centro de Salud de Barrancominas	2
Putumayo	Villa Garzón	ESE Hospital San Miguel Arcangel	40
Putumayo	Puerto Guzmán	ESE Hospital Jorge Julio Guzman	37
Putumayo	Puerto Caicedo	Centro de Salud Alcides Jimenez	61
Putumayo	Villa de Gamuez	Hospital Sagrado Corazón de Jesús	33
Putumayo	Orito	ESE Hospital Orito	22
Putumayo	San Miguel	Hospital Fronterizo la Dorada	23
Putumayo	Puerto Leguizamo	Centro de Salud Maria Angelinez	71
Vaupés	Taraira	Centro de Salud de Taraira	6
Vaupés	Carurú	Centro de Salud de Carurú	7

the information system of the centre, SAI, the image managing system and Sofia, the platform for virtual learning [20].

Saruro allows to provide telemedicine services on an efficient and scalable way by managing availability of the system information in the Virtual Hospital. Medical information is structured following the HL7 model and a service-oriented architecture. On the other hand, SAI, which stands for Image Managing System in Spanish, is a platform designed for allowing people to work with different medical images and to store and access them online, without having to install a specific software for visualising them. Furthermore, it allows extraction of data existing within the images, such as metadata in DICOM format, and download them in different formats such as bmp, jpg or png, for their better handling in the computer. Finally, Sofia is a platform for learning online designed as support for pedagogic activities by the use of medical teaching tools [20].

The Centre currently counts with 21 specialists providing telemedicine services to 29 heath care centres along the country[27]. 27 of them belong to the Caprecom project described in detail in Section 3.2.1[28]. These are shown in Table 3.3.

All these health care centres, except ESE Hospital San Jose del Guaviare, receive basic telemedicine basis services, whereas, ESE San Jose del Guaviare receives basic telemedicine and intermediate care services. For providing the latter, it counts with intern doctors providing services 24 hours a day[29]. This health care centre has been operated by the Centre since December 2005, first within the T@lemed project, described in Section 3.2.8, then through a private agreement between both institutions, and currently through Caprecom. According to Dr. Romero, director of the Centre, the project with ESE San Jose del Guaviare is the most successful telemedicine projects in the country, due to the savings it produces each time a remission is avoided[30]. This is corroborated by Mr. Bermúdez, coordinator of the project, who provides data to confirm this topic: 35,000 COP for medical consultation, between 500,000 and 2 million COP for travelling expenses, 200,000 COP per accommodation (stays last between 5 and 10 days) and a variable costs related to the time the patient does not work. Therefore, when patient belongs to the subsidized regime, state saves between 4 and 5 million COP per patient[31].

[27] Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 2.
[28] Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.
[29] Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.
[30] Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.
[31] Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.

Table 3.3: Institutions within the agreement between Centro de Telemedicina and Caprecom

Department	Municipality	Health Institution
Amazonas	Puerto Nariño	Hospital Local de Puerto Nariño
Amazonas	Puerto Santander	Centro de Salud de Puerto Santander
Amazonas	La Pedrera	Centro de Salud de la Pedrera
Amazonas	Tarapacá	Centro de Salud de Tarapacá
Amazonas	La Chorrera	Centro de Salud de La Chorrera
Caquetá	Cartagena del Chaira	ESE Hospital Local
Caquetá	La Montañita	Centro de Salud La Montañita
Caquetá	Belen de Andaquies	Hospital Local San Roque
Caquetá	Morelia	Centro de Salud Morelia
Caquetá	El Paujil	Hospital Local El Paujil
Caquetá	El Doncello	Hospital el Buen Samaritano
Caquetá	Solita	Centro de Salud Solita
Caquetá	San Jose de la Fragua	Centro de Salud San Jose de la Fragua
Caquetá	Puerto Rico	Hospital Local San José de Puerto Rico
Caquetá	San Vicente del Caguan	Hospital San Rafael
Caquetá	Milan	Centro de Salud Milán
Caquetá	Curillo	Hospital Local de Curillo
Caquetá	Solano	Hospital Local Solano
Caquetá	Valparaiso	Centro de Salud Valparaiso
Caquetá	Albania	Centro de Salud Albania
Guaviare	Calamar	Puesto de Salud de Calamar
Guaviare	Miraflores	Centro de Salud de Miraflores
Guaviare	San José de Guaviare	ESE San José del Guaviare
Guaviare	El Retorno	Centro de salud de El Retorno
Vichada	La Primavera	Hospital La Primavera
Vichada	Cumaribo	Hospital de Cumaribo
Vichada	Santa Rosalía	Hospital de Santa Rosalía

The Centre has also an agreement with Clínica Leticia for providing telemedicine services since September 2005[32], specially in radiology and dermatology[33]. In deed, one of the papers recovered described in detail how this network allowed treatment of a patient with cutaneous tuberculosis [3]. According to Dr. Gutierrez, director of Clínica Leticia, the agreement has allowed weekly resolution of these kind of cases, when before this happened three times a year [95]. Mr. Bermúdez attributes this impact to the wide use of Saruro, due to the several training programs carried out in the Centre about this specific platform[34].

The other health care institution where Centro de Telemedicina provides telemedicine services is the Hospital Nuestra Señora de los Remedios in Riohacha. This project began, with financing remaining from T@lemed, in December 2006, which provided the infrastructure required[35]. Although this network worked smoothly during 2007, nowadays the institution is looking for financing for project continuations, since operation costs were assumed by the hospital[36].

Among the 29 of them, the Centre has attended around 10,000 patient in different specialties. Table 3.4 sums up cases attended by each institution in each of the specialties offered[37]:

In addition to the patients attended, according to Dr. Romero, both health care staff's and patients' satisfaction is very high, and gives and example "using traditional methods it takes 3 or 4 months to get an appointment with an specialist, meanwhile using telemedicine it takes 1 or 2 hours"[39]. He also mentions one of the reasons of the great success reached by the projects carried out by the Centre: "we use technology developed by us"[40]. This work is developed by the research group of the Centro called Bioingenium [20], which, among other things, has developed a robotized microscope with an attached camera for filming and recording the content of the lens of the microscope. The model, currently in a designing stage, also allows picture capture and handling through a novel method created by them called JPEG2000, described in detail in [14]. It allows as well identification of malaria areas within the images.

Furthermore, the Centre did also develop projects in the past. The first one was called TeleAma-

[32]Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 2.
[33]Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.
[34]Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.
[35]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 3.
[36]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.
[37]Document attached to contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.
[39]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 3.
[40]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.

Table 3.4: Patients attended by Centro de Telemedicina -Universidad Nacional

Specialty	**Caprecom**[38]	**ESE San Jose del Guaviare**	**Clínica Leticia**	**Hospital Ntra. Sra. Remedios**	**All**
Cardiology	12	19	1	0	32
Intermediate Care	0	2	0	0	66
Dermatology	57	415	781	32	1285
Ginecology	23	1	0	0	28
Infectology	8	93	0	2	103
Mammography	0	0	363	0	363
Internal Medicine	39	3	1	0	43
Pediatric Neumology	0	0	1	0	1
Orthopedic	12	0	0	0	12
Othorrinolaringology	7	6	0	0	13
Pathology	0	0	2	0	2
Radiology	18	4751	933	1781	7483
Hemathology	0	2	2	0	2
Urology	4	3	3	0	7
Total	212	5295	2082	1815	9404

zon, and its results are published in [15]. It took place in 1996 and implied an identification of the deficiencies of public health care system needs of the department of Amazonas that could be solved through the use of ICTs. This project allowed to lay the foundations of a bigger telemedicine project, 455,000 USD budget, started in 2000 by the Universidad Nacional jointly with ITEC-Telecom(the National Telecommunications Company) with financing from the Department of Hospitals from France, Colciencias and the Fund for Social Communication [72]. This project aimed at interconnecting institutions belonging to the three levels of health care attention in order to provide high quality heath services in remote areas. To do so, they developed two different pilot projects: one interconnecting the Puesto de Salud Centro Providencia, a level one institution located in Apaporis, a remote area of the Amazonian jungle, the Hospital San Rafael in Leticia, a level two hospital located in the capital of the department of Amazonas, and the Universidad Nacional as the reference centre. In the other project the university also acted as the reference centre and the level one and two facilities were Hospital old Providence, located in the island of Providencia and Hospital Timothy Britton, located in the island of San Andrés, respectively [72].

Remote stations were provided with telemedicine devices such as webcams, digital cameras, digital stethoscopes and microscopes, x-ray scanners as well as a personal computer for handling and transferring data. Furthermore, an Internet connection using Clear Channel technologies was installed in every station using ITEC-Telecom infrastructure, solving this way communication problems due to the huge distances between nodes (Bogotá is 1088 km away from Leticia and 1025 km. from the island of San Andrés) [72]. In addition to this, a software called Galeno was developed by ITEC-Telecom within the project. It allowed clinic histories management and counted with tools for visualisation and handling of medical images [115]. However, before starting using the software, ITEC-Telecom was winded up by the government and the software was never used due to legal property issues, although the Company had invested 230 million COPs in the project[41].

In addition to this, according to Dr. Salazar, responsible for software Galeno development, the network among San Andrés, Providencia and Bogotá was never used, and the network with Leticia and Apaporis never worked as it was expected[42]. Furthermore, Dr. Romero observed that “he does not know any register of any patient attended within these networks” and points to the lack of a clear

[41] Contacts with GIB-Universidad de los Andes, email No. 2.

[42] Contacts with GIB-Universidad de los Andes, email No. 2.

objective as the the cause of the project failure[43]. He also adds that the satellite link with Apaporis was very expensive and that there [in Apaporis] indigenous never felt part of the project due, partly, to language differences[44]. The failure was such that the French government asked for the devolution of devices installed in Apaporis[45]. Moreover, devices in the island of Providencia were destroyed by hurricane in 2006[46].

Centro de Telemedicina-Universidad Nacional presented its results in the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore, it is present in both systematic review retrieved [72] and [115]. In addition to this, it has been mentioned for almost all the people interviewed.

3.2.4 Fundación Cardiovascular de Colombia

CV was created in 1986 in Bucaramanga, department of Santander, thanks to the efforts of a group of cardiologists willing to improve health care attention in Colombia, and, nowadays, it is one the leaders in the health sector in the country [51].

In 2004 the Centro Nacional de Telemedicina (CNT) of the FCV was authorized as a center of reference for telemedicine provision, which coincided with the beginning of the first telemedicine project carried out by them. It was a pilot telemedicine program in the department of Santander called "Programa Galaxia", which provided telecardiology and teleradiology consultation to 50 municipalities, using Internet. The teleradiology activities were carried out through the use of digital cameras, while for the telecardiology ones, CNT counted with its own designed digital electrocardiograph called ECG 1200. Furthermore, CNT had developed an online platform to facilitate information exchange, together with an electronic medical history of their patients [87].

Within this program a comparison between the performance of ECG 1200 and traditional method was carried out [89]. The study consisted in a random trial of 87 patients, ranging from 18 to 80 years old, where 7 experts evaluated results from both methods. Results showed that in all cases (100%) cardiac rhythm analysis was coincident using both methods, and evaluation of cardiac frequency showed similar results. Thus, concluding that the use of ECG 1200 was an appropriate tool for providing cardiology services on a telemedicine basis.

[43]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 3.
[44]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.
[45]Contacts with GIB-Universidad de los Andes, email No. 2.
[46]Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.

Nowadays, CNT-FCV offers its services in a wider range of specialties, including telemonitoring of patients in critical state. To do so, the centre is made up of an interdisciplinary group for developing both telemedicine tools and providing medical services [51]. A brief description of the services offered by CNT-FCV is provided bellow.

Teleconsultation. Consultation on a telemedicine basis is provided in the following specialties: cardiology, internal medicine, neurology, gynecology, cardiovascular surgery, and odontology. These services work as follows: the remote doctor from the IR accesses the online platform[47], introduces patient's medical history and selects the specialty to be consulted. The CNT-FCV Contact Centre receives the request and contacts the expert required to attend such a consultation. Then, the expert analyzes the medical history and medical data attached, talks to the remote doctor by chat and defines a diagnostic for the patient.

Teleradiology. This service uses the same platform described above, but in this case, a special device, called UPT, is needed in the IR for taking radiology images. Then all data, together with the medical history is introduced in the application, where the experts analyze it in the next 24 hours in general cases and immediately in case of emergency

Telecardiology. For providing this service, the CNT-FCV makes use of ECG 1300 and evolution of the ECG 1200 described above, which allows real time electrocardiography capture and non invasive cardiology monitoring. For the rest, remote doctor has to follow the protocol already described.

Tele-ICU. This services consists in a group of specialists accessing remotely to the devices monitoring a patient in the IR. Thus, the specialist has access to patient's vital signs and interacts with the staff at the IR for taking the appropriate measures at the right time. This service is actually being provided by the CNT-FCV in 10 health care centres within the agreement with Caprecom. Health care staff from these institutions also receives training on the use of the different devices and the online platform. In addition to this, FCV staff carries out a great effort making beneficiaries part of the project, thus trying to guarantee project sustainability [52]. Table 3.5 shows the institutions part of the agreement with Caprecom.

Until June, this project had provided attention through his service to 170 patients[48]. The first case attended within this agreement was motive of an article in the local newspaper [98].

In addition to this, the CNT provides the other three services in many health care centres. Table 3.6

[47] `www.fcv.org/cnt`

[48] Contacts with Fundación CardioVascular de Colombia, call No. 2.

Table 3.5: Institutions within the agreement between FCV and Caprecom

Department	Municipality	Health Institution
Amazonas	Leticia	ESE Hospital San Rafael de Leticia
Caquetá	Florencia	Hospital Departamental María Inmaculada
Chocó	Quibdó	Clínica Quibdó IPS Caprecom
Guainia	Puerto Inirida	ESE Hospital Departamental Manuel Elkin Patarroyo
Putumayo	Puerto Asís	ESE San Francisco de Asís
Putumayo	Colón	Hospital Pío XII
Putumayo	Mocoa	ESE José María Hernández
San Andres Island	San Andrés	Hospital Departamental de San Andrés Isla
Vaupes	Mitú	ESE Hospital San Antonio
Vichada	Puerto Carreño	ESE Departamental San Juan de Dios

shows a relation of [51]:

According to Dr. Miserque, director of CT-FCV, they count with impact evaluation of these projects[49]; however, they can not be shared due to confidentiality issues[50].

Despite the fact that FCV has been referred for almost all contacts interviewed[51], it does not appear in any of the systematic reviews retrieved.

[49]Contacts with Fundación CardioVascular de Colombia, call No. 2.

[50]Contacts with Fundación CardioVascular de Colombia, email No. 5.

[51]Contacts with Inti tutions involved.

Table 3.6: Other FCV telemedicine projects

Department	Institutions
Valle del Cauca	42 IPS
Tolima	27 level one hospitals and 6 level two institutions
Boyacá	21 IPS
Sanatander	7 regional hospitals

3.2.5 Subprogram EHAS - Colombia

Enlace Hispano Americano de Salud (EHAS) [42] has developed one of its national subprograms in Colombia. These subprograms are always composed by two partners: one in charge of the technical issues and the other of the medicals. In Colombia both of them belong to the Universidad del Cauca: *Grupo de Ingeniería Telemática* (GIT), as technical partner, and the *Grupo de Sociedad y Salud* as medical. The program aims at developing pilot telemedicine experiences in rural areas for improving efficiency in public health care system in remote municipalities using appropriate and low-cost technologies [42].

GIT is in charge of adapting EHAS solutions according to local needs. To do so, it counts with a Low Cost Communications Lab, which was financed by Colciencias. EHAS proposed two different technologies for providing voice and data communications to remote places: VHF and WiFi. The first one uses radios for accomplishing both tasks; for data transfer radios are connected to a computer through a modem. The communication through WiFi is achieved using standard devices tweaked for allowing long distance links, thus providing broadband voice and data services. When deploying networks using any of the systems, costs of internal communications is zero and the cost of the Internet connection is shared among the institutions comprising the project. In addition to this, it is worth mentioning that both systems can be supplied by solar power means [100]. All these data revolve around the economic sustainability of the project.

Using these two systems, in February 2002 Subprogram EHAS-Colombia started the design of two networks: EHAS-Silvia and EHAS-Costa Pacífico. The first one was financed through an @LIS program as well as T@lemed, the Project described in Section 3.2.8, while the second was financed by the Infodev World Bank Program [42].

The EHAS-Silvia network counts with an Internet connection installed in the Universidad del Cauca, which is directly connected through a WiFi link to Nueva Guambia, a mountain located 36 km away. Both Hospital San Carlos and Hospital Mama Dominga, located in Silvia within the Ingenous Reservation of Guambía, connect to this point and deliver the signal through VHF systems to several health care posts for which they are the reference centres [100].

Another Internet connection at the Universidad del Cauca also connects to Cerro Santana, a mountain in the Occidental Mountain Range, where EHAS-Costa Pacífico network begins. This station provides connectivity through WiFi links to the hospital in Timbiquí and the health post in Agua

Clarita located at 88 and 53 km, respectively. The former is also in charge of repeating the signal to the hospitals in Jambaló and Guapí, which are also in charge of providing connectivity to some of the level one institutions of their area of coverage.

In total both EHAS-Silvia and EHAS-Costa Pacífica provides connectivity to 5 level two hospitals and 26 level one health care posts, some of which can only be accessible through the river such as those depending on Timbiquí and López de Micay. In addition to the connectivity EHAS program provides a wide range of telemedicine services available by email: epidemiological surveillance, continuous training, reference-counter reference management system and teleconsultation. It is worth mentioning that services provided have been chosen by users according to its needs, through what is known as Participatory Action Research [100].

Within the EHAS-Costa Pacífica a evaluation was carried out in order to assess the real impact of the network. It analyzed different factors such as users satisfaction, usability or sustainability. Results showed that 71.6% of the users were very satisfied with the system, specially with the use of voice services since they found it very easy to use (63.3%). This last data contrasts with the one for the computer, where more than 50% of the users found it difficult or very difficult to use. Something similar happens with Internet access; 66.6% of them found it difficult. Therefore, the use of voice services was more frequent: more than 40% of the users used it very often, while the computer only 7.7%. A great part of these voice communications had the reference centre as destination (90%), some of them for coordinating consultation appointments (77.7%). Furthermore, the reference-counter reference management system was slowly been used (12.3% of the references). In addition to this, the system was also used for both clinic and administrative second opinion: 66.7% declared having used the system for the former often or very often, while 42.9% for the latter. Second opinion allowed avoiding an average of 0.5 remissions per month, saving around 250,000 COP per remission. The network also changed health care professionals situation in the area; 45.5% stated that her/his situation had improved a lot. Overall, perception on the impact of the network was positive (30.8%) or very positive (69.2%) [123].

However, despite of this positive results, according to Dr. Rendón, director of GIT, these projects have difficulties to achieve great impacts in the area due, mainly, to two factors: “public health care system in Colombia is deteriorating, specially in rural areas where many health care posts are being abandoned, and hospitals priorities are centre on surviving, which is far from EHAS objectives”[52].

[52]Contacts with Subprogram EHAS – Colombia, email No. 3.

In addition to these networks, the Subprogram EHAS-Colombia is currently carrying out two more projects oriented to reinforce training where networks were deployed: one for strengthening AIEPI methodology in Silvia and Jambaló though the use of ICTs and another one for telehealth services as support for collective health[53].

The Subprogram EHAS-Colombia presented its results in the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore, it is present in both systematic reviews retrieved [72] and [115]. In addition to this, it has been mentioned for several people interviewed6.

3.2.6 GNTT-Universidad del Cauca

GNTT was created during the last decade [58], but it did not start its telemedicine activities until 1999 when with financing from Colciencias and the *Ministerio de Comunicaciones* started *Programa de Investigación y Desarrollo en Redes de Acceso Universal para la teleducación y la telemedicina* [72]. Under its framework, a pilot network was designed for developing teleducation and telemedicine activities in the south west part of Colombia, covering the departments of Cauca, Valle and Nariño. Due to geographic and economic factors it could not be implemented[54], however it provided actors interested in developing telemedicine networks in Colombia a document containing an in-depth analysis of the available strategies to do so [59], which has been widely used.

One of the projects that has used the designs proposed in [59] was the *Red Piloto de Teleasistencia Sanitaria* (ReTAS). This project was developed by the GNTT together with *Grupo de estudios de Tuberculosis* and the *Grupo de Tecnologías de la Información*, both of them belonging to the Universidad del Cauca. It allowed installing a network supporting telemedicine applications for prevention, early detection and appropriate treatment of Tuberculosis in chosen municipalities of the department of Cauca: Popayán, Santander de Quilchao, Silvia, Caloto, Morales, Caldono and Guapí. The project which was financed again by Colciencias and the *Ministerio de Comunicaciones*, was carried out between June 1st 2003 and July 31st 2004 for communicating level one institutions in the aforementioned localities with Departmental Office for Health in Popayán [60].

Several applications such as individual tuberculosis cards, for a better follow-up of the patient, teleconsultation and teleducation tools and a forum for opinion exchange between patients and health care professionals were designed. All these services are still available through a server accessible at

[53] Contacts with Subprogram EHAS – Colombia, email No. 3.

[54] Contacts with GNTT-Universidad del Cauca, email No. 10.

`http://www.retas.unicauca.edu.co`. In some of the institutions, these applications used Compartel infrastructure for transmission, other counted with their own such as the one in Silvia provided by EHAS, and the one in the hospital in Guapí provided by *Red Telemática para la Prestación de Servicios de Telesalud y Telemedicina*. In these cases, tests were carried out for ensuring compatibility among networks before installation. Furthermore, in all cases security was granted through the use of Virtual Private Networks (VPN) [60].

This network was installed and worked at full operation during some months, when the technical responsible of the maintenance of the network was GNTT. Furthermore, at that time, health care professionals were fully trained due to several courses they received and technical and economic evaluations were performed. Although Dr. Castillo, creator of the project, indicates that they obtained excellent results in improving medical attention and promptness of the service, these documents could not be retrieved and results can not be showed[55]. Once operation and maintenance of the network were transferred to the Departmental Office for Health, particular bureaucratic issues hindered its adoption, and nowadays it only operates as support for *Grupo de estudios de Tuberculosis* activities[56].

GNTT attended the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore it has been mentioned by several people[57].

3.2.7 Facultad de Ingeniería Electrónica-Universidad del Cauca

Red Telemática para la Prestación de Servicios de Telesalud y Telemedicina was conceived for designing and implementing a pilot project which allowed the provision of telemedicine and telehealth services in the department of Cauca [26]. It was carried out between 2000 and 2001 by the *Facultad de Ingeniería Electrónica-Universidad del Cauca* and counted with the support of Colciencias and the *Ministerio de Comunicaciones* [113].

The project took place in Hospital San Francisco de Asís located in Guapí, in the department of Cauca. There, it was installed a telematic network with access to Internet through traditional telephone lines, which allowed the institution providing telemedicine services such as management of medical services, digital arrangement of appointments, and access to medical [96].

[55]Contacts with GNTT-Universidad del Cauca, email No. 10.

[56]Contacts with GNTT-Universidad del Cauca, email No. 8.

[57]Contacts with *Centro de Telemedicina de Colombia*, email No. 2, contacts with GIB-Universidad EAFIT, call No.1, contacts with Hospital Universitario la Samaritana, email No.5 and contacts with GIT-Universidad de Caldas, call No.2.

It was impossible to recall more information regarding this project since no contact could be establish with Dr. Rafael Rengifo, responsible of the project and current dean of the Facultad de Ingeniería Electrónica of the Universidad del Cauca[58].

This project was presented in the First National Meeting on Telemedicine held in Colombia in 2003. In addition to this, it has been mentioned for several persons interviewed[59].

3.2.8 T@lemed

T@lemed: Evidence Based Telemedicine for Remote and Rural Underserved Regions in Latin America Using e-Health Platforms, was a demonstrative project carried out within the @LIS program of the European Union. It took place between October 1st 2003 and September 30th 2006 [47] and was carried out jointly for 14 institutions from different countries such as Universidad Santiago de Cali, Universidad Nacional, *Centro Internacional de Vacunas* and *Cámara de Industría y Comercio Colombo-Alemana* from Colombia and Fraunhofer Society from Germany to name a few [48]. The later institution was in charge of the coordination of the whole project.

This project was created aiming at improving public health care systems quality for those people living in remote and rural underserved regions through the interconnection of high level and quality medical resources available in big cities to those of low level located in remote and rural regions [47]. To do so the project consisted in two subprojects, one in Colombia and other in Brazil. The one taking place in Colombia: "Telemedicine for the diagnosis and treatment of malaria in underserved regions" had two objectives: improving combat against infectious diseases in rural or remote regions in particular for malaria and improving primary care in target regions (i.e. dermatology, radiology)" [47].

The telemedicine system was based on a platform called TopCare developed by Fraunhofer Institute. This system consisted in installing a Topcare telehealth Kiosk in the remote stations and a server in the reference centre. The Kiosk was made up of a PC running GNU Linux [102] and an application for using the telemedicine hardware attached, composed by a video and audio solution suitable for connection to different medical devices such as microscope, X-ray scanners [47] and equipment for taking different measurements such as blood pressure, amount of sugar in blood, etc [48]. For every new patient entered in the application, a report was created, and all medical data acquired: images,

[58]Contacts with Departamento de Ingeniería Electrónica-Universidad del Cauca.

[59]Contacts with *Centro de Telemedicina de Colombia*, email No. 2, contacts with GIB-Universidad EAFIT, call No.1, contacts with Hospital Universitario la Samaritana, email No.5 and contacts with GIT-Universidad de Caldas, call No.2.

measurements, was attached, together with the patient's symptoms [102].

Furthermore, the platform counted with a TopCare telehealth Server in charge of managing the whole telehealth network, supervising every information transfer process in the network and storing every patient's medical data. Furthermore, it is in charge of keeping update all the epidemiological data entering the network [47].

As it was stated above, the project defined two objectives for the subproject carried out in Colombia, each of them corresponded to a different project: the telemedicine network Cali-Costa Pacífica, where a big attention was gave to infectious diseases, concretely malaria, and the telemedicine network Bogotá–Guaviare focused on primary attention [47]. Both of them will be described in detail below.

Telemedicine Network Cali – Costa Pacífica

In this network three Kiosks were installed and adapted for following up of infectious diseases [102] in between August and December 2005 [71]. The first one was installed in Buenaventura, one of the most important cities in the department of Valle del Cauca with 320,000 inhabitants. The Kiosk was installed in a health care centre specialised in malaria, and in 12 months of operation, 334 patients were attended. A second Kiosk was installed in a militar base located in Bahia Malaga, were 500 people lived. This Kiosk attended 11 people in 6 months. The third kiosk was installed in a hospital located in San Andrés de Tamuco, one of the most important cities in the department of Nariño with 150,000 inhabitants. There 94 patients received care in 5 months of operation. Furthermore, a TopCare telehealth server was installed in the *Centro Internacional de Vacunas* located in Cali where supervision and second opinion took place. In addition to this, Universidad Santiago de Cali was in charge of the technical support of the network [47].

Following-up of cases was carried out according to the following protocol: first of all, patients had to sign a document authorizing the telemedicine activity [71], then doctor filled out a pre-designed report with all the information related to the case and sent it together with all the microscope images containing blood samples of the patient [47]. Specialists checked the cases twice a day, following an store and forward basis, each of which took them around 20 minutes [71].

In total 439, cases were attended in 12 months of operation, which included 2632 images, out of which 2271 were from the microscope. A total of 280 cases were identified as malaria (117 de p. vivax, 162 de p. falciparum y 1 p. malarie), resulting negative 156 of them. Furthermore, other

diseases were consulted, such as anemia (35 cases), urine infection (60 cases) and potential dengue (25 cases). However, the telemedicine service only served for diagnosis confirmation: in 25% of cases a uncertainty occurred, but only in 3 cases diagnosis changed [47].

Due to this project a repository containing epidemiological information from the Colombian Pacific Coast was created in order to enable a better epidemiological vigilance planning based on evidence. This network also served for improving skills of health care professionals working in rural and remote areas due to continuous medical training [71].

However, this project also faced some problems such as power supply instability in some of the Kiosks which caused unavailability of the service in particular moments, failures in the communication system due to the bandwidth was not enough for transferring some high quality images and problems related to the lack of security in poor areas [71].

After the project, continuity tried to be granted through the Centro Internacional de Vacunas en Buenaventura, or the Hospital in Tumaco, however, the lack of will from health authorities made it impossible at that time [71]. Nowadays, a new project is trying to be developed in the area with local resources, but it is difficult since institutions does not count with the economic resources, and the communication infrastructure this telemedicine projects require. According to Dr. Yunda, technical responsible of the network at Universidad Santiago de Cali, "if the state does not finance maintenance of this type of networks it is difficult to sustain them since this projects do not make up the core of business of private companes"[60].

Telemedicine network Bogotá-Guaviare

The telemedicine network between Bogotá and Guaviare is a result of the project presented by the Governor's Office of the department of Guaviare an the First National Meeting on Telemedicine held in Colombia in 2003[61]. That project aimed at improving access to both basic and specialised consultation in the area without having to go to a bigger city outside the department, located in the Amazonian jungle. In its initial design it counted with 15 stations, being the reference centre the Hospital San Jośe del Guaviare [36], beneficiary of the T@lemed project. It is worth mentioning that three more care centres belonging to the Governor's Office plan are currently covered by another telemedicine program: the agreement between *Centro de Telemedicina-Universidad Nacional* and

[60] Contacts with T@lemed, email No. 2.

[61] Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.

Caprecom, for more details see Section 3.2.3.

In the T@lemed project this network only counted with two Kiosks, one in San Jose del Guaviare, capital of the department. It was installed in the level two hospital existent in the city in December 2005, where three specialists in radiology, gastroenterology and dermatology were available once a month. The telehealth server was installed in the Centro de Telemedicina-Universidad Nacional, where technical support was also provided. Furthermore, another Kiosk was tried unsuccessfully to be installed in Florencia, department of Caquetá [47], which was finally installed in Riohacha, at the end of the project [103]. In addition to this, due to the project another radiologist and another dermatologist were hired in the hospitals to attend cases once a week, improving considerably attention quality [47].

Similarly to the telemedicine network described above, patients had to sign a document authorizing the telemedicine activity and then consultation took place. In this project, experts answer consultations once a day, with the exception of dermatology cases which were answered once a week. Each case took experts in between 10 and 20 minutes. Although health care staff did not count with experience working with computers, they found Kiosk very easy to use [71].

The whole balance of this network consisted in 1875 cases transferred in 12 months of operation from a single hospital. However, 155 out of them were discarded due to files corruption and were resent. 1602 from the 1720 resulting cases were radiology consultations, 84 were dermatology cases and 12 cases were related to infectious diseases. Second opinion avoided 170 references to Bogotá, which brought great savings to the state, since most people in this department belongs to the subsidized regime, but also to patients who had to pay for their trip and accommodation expenses [47]. It is estimated that by avoiding one reference 5 million COPS were saved[62]. Therefore, this project brought about savings around 800 million COPs. These savings contrast with the 3 million COP invested in the installation of the whole telemedicine network, including operation costs [47].

However, sometimes the Internet connection did not allow online training of doctors. Furthermore, as well as in the other network power supply instability did not enable operation at all times. In the economic stance, although hospitals increased price of examinations in a 125%, increasing a lot its benefits, it did not allow covering expenses such as the Internet connection and efforts from the hospital itself were needed [47].

This project granted continuity of service provision until February 2007 [71]. Then, the institution

[62]Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.

signed a contract with the Centro de Telemedicina-Universidad Nacional, for continuing with the telemedicine activities, due to the great impact it had and the satisfaction of departmental authorities. Later, it was pointed out as one of the candidates of the Caprecom project, and since January 2008 is part of it[63].

T@lemed took part in the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore, it has been also referred by three of the people interviewed[64]..

3.2.9 Fundación Santa Fe de Bogotá

The *Fundación Santa Fe de Bogotá* created the *Centro de Educación Virtual y Simulación* in 2004 [24]. It counts with a telemedicine centre which seeks implementing novel education and health care programs through the use of ICT. These programs aims at allowing Colombian population access to health care services, and providing health care professionals tools for improving their medical skills [53]. During these four years, the Foundation has carried out several telemedicine projects which will be described below. Its worth mentioning here that the information showed in this section comes from interviews with the responsible of the Centre, since it was impossible to recall impact or feasibility studies due to it jeopardizes confidentiality of the company[65].

Doctor Chat

Doctor Chat is an open system for synchronous and asynchronous free teleconsultation developed in 2006 [116]. Halfway through 2008, more than 1200 consultation had been carried out[66], however, since authors were in process of writing an article for an indexed journal, no more details about current situation of the project will be available this year[67].. Despite of this fact, Dr. Valenzuela, responsible of the project, indicates that the service, and health information demand through the Internet in general, continues growing accordingly with the connectivity indexes of the country[68]..

In addition to this, data from an evaluation carried out after its their first six months of operation

[63]Contacts with *Centro de Telemedicina-Universidad Nacional*, email No. 4.

[64]Contacts with *Centro de Telemedicina de Colombia*, email No.2, contacts with Red Piloto de Teleasistencia Sanitaria, email No. 9 and contacts with *Fundación Cardiovascular de Colombia*, call No.2.

[65]Contacts with *Fundación Santa Fe de Bogotá*, email No. 5.

[66]Contacts with *Fundación Santa Fe de Bogotá*, email No. 3.

[67]Contacts with *Fundación Santa Fe de Bogotá*, email No. 5

[68]Contacts with *Fundación Santa Fe de Bogotá*, email No. 5

has been recalled, [116]. This study shows the results of the 270 teleconsultations occurred within that period focusing on three variables: purpose of the consultation, specialty and origin of the consultation. The first variable showed that 55.2% of requests were about symptoms and diseases, and 25.9% about medicaments and treatments; overall 93% requested information and 7% requested immediate action. This is explained as a result of patients preference to get their doubts solved before starting the tedious process of getting a citation with the general doctor, due to the long queues and waits patients have to stand. Regarding the second variable, 91 consultations were related to sexually transmitted diseases, out of which 35% were carried out by people between 18 and 23 years old, showing Doctor Chat as an appropriated tool for sexual education; 28 of them were related to dermatology, 22 to urology and 18 with gastroenterology. When analyzing consultation origin, it is worth mentioning that only 2 of them were carried out from remote areas, whereas the rest came form Bogotá and other main cities. Furthermore, the study shows other results such as gender of the consultant, 168 (62.2%) were women, and satisfaction with the system, out of the 19 that voluntarily replied, 18 of them (95%) were satisfied.

Teledermatology project

Along 2007 the Centre also created a teledermatology platform aiming at supporting resolution of cases with an impact over public health in first level hospitals located in isolated areas of the country[69]. However, due to legal issues related to health care provision on a telemedicine basis, it had to stop and it is now being redesigned[70]. While the project was active, the platform was accessible to hospitals located in the north of the country whose connectivity was granted by the Compartel program, and 29 doctors got registered. They attended cases in different categories, such as urticaria, erythema, infectious and inflammatory dermatitis and skin tumor[71].

Virtual Clinics

The Centre counts with two virtual clinics, one regarding pain and and another one regarding palliative care[72]. Furthermore, another virtual facility regarding anti-coagulation will join soon the two

[69]Contacts with *Fundación Santa Fe de Bogotá*, email No. 3.
[70]Contacts with *Fundación Santa Fe de Bogotá*, email No. 5.
[71]Contacts with *Fundación Santa Fe de Bogotá*, email No. 7.
[72]Contacts with *Fundación Santa Fe de Bogotá*, email No. 7.

existing ones. Their purpose is allowing interaction among specialists, between them and students and among both and patients, for supporting the face-to-face attention provided in the Hospital Universitario of the Foundation[73]. However, no more details could be retrieved, since Dr. Valenzuela assured that he could get them but it would take a time not suitable for the framework of this research[74].

Other Projects

In addition to the projects described above, three more projects are being carring out currently by the Foundation: two projects for evaluating impact and cost-effectiveness of teleconsultations systems regarding: a) suicide risk and b) sexually transmitted diseases in schools located in Bogotá DC; and the third one, together with the GIB-Universidad de los Andes, for developing a methodology for evaluating means of digitalizing radiologic images[75].

Fundación Santa Fe de Bogota has also a big concern on virtual education and counts with a program of the kind regarding medicine. More than ten online courses has taken place, with more than 4200 students from the whole continent. In addition to them, five more courses are planned to be developed along 2008[76].

Furthermore, *Secretaría de Salud* has authorized recently the *Centro de Telesalud* of the Foundation as a reference centre [53]. This will allow the institution to provide different health care services on a telemedicine basis such as internal medicine, cardiology, gynaecology and pediatrics, and taken up again teledermatology services[77]. This event may serve as well for making use of results of the PESCA project, which is currently carried out jointly with Universidad Austral from Argentina, with the purpose of implementing a digitalized clinical history with support for communication with mobile devices in first level hospitals[78].

One more project was designed by the Foundation, but it never became operational: ARCAL 007. It was an International Atomic Energy Agency project presented in the First National Meeting on Telemedicine held in Colombia in 2003 by the Foundation, its national coordinator. It aimed at grouping through a telemedicine network all nuclear medicine centres both nationally and continen-

[73]Contacts with *Fundación Santa Fe de Bogotá*, email No. 7.
[74]Contacts with *Fundación Santa Fe de Bogotá*, email No. 5.
[75]Contacts with *Fundación Santa Fe de Bogotá*, email No. 3.
[76]Contacts with *Fundación Santa Fe de Bogotá*, email No. 3.
[77]Contacts with *Fundación Santa Fe de Bogotá*, email No. 7.
[78]Contacts with *Fundación Santa Fe de Bogotá*, email No. 3.

tally for optimizing existing resources and improving service quality. However, no more information was found about this project in the Internet and, moreover, Dr. Romero, director of the *Centro de Telemedicina-Universidad Nacional*, institution in charge of its continental coordination, had never heard of it[79].

Fundación Santa Fe de Bogotá presented its activities in the First National Meeting on Telemedicine held in Colombia in 2003. In addition to this, it has been mentioned for one person interviewed[80].

3.2.10 SaludCoop

SaludCoop is one of the biggest Colombian EPS, since it counts with more than 5,500,000 affiliated people and it is present in more than 900 cities and towns in Colombia through 13 regional offices for covering 27 departments of the country[81]. In April 2002, it developed a Telemedicine Program as a support to the great geographic scattering of their affiliates and the low offer provided in several specialties in particular areas of the country[82]. Nowadays, the coordinator of the program is Mrs. Rubi Patricia Arias, who has been interviewed to collect more information about this program.

The program offers health care services on a telemedicine basis in several specialties, but currently the most demanded ones are: specialties in pediatrics such as neuropediatrics, endocrinology, gynecology, gastroenterology, and cardiology, and other specialties such as HIV treatment both in children and adults, neumology, oncology, endocrinology and orthopedy[83].

Telemedicine services are provided according to the following protocol: whenever a doctor located in remote SaludCoop centre identifies a case he/she is unable to solve, he/she makes an appointment with a specialist in Bogota, where the reference centre, 104 Jose Piñeros Cortas, is located. Once the appointment is arranged, the remote doctor prepares the case and sends the clinical history, together with the relevant files to the specialist who will attend the case. Then, the specialist provides attention to the patient in real time at the moment the appointment was arranged[84].

[79] Contacts with *Centro de Telemedicina-Universidad Nacional*, call No. 2.

[80] Contacts with GIB-Universidad de los Andes, email No. 3.

[81] Contacts with SaludCoop, call No 2.

[82] Document attached in Contacts with SaludCoop, email No. 2. Arias, Rubi Patricia, "Telemedicina Grupo SaludCoop", July 15th 2008.

[83] Document attached in Contacts with SaludCoop, email No. 2. Arias, Rubi Patricia, "Telemedicina Grupo SaludCoop", July 15th 2008.

[84] Contacts with SaludCoop, call No. 2.

Nowadays, SaludCoop counts with 22 health care centres. All of them are shown, in Table 3.7, and as it can be seen, are scattered along the country[85]. It is worth mentioning that all 22 of them are located in big cities, which facilitates the provision of real time services due to they count with telecommunication infrastructure. On the other hand they are far from rural areas where people in need of these services live.

The number of consultations carried out during 2007 per regional office are shown in Table 3.7[86]. A total of 21581 patients were attended. The price of this consultation is established by the government according to the income level of the patient, and it ranges from 1,800 and 18,000 COP, (around 1 to 10 USD)[87].

According to Mrs. Arias, it is difficult to know exactly how many doctors are involved in telemedicine tasks, since teleconsultation depends on shifts and service demands, which are compulsory covered for almost all doctors. Regarding patient satisfaction, Mrs. Arias defines it as a learning process, where in the beginning patients showed great distrust, but slowly they got used to the way health care was provided and nowadays they are very satisfied. Even so, Mrs. Arias highlights the fact that patients from very remote areas were from the beginning very satisfied with the service, since they had never before had the chance of benefiting from attention in particular specialties[88].

SaludCoop participated in the the First National Meeting on Telemedicine held in Colombia in 2003, and furthermore has been referred by Dr. Romero and Mrs. Hoyos[89].

3.2.11 GIB-Universidad EAFIT

GIB-Universidad EAFIT deployed a telemedicine pilot project in Medellín, between the *Centro de Diagnóstico Radiológico* CEDIMED and the *Centro de Resonancia e Imágenes* CERI which results were published in [55]. It was carried out together with the *Instituto de Ciencias de Salud* (CES) and

[85]Document attached in Contacts with SaludCoop, email No. 2. Arias, Rubi Patricia, "Telemedicina Grupo SaludCoop", July 15th 2008.

[86]Document attached in Contacts with SaludCoop, email No. 2. Arias, Rubi Patricia, "Telemedicina Grupo SaludCoop", July 15th 2008.

[87]Document attached in Contacts with SaludCoop, email No. 2. Arias, Rubi Patricia, "Telemedicina Grupo SaludCoop", July 15th 2008.

[88]Contacts with SaludCoop, call No. 2.

[89]Contacts with *Ministerio de la Protección Social*-Caprecom, call No. 2 and Contacts with *Centro de Telemedicina-Universidad Nacional* call No. 2.

Table 3.7: Cases attended in Piss served by Salud Coop

SaludCoop Regional Office	High Complexity Corporative Centres	Medium Complexity Corporative Centres	Other Institutions	Cases 2007
Antioquía	Clínica Juan Luis Londoño (Medellín)	Clínica Apartadó (Apartadó – Antioquía)		482
Boyacá	Clínica Tunja (Tunja)		C. E. Duitama . (Duitama)	4513
Córdoba		Clínica Montería (Montería)		651
Costa	Clínica Julio E. Medráno (Barranquilla) Clínica Santa Marta (Santa Marta)		C. U. Cartagena (Cartagena)	658
Cundinamarca	Clínica 104 Jorge Piñeros Corpas (Bogotá)	Clínica La Mesa (La Mesa)	IPS Leticia (Leticia)	9174
Eje Cafetero	Clínica Armenia (Armenia – Quindío)	Clínica Pereira (Pereira)		1087
Huila	Clínica Santa Isabel (Florencia – Caquetá) Clínica Neiva (Neiva)	Clínica Pitalito (Pitalito – Huila)		356
Llanos	Clínica Llanos (Villavicencio)			1815
Nariño	Clínica Los Andes (Pasto)			236
Norte de Santander	Clínica La Salle (Cúcuta)			472
Occidente	Clínica Cali (Cali)			81
Santander	Clínica Bucaramanga (Bucaramanga)			88
Tolima	Clínica Ibagué (Ibagué)			1968

consisted in three stages: storage, data transmission and visualisation.

The first one was carried out through computerized tomography and magnetic resonance devices. These devices acquired medical studies in a DICOM format and storaged them in a server. Data transmission was performed through a virtual private network, where both stations communicate through Internet via RDSI lines, which allowed 64 Kbps per channel. For communicating they used a software called Terminal Service which allowed synchronous remote access to the stations, guaranteeing this way security, integrity and confidentiality of data. Working stations located in the institutions, acted as clients and could access the server for transfer and visualisation in real time, as well as downloading medical images asynchronously for a detailed checking. Visualisation was carried out through a Java application developed by the group. It allowed to work with DICOM files, and to convert them to other formats such as jpeg, tiff or bmp. An evaluation study was carried out by expert radiologist from both institutions to assess diagnosis quality of images sent, consisting on sets of computerized tomography, ultrasound, magnetic resonance, nuclear medicine and digital radiography concluded that 1,525 out of 2,023 (75.38%) images had the same quality as the traditional ones.

This project was carried out in order to assess technical feasibility of the system, which was wanted to be used in a similar project that would link the Hospital Universitario San Vicente de Paul and the *Instituto de Alta Tecnología Médica de Antioquía* (IATA) through Universidad EAFIT. In the future, this node would act as Central Node of an hypothetic Metropolitan Teleradiology Network in Medellín [61]. However, this project did never become operational since both institutions broke their agreement before the project started[90].

Nowadays, GIB is working on the security tests of the teleradiology network. Moreover, they are carrying out a project called MANTIS-GRID, for interchanging medical images using Renata infrastructure. This project is carried out, together with CES and *Escuela de Ingeniería de Antioquía*[91].

GIB-Universidad EAFIT took part in the First National Meeting on Telemedicine held in Colombia in 2003.

3.2.12 Centro de Telemedicina de Colombia

The *Centro de Telemedicina de Colombia* was created with the purpose of providing support to those living in remote and isolated areas, and those hurt by land mines because of regional and

[90] Contacts with GIB-Universidad EAFIT, call No 1.

[91] Contacts with GIB-Universidad EAFIT, call No 1.

national armed conflicts [119]. This support could be translated in teleeducation programs, providing expert remote support and follow-up of patients. Furthermore, it could serve for carrying out a better statistical control and, therefore, a better planing of health initiatives developed in the area. Statistical information could be epidemiological and geographic, containing data about areas where land mines were located and areas where armed conflicts were taken place. It would also serve to receive advice from the International Rehabilitation Centre, a partner in charge of providing support for rehabilitation of land mines victims [119]. However, none of these activities have been confirmed by none of the creators of the Centro, Dr. Navarro and Dr. Velez[92], interviewed about this issue.

On the other hand, the *Centro de Telemedicina de Colombia* has carried out an intense work in remote education. Part of this concern is reflected in the course about *Telemedicina y Simulación Médica* they have created for the *Ingeniería en Sistemas y Computación* degree in the Pontificia Universidad Javierana (PUJ), where more than 80 students have acquired basic skills for controlling different environments for telemedicine and telehealth simulation. This course counts with the support of the PHO, ITU and the Organization of American States(OAS) [120]. The principal services bear by the software architecture of the simulator are telesimulations of surgical specialties in ophthalmology and othorrinolaryngology [120]. The simulator emerged as a Centre idea, however it was 100% financed and carried out by the Destino Group and the PUJ. Despite of its use for teleeducation purposes, it has not yet used in real cases[93].

In addition to this simulator, and with the same purpose of integrating education and training, they have also developed, together with Universidad Icesi, a system for supporting diagnosis and surgical activities in paranasal sinuses, a tool for virtual surgery planning and, together with DITEC with Universidad de Murcia, Spain, a system for image processing [120].

Furthermore, the *Centro de Telemedicina de Colombia* has taken part in the development and implementation of a postgraduate course in the Universidad Icesi, which has allowed a new model of international cooperation including countries such as United States, Canada, Spain, Argentine, and Ecuador[94].

The Centro de Telemedicina presented its results in the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore, it is present in both systematic review retrieved [72] and [115].

[92]Contacts with *Centro de Telemedicina de Colombia*.

[93]Contacts with *Centro de Telemedicina de Colombia*, email No. 2.

[94]Contacts with *Centro de Telemedicina de Colombia*, email No. 5.

In addition to this, it has been mentioned for two persons interviewed[95].

3.2.13 Hospital Universitario La Samaritana

In 1995 began a project for the creation of a telemedicine network in the department of Cundinamarca, promoted by Hospital Universitario La Samaritana, one of the biggest of Colombia, and the Governor's Office of Cundinamarca. This project aimed at implementing a teleradiology program for helping to solve a problem of attention in the public health network of the department. To do so, four hospitals located in La Mesa, Fusagasugá, Zipaquirá and Facativá, were provided with connection devices for communicating with its hospital of reference, Hospital Universitario La Samaritana, becoming the first teleradiology experience in the country [57].

The project began due to an agreement with a Colombian Company called Vision Technology Group (VTG) who provided the hardware needed for this project. The evaluation of radiologies was carried out by specialists hired through outsourcing by the same company. In addition to this, technicians were hired by each health care centre involved for taking radiology images, which improved its quality, and optimized radiologists time for carrying out other jobs[96].

The system worked as follows: the remote doctor requested a particular set of radiology studies, including in the request his/her hypothetical diagnosis, then, the technicians took all the radiologies requested and sent them to the central office of the evaluation company through a methodology called Disperse Reading, using traditional telephone lines. Once in the central office, data was sent to the radiologist on duty, who was in charge of the evaluation of the medical images. Once evaluation was completed a report was sent back by fax to the remote health care centre [11].

According to Dr. Kopec, Scientific Manager of the Hospital Universitario La Samaritana form 1995 to 1999, the beginning of the project was not easy do to resistance to the technological change from both patients and doctors. However, once they got to know the system, fear disappeared. In deed, people from near villages started to demand the service[97].

This pilot project, which finally began in May 1996, attended 2754 cases in 9 month of operation, 358 of which were emergency cases. For these special cases mean response time was one hour, whereas, for the rest of cases, it was about 8 hours. These cases helped to increase billing of the insti-

[95] Contacts with Fundación CardioVascular, call No. 2 and contacts with GNTT-Universidad de Caldas.

[96] Contacts with Hospital Universitario La Samaritana, email No. 5.

[97] Contacts with Hospital Universitario La Samaritana, email No. 5.

tutions involved: in a 25% in the remote health care centres and 22.5% in the regional hospital [57].

However, despite of the system validation and the reduction of costs, since remission of patients was avoided, factors such as the change in the health centres managers brought about the abandoned of the project one year after it became operational [57]. According to Dr. Torres, current director of the telemedicine group of the hospital, another factor was the lack of an application in charge of an ordered billing, since although results showed to be positive, at that time there was a great feeling of a negative economic impact[98].

Nowadays, the hospital counts with a research group called GINIC-HUS [25], directed by Dr Torres [63], which is working on a project for updating the communication system within the hospital for enabling digital managing of medical images. Furthermore, they are designing a project for interconnecting via Internet three remote centres of the departmental network for providing again teleradiology services[99]. In addition to this, Hospital Universitario La Samaritana uses Esoft systems, which are described in Section 3.2.22.

Hospital Universitario La Samaritana participated in the First National Meeting on Telemedicine held in Colombia in 2003. Furthermore, it has been also referred by one of the people interviewed[100].

3.2.14 Ecopetrol

In [100] and [72] they mentioned a telemedicine project designed by Ecopetrol (Colombian Petroleum Company) for supporting teleconsultation and telediagnosis by videoconference when complex cases would occur in its facilities. It also aim at generating standards for attention and prevention of emergencies and training employees. The responsible of the project was Jorge Alberto Velez, current director of the *Centro de Telemedicina de Colombia*, who, in one of the interviews held, pointed out that after working in the analysis and design phases, the project "was never carried out"[101].

[98] Contacts with Hospital Universitario La Samaritana, email No. 2.
[99] Contacts with Hospital Universitario La Samaritana, email No. 2.
[100] Contacts with GIB-Universidad de los Andes, email No. 2.
[101] Contacts with *Centro de Telemedicina de Colombia*, email No. 5.

3.2.15 Vision Technology Group

At the mid-nineties the Colombian company Vision Technology Group developed the first teleradiology network in Colombia, described in Section 3.2.13, and followed with an endless number of contracts with several health care institutions in the country [43].

Among these projects, it is worth mentioning the one developed within the framework of a an agreement signed with the *Instituto de la Seguridad Social* of Cundinamarca, which then, and still today is considered one of the biggest teleradiology projects in the world [106]. In an article published in Telemedicine Today in October 1997, it was the one with higher productivity indexes, and with more telemedicine studies transmitted [11]. This project took place in the *Centros de Atención de Ambulatoria* (CAA) which had the appropriate infrastructure for offering teleradiology services, such as x-ray devices [39]. These institutions were also provided with a system for capturing and digitalizing images took from the x-ray machine, which was compliance with DICOM standard, and with a personal computer with an Internet connection through standard telephone lines. In the diagnostic center, placed in Cali, a server using Windows NT and a software for managing billing and delivering reports was installed. Furthermore, the system also counted with a software for radiology reports management designed by VTG [108]. This way, radiology services were provided on a telemedicine basis with an availability of 24 hours a day, 365 days a year.

The project lasted 21 months, between 1997 and 1999, and began in the following CAAs: Alquería – La fragua, Chapinero and Central located in Bogotá DC and Muña located in Sibaté [39]. Lately, the project was extended to other CAAs: Kennedy, La Granja and Comercial y Bancario, located also in the Capital, and the CAAs located in the municipalities of Madrid, Facatativá and Zipaquirá [65], reaching a total of 10 CAAs. The way this project operated was equal to the one used in Hospital Universitario La Samaritana, described in detail in Section 3.2.13. In this project, emergency cases review took 3 hours and the rest of them a maximum of 24 [43]. Furthermore, follow-up and training courses took place every two months, in order to solve deficiencies identified in previous visits [11].

During this time a total of 173,725 cases were attended. These data were also used for carrying out a comparative study between the costs originated to do so, and the costs that this attention would have cost using traditional methods. This study was published in [11] and showed that costs were reduced in a 57%. Furthermore, another economic study with same purpose was carried out by Finconsult in between May and November 1998. It concluded that with the same budget used by

VTG,130% patients more could have been attended11. Additionally to the savings and the increase in productivity, VTG counted with a software which allowed them to analyze management issues. Results from this software, which was installed in the following CAAs: Kennedy, Madrid, Alquería, Chapinero and Central, showed that studies had a high technical quality (2.4 out of 3), and that very few were rejected (1.3%) [107].

Thanks to these results, the system was extended to several places. ISS decided to contract VTG services for the health centres of San Pedro Claver, Carlos Lleras Restrepo, San Blas, Guavio and Niño in Bogotá DC [65] [72]. Furthermore, Governor's office of the department of Valle del Cauca department, contracted its services for providing teleradiology consultation in several cities such as Tuluá, Cartago, Roldanillo, Sevilla and Caicedonia [43]. Moreover, other radiologic centres along the country such as those in Duitama, department of Boyacá, or Villavicencio in the department of Meta, also contracted its services. In addition to this, many companies worked jointly with VTG for developing their own teleradiology networks. That was the case of Radiólogos Clínicos with a network among Bogotá, Manizales and Girardot, Mediagnóstica with a network among Duitama, Sogamoso and Belencito and Sabag Radiólogos in Barranquilla. At the highest peak of operation, the company counted with 25 radiologists providing service to 22 public hospitals and 7 private institutions [72].

However, according to Dr. Tavera, creator of the company, in spite of carrying out more than 500,000 consultation along 5 years of operation, the company could not survived the Colombian economic crisis at the end of the last decade [106]. This factor, joined to a reduction on the prices of traditional radiology services, made the company disappear at beginning of the century [72].

VTG teleradiology project is present in one of the systematic review retrieved [72].

3.2.16 Cardiobip Ltd

The telemedicine project carried out by the Colombian company Cardiobip Ltd consisted in a cardiac telemetry network which began its activities in 1994. It covered a great area of the country and provided the service to a wide range of the population, reaching, at its operation peak, 113 hospitals and health centers along Colombia. Due to initial resistance from cardiologists who feared that patients attended on a telemedicine basis decided not to come back, the system was mainly installed in public hospitals [72].

For transmitting electrocardiograph images it used traditional phone lines and cellular mobiles

networks. Although both of them suited the telecommunications needs of the system, there is no formal evaluation which supports this point. The use of already existing telecommunication infrastructure allowed low cost diagnosis about almost any heart failure susceptible to be detected by an electrocardiogram. Furthermore, it allowed service provision 24 hours a day, 365 days per year, regardless geographic and weather issues. Devices used were able to transmit any number of electrocardiograms a day, with the only limitation of the time needed for the transmission of the study, which took 3 minutes [72].

In April 1998 a group of cardiologist from Cardiobip carried out a study obtaining samples of 1000 patients. 682 of them showed symptomatology, and 318 were used as a control group. The results showed that 31% of the studies presented arrhythmia traces, 30.8% presented blocks, 24.2% hypertrophy and 42.8% showed a coronary disease. Out of them, 340 (34%) therapeutic and clinic recommendations were made in order to solve the heart failures detecteds [72].

However, success decreased and at the end of 1999, out of the 113 health centres covered, 33 remained, mainly located in Cundinamarca, but also in Tolima, Antioquía, Caldas, Norte de Santander, Quindio and Meta[102]. Most of this reduction was related to the end of the contracts with the Ministerio de Salud and the *Secretaría de Salud* of Bogotá DC. Since that moment hospitals and health centres had to contract directly Cardiobip Ltd services. However, according to Law No. 100 level 1 hospitals could not offer specialised services and therefore could not contract Cardiobip Ltd telecardiology services. In addition to this, once individual institutions contracted its services, the economic situation in the country at the end of last decade caused that several institutions could not afford payments[103]. This lack of liquidity caused that in 2002 the company only provided services 8 hours a day [72]. Although Cardiobip Ltd was bought by the Aviatur Group some years later[104], the program is currently out of service since the devices are obsoletes[105].

Cardiobip Ltd. teleradiology project is present in one of the systematic reviews retrieved [72].

[102]Document attached in Contacts with Cardiobip Ltd., email No.5. Cardiobip Ltd. Informe del Gerente Correspondiente al ejercicio del año 1999. Junta de Socios, March 16th 2000.

[103]Document attached in Contacts with Cardiobip Ltd., email No.5. Cardiobip Ltd. Informe del Gerente. Junta Extraordinaria de Socios, December 3rd 1999.

[104]Contacts with Hospital Universitario La Samaritana, email No. 5.

[105]Contacts with Cardiobip Ltd., email No.2.

3.2.17 GITEM-Universidad Distrital Francisco José de Caldas

GITEM-Universidad Francisco Jose de Caldas is currently implementing a project called *Gestión de Salud para el Distrito Capital*. This project is being carried out jointly by GITEM and Empresa de Telecomunicaciones de Bogota, ETB, which is in charge of providing the infrastructure. It aims at promoting integral attention in interconsultation and improving hospital resources management in Bogotá DC. The infrastructure used will allow to provide other telemedicine services such as telediagnosis and teleducation, and using other information systems such as medical history management and teleadministration. To carry out this design, they performed an in-depth analysis of the communication needs of Bogotá DC [6]. No more information related to the project can be provided, since, even after Dr. Aparicio, director of GITEM, offered to send me information, she never did so[106].

GITEM-Universidad Distrital Francisco Jose de Caldas took part in the First National Meeting on Telemedicine held in Colombia in 2003, and has been referred by Mr. Calderón, Dr. Castillo and Dr. Romero[107]. In addition to this, it appears in [115].

3.2.18 GIB–Universidad de los Andes

GIB has been referred by several contacts as an active member in the telemedicine arena in Colombia[108]. Therefore, contact was established with its director, Dr. Briceño. He pointed to Dr. Salazar as the person in charge of telemedicine within GIB and provided me with his contact information[109].

According to Dr. Salazar GIB does not provide health care services on a telemedicine basis since it would entail registering as an IPS, which is not within University's current interests. However, they carry out several telemedicine activities such as the creation of a Telemedicine lab last year[110]. One of the projects developed there, carried out jointly with Fundación Santa Fe de Bogota, aims at proposing a methodology for evaluating means of digitalizing radiologic images[111]. Furthermore, they count with a big research and development program regarding hospital information systems and

[106]Contacts with GITEM-Universidad Distrital Francisco Jose de Caldas.

[107]Contacts with Red Piloto de Teleasistencia Sanitaria, emails No 3 and 9, and contacts *Centro de Telemedicina-Universidad Nacional*, call No.2.

[108]Contacts with GIB-Universidad EAFIT, call No. 1, contacts with Fundación Santa Fe de Bogota, email No.3 and contacts with Hospital Universitario La Samaritana, email No.2.

[109]Contacts with GIB-Universidad de los Andes, call No. 1.

[110]Contacts with GIB-Universidad de los Andes, email No. 2.

[111]Contacts with GIB-Universidad de los Andes, email No. 2.

medical processing[112].

3.2.19 Facultad de Medicina-Universidad de Antioquía

TeleMAP stands for *Herramientas Tecnológicas para la prevención y atención a víctimas de MAP – MUSE* and it is promoted by the Facultad de Medicina of the Universidad de Antioquía[113].. The program is within implementation process, but it will cover areas affected by the land mines conflict. All the design process was carried out locally, which will allow a better maintenance of the network in the future[114].

As it figured in its name, TeleMAP addresses two issues: prevention and attention. The prevention area is based on virtual education programs for continuous training of health care professionals and community agents. This will provide a constant link with training institutions, which will improve local people's skills. By joining efforts with the other institutions working there: *Servicio Nacional de Aprendizaje* (SENA) and Universidad de Antioquía, this will strengthen prehospitalary attention and formation of professional technicians. This area is composed by the departments of Chocó, Antioquía and Caldas, the three departments where more land mines victims are located, but it might be enlarged to cover the department of Nariño[115]..

Telemedicine component of TeleMAP is based on a complex structure where Hospital San Vicente Paul facilities, in Medellín, will be both the reference centre and the institution in charge of coordinating all cases. Thus, all the decisions for allocating cases to the appropriated department will be made there. Furthermore, in this hospital land mine victims be cared. In this infrastructure, IPS Universidad de Antioquía will be in charge of the rest of the telemedicine services[116]..

Communication among centres will be based in a videoconference system with support for another channel for transferring information related to the patient (electrocardiograms, vital signs, heart

[112]Document attached in contacts with GIB-Universidad de los Andes, email No. 2. Salazar, Antonio, "Telemedicina y Sistemas de Información hospitalaria". GIB-Universidad de los Andes.

[113]Document attached in Contacts with Facultad de Medicina-Universidad de Antioquía, email No. 2. Facultad de Salud, "Centro de Simulación"

[114]Contacts with Facultad de Medicina-Universidad de Antioquía, email No. 2

[115]Document attached in Contacts with Facultad de Medicina-Universidad de Antioquía, email No. 2. Facultad de Salud, "Centro de Simulación"

[116]Document attached in Contacts with Facultad de Medicina-Universidad de Antioquía, email No. 2. Facultad de Salud, "Centro de Simulación"

sounds, etc). Whenever possible, broadband Internet will be used as transmission platform, when not, other technologies such as microwave signals, mobile cellular phones and traditional telephone lines will be used. In addition to this, TeleMAP is complemented with a program for domiciliary telecare and psychology support of the victim and his/her family[117].

This project has been referred by Dr. Velez[118].

3.2.20 EIT-Universidad Pontificia Bolivariana

EIT-Universidad Pontificia Bolivariana was created through an agreement between two research groups of the Universidad Pontificia Bolivariana, *Grupo de Investigación en Bioingeniería* and *Grupo de Investigación, Desarrollo y Aplicación en Telecomunicaciones*, for carrying out *Red de Telemedicina de Antioquía* [72]. This project counted with financing from Colciencias and *Ministerio de Comunicaciones* through the call for Telemedicine and Teleducation projects from March 2000. It focused on health care centres, health care posts and hospitals located in the department of Antioquía and aimed at interconnecting those located in the Aburrá Valley for better resolution of medical cases through a videoconference system [43].

EIT considered many technological alternatives for the development of the network, and finally decided to use RDSI due to several factors: it adapted better to the requirements of their applications, it offered an excellent cost-benefit ratio and an easy management [43]. However, time past designing the different applications for this technological solution and by the time the project was ready to carry out evaluation tests, RDSI was no more as available as in the past and it was being substituted for other solutions in the region. Therefore, as the applications were designed for this specific technology, it was impossible to implement the network, which is now within a redesign process[119].

Although *Red de Telemedicina de Antioquía* has been never deployed, it appears in the two systematic reviews regarding telemedicine projects in Latin America retrieved [115] and [72]. Furthermore it is has been referred by some of the people interviewed[120].

[117]Document attached in Contacts with Facultad de Medicina-Universidad de Antioquía, email No. 2. Facultad de Salud, "Centro de Simulación"

[118]Contacts with *Centro de Telemedicina de Colombia*, email No.5.

[119]Contacts with EIT-Universiad de Antioquía, email No. 5.

[120]Contacts with *Centro de Telemedicina de Colombia*, email No. 5., contacts with Hospital Universitario La Samaritana , mail No. 5, and contacts with Red Piloto de Teleasistencia Sanitaria, email 9.

3.2.21 Asociación Colombiana de Medicina, Informática y Telesalud

Asociación Colombiana de Medicina, Informática and Telesalud is mentioned in the First National Meeting on Telemedicine held in Colombia in 2003 [19]. Its president is Alberto Kopec, one of the main actors within the Telemedicine field in Colombia, for instance he was Scientific Manager of the Hospital Universitario La Samaritana within the period 1995- 1999 and he is the co-author of [72], a reference document about Telemedicine in the Andean Region. In one of the interviews we held, he told me he is "developing the Association for creating in Colombia an institution with no profit motive in mind, where all actors involved in telemedicine development can access a forum where interchange ideas and progress jointly"[121]. However, the forum is not ready yet.

3.2.22 Esoft Ltd

Intelligent Information Systems (former Esoft Ltd., and nowadays Bitakora Ltd.) was created in 1999 by Didier Beltrán and Mauricio Parra, together with an interdisciplinary group of professionals aiming at promoting technology use by implementing last mile applications for provision of telemedicine [45].

Among its developments, it is worth mentioning a platform called *Gestión Médica*, which allows real time retrieval and handling of medical histories through an electronic bracelet wore by patients. This device sends radio signals to other electronic devices such as Personal Digital Assistants (PDA) using a technology called RFID. When both devices are located close, the medical history appears automatically in the screen. Then, the document can be read and modified in real time. Furthermore, the system allows telepharmacy services, since once a treatment is written in the application, the pharmacy of the hospital instantly gets the request. *Gestión Médica* also allows teleconsultation services with other departments side the hospital [38]. It is worth mentioning that data travel through wireless links located along the building which count with tools for guaranteeing integrity and security of every transference [12].

In addition to this, Esoft Ltd provides training courses for the appropriate use of the platform, since it has identified that the cultural change introduced by this platform introduces is very big. According to Parra, creator of the application, at the beginning of the company health care managers

[121] Contacts with Hospital Universitario la Samaritana, email No. 5.

Table 3.8: Impact of Gestión Médica

Activity	Gestión Médica expend time (min)	Traditional method expend time (min)
Medical Consultation	5	15
Transport of the consultation report	0	30
Time between the emission of an order and its execution	2	25

rejected the system due to its novelty[122]. To convince them, they constructed a fake health care centre where they showed how the system worked. Due to this strategy, they started providing services in Hospital Universitario Santander and Hospital Universitario La Samaritana [38].

Operation at the Hospital Universitario Santander started in September 2007. There, the platform interconnects several departments such as neurosurgery, general and plastic surgery, urology, radiology, pharmacy and the clinical lab. This has provided several benefits to the institution, including elimination of failures due to the wrong read of handwriting notes. It has also improved the provision of accurate information which allows to optimize procedures and increase staff productivity. All these benefits reflect on attention quality, which increases widely, and, therefore, improves patients' quality of life [63]. However, there are very few available data to confirm this, since, although Esoft counts with different feasibility and impact evaluations, they are not available due to confidentiality issues[123]. The only available one shows that optimization of procedures mentioned above is justified through the the results showed in Table 3.8, which compared the impact of the use of *Gestión Médica* on the traditional means of attention [45]:

According to Parra, the success of the platform comes from three factors: the innovation of the product, the ease of use due to the graphic design of the software allows intuitive handling of the platform, and the long training experience, which allows users to benefit quickly from the platform advantages[124].

Esoft Ltd. was referred by Dr Kopec[125].

[122]Contacts with Esoft, call No. 1.

[123]Contacts with Esoft, call No. 1.

[124]Contacts with Esoft, call No. 1.

[125]Contacts with Hospital Universitario La Samaritana, email No.5.

3.2.23 Dr. Díaz

Dr. Gonzalo E. Díaz offers several telemedicine services through his website [40]. Among them, there are setting up of telemedicine networks through wired and wireless technologies, remote image diagnosis, remote fetal ultrasound scan diagnosis, and telemedicine training on digital medical image interpretation. No more information can be provided regarding this institution due to infructuous contacts with them, which currently they only answer questions regarding support for setting up networks[126].

3.2.24 ITMS-Colombia

ITMS (Telemedicina de Chile) is an affiliate company of Global Telemed, a Swiss telemedicine company with great experience in the field [67]. ITMS started its activities in Colombia in 2007, and nowadays provides health care services on a telemedicine basis in 135 health care centres from the departments of Antioquía, Cundinamarca, Risaralda, Quindió, Huila, Caquetá and Bogotá D.C. During this period, ITMS-Colombia has attended around 30,000 patients in the following specialties: tele-electrocardiography, ambulatory tele-monitoring of arterial pressure and tele-esperiomerty[127]. This last service consists in analysing patient's saliva looking for respiratory diseases. Both, this service and tele-electrocardiographies, are requested by the doctor, who is in charge of taking the sample and sending it to the specialist. For tele-monitoring of arterial pressure, patients need to carry a device for 24 hours which measures and records arterial pressure every 15 minutes. Once the record has been done, the remote doctor sends it to the specialist [68]. According to Mr. Zeballos, director of the company, for acute coronary events average response time is less than 10 minutes, while the average for the rest of reports is 20 minutes.

It is also worth mentioning that, before starting providing services, ITMS carried out an evaluation comparing between an electrocardiograph which provide digital images and a traditional one. Results showed that traces obtained through both methods were so similar, that no differences were found between them [44].

According to Mr. Zeballos, ITMS success in Colombia is due to the good performance of the devices they used, mainly imported form Europe and Israel. In addition to this, he points to the use

[126] Contacts with Dr. Díaz, email No. 3.

[127] Contacts with ITMS-Colombia, email No.2

of a macro-software developed by them which allow health care professionals to telework, as another important factor for it success[128].

ITMS-Colombia was referred by Martha Giraldo, the expert contacted[129].

[128]Contacts with ITMS-Colombia, email No.2

[129]Contacts with expert selected, email No.2.

4 Analysis

Once information about all projects retrieved have been presented, it needs to be classified according to the indicators detailed in Section 2.2.1, and assessed according to the scientific evidence of the data found according to the nine-level categorization described in Section 2.2.2. In this section these two tasks will be carried out in a project by project basis.

4.1 Analysis of the projects

4.1.1 Ministerio de la Protección Social-Caprecom

This project contains, in its own purpose, a reference to one of the indicators detailed in Section 2.2.1: (**10) accessibility to a higher quality health care system**. This is confirmed by two facts: on the one hand the intense revision carried out by *Grupo de Atención en Emergencias y Desastres* identificating those departments lacking of key services for emergency attention. On the other, Ministry data about number of patients attended after six months of operation, exceeding 3,000. In addition to this, short response time (2 hours) may also have a great impact on the **(8) system utility**. Despite these promising numbers, none of these data come from descriptive documents which contains no scientific evidence and, therefore, any recommendation can be given.

Something similar happens with the **(4) acceptance** indicator. Although, it seems that being a Government project, institutional sustainability will be granted for many years, there is no scientific evidence which ensures that this will always be true further than the end of 2008.

4.1.2 GIT-Universidad de Caldas

Despite the lack of commitment of some health centres managers with the teledermatology project carried out by GIT, it seems to count with a good (4) acceptance, due to the agreement with the Departmental Office for Health. Product of this acceptance is the proposal for extending the project mentioned by Dr. Arbelaez. However, as well as it happened with the previous project, data come from descriptions made by the coordinator of the project, thus bearing none scientific evidence.

Data regarding patients attended by this service, more than 2,700, and, therefore, regarding **(10) accessibility to a higher quality health care system**, bear some scientific evidence since they are part of a descriptive study, however, according to the specifications of Section 2.2.2, it is insufficient for making any recommendation. Results also show that **(8) utility** of the system may increase due to the decrease on the awaiting time for having the opinion of an expert (48 hours). However, no previous data to compare with this assertion have been recalled, thus making impossible to assess the impact of this particular project in the utility indicator.

In the description of this project, information about **(3) ease of use** also appears. In this case, it makes reference to it in a negative sense, since the lack of follow-up from the university caused the non continuity of the telemedicine services in many institutions, thus revolving around the difficulty in using the system. However, as it is a subjective opinion from Dr. Arbelaez, it does not posses any scientific validity. High rotation of the personal is also mentioned, but it can not be related to the **(9) feeling of isolation of the health care staff** since no other data are provided.

The other two projects, teleradiology and virtual education1, are about to show results bearing enough scientific data to make a recommendation. Unfortunately, none of them was finished by the time this document took place.

4.1.3 Centro de Telemedicina-Universidad Nacional

Reviewing results showed in Section 3.2.3, one may assess that it counts with great **(4) acceptance**. ESE San Jose del Guaviare reflects this fact, where the Centre has been working for three years, within three different agreements. In addition to this, according to Dr. Romero, patients satisfaction level is very high due to what can be considered a great change on **(8) utility**, having to wait two hours instead of three or four months. This has been also ratified By Dr. Gutierrez, who points to an increase in the number of times specialised consultation in Clínica Leticia, from three times a

year to once a week. However, none of these four references to the indicators described in 2.2.1 can be taken into account, since no scientific data accompanied these affirmations.

Furthermore, it seems also clear, that the great number of patients attended within the different specialties offered in 29 health care centres located in rural departments, has brought about a huge impact in **(10) accessibility to a higher quality health care system**. These facts have also had a great economic effect on the **(12) national health care system** due to the savings projects introduced, according to what Dr. Romero and Mr. Bermúdez pointed out. However, as it happened with the other indicators referred above, no scientific evidence accompany these data.

These fruitful results may be the product of different facts, such as the use of its own standard-based technology, which allows them to manage and modify every aspect of the platform and to make use of almost any device compliance with the international standards, and the great effort they devote to training issues. Then, they may improve **(3) ease of use of the system**, and hence, increasing the technical feasibility of the telemedicine platform they offer. Nevertheless, there is no scientific evidence which allow making any recommendation. On the other hand, results showed above may be product of its great experience which has allowed them to learn from errors happened in the past, specially in the San Andrés-Leticia-Bogotá network. This project which counted with a great budget was never applied mainly due to the fact that beneficiaries were neither included in the project nor satisfied with it. The lack of a clear purpose was another factor for failure, since 230 billion COPs were invested for Galeno, a software that was never really used.

4.1.4 Fundación Cardiovascular de Colombia

FCV is one of the most active actors in the telemedicine provision field in the country, as it is currently operating in the more than 90 health care centres it is currently operating. Although this might reflect an impact on **(10) accessibility to higher quality health care system**, it is not possible to assure so, since due to confidentiality issues I could not have access to FCV evaluations. Similarly happens with **(4) institutional acceptance** FCV seems to have regarding its great number of projects. This can be related to the work they carry out for making beneficiaries feel part of the project, to the programs of training or to the use of their own technology, but as there was no access to FCV documents it is not possible to know the real reason behind it. Despite of confidentiality issues have hindered the analysis of one of the most important telemedicine institutions in Colombia, one of

the articles published by them belongs to Category No. 3, which according to what was described in 2.2.3, contains sufficient scientific data for making a recommendation. In [89], a control trial of small sample was carried out in order to assess *(1) effectiveness of ECG 1200*, an electrocardiograph developed by FCV, compared with traditional methods. Results showed that electrocardiographies taking and then send to the reference centre by ECG 1200, allowed almost the same analysis than those analyzed on site.

4.1.5 Subprogram EHAS - Colombia

The Subprogram EHAS – Colombia counts with an extensive evaluation of the EHAS-Costa Pacífica project. This evaluation considers many of the indicators present in this document showing different results. One of them points to **(6) an improvement of diagnostic capacity** due to the introduction of the system: the use of second opinion has avoided 0.5 remissions a month. This has had an **(11) economic effect on the health care centre**, since each remission avoided allows savings around 250,000 COPs. Furthermore, the network counts with a great **(4) acceptance**: 69.2% of the staff states it is very positive for them, while 30.8% considers it is just positive. This can be related to the extensive participatory work carried out when designing the network, taking beneficiaries proposals into account. It can be also related to **(3) the ease of use** of the voice system; 63.3% of the users points out it is very easy to use. These results are reflected in the way health care staff use the system, 40% of them states they use the voice service very often. Similarly, difficulty they find when using a computer and Internet, has brought about less changes than expected , since only 7.7% of them use them very often. Overall, the system has had an impact on **(7) the organization process**; now many consultations, both clinical and administrative, are made by these means, thus decreasing the number of times health care staff has to travel to the reference centre. This, has also impacted their **(9) feeling of isolation**; 45.2% consider their situation has been improved. Unfortunately, none of these results can be used for making recommendations since data come from a descriptive study which bears poor scientific evidence.

In addition to the results showed above, both EHAS-Silvia and EHAS-Costa Pacífica projects seem to have had a big impact on **(10) the accessibility to higher quality health care system**. Health care posts located in small municipalities, such as those which have hospitals in Timbiquí and Lopez de Micay as their reference centres, only accessible by river, can now carry out teleconsultation with

them without having to move physically there. It is also worth mentioning the steps took towards **(5) economic sustainability** of the project, such as the use of solar power and low cost devices, and the way of sharing the Internet connection among all centres of the network. Sustainability of the networks, is also being promoted through other small projects which reinforce training and boost usage. However, there is no scientific data to confirm neither the impact on the accessibility nor the feasibility of the networks.

Nevertheless, all these positive results are constrained by external factors around the projects, which are, according to Dr. Rendón, public health care system deterioration in rural areas and hospitals priorities, far from Subprogram-EHAS Colombia aims. Therefore, this lack of higher level **(4) institutional acceptance** may hinder achieving better results on the long term.

4.1.6 GNTT-Universidad del Cauca

Within the two projects carried out by this group, ReTAS is the only one where data could be found in regard to the indicators described in 2.2.1. It stands out the change in use of the project; when it was managed by the group the network ran smoothly an staff were fully trained, but when it was transferred to the Departmental Office for Health everything stopped working. This fact, which was caused by bureaucratic issues, is related to a bigger problem regarding the transfer of the management of a pilot project to the final beneficiaries when they are not fully prepared. It is worth mentioning also the technical feasibility analysis carried out by the Grupo regarding **(2) reliability** issues in order to assure compatibility with other telemedicine networks, such as those run by EHAS. However, as it happened with other projects there is no scientific evidence which corroborates these assertions.

4.1.7 Facultad de Ingeniería Electrónica-Universidad del Cauca

Since it was impossible contacting the responsible of the network, there are no data regarding any of the indicators and, hence, it is impossible to reach any conclusion or give any recommendation based on *Red Telemática para la Prestación de Servicios de Telesalud y Telemedicina*.

4.1.8 T@lemed

As it was described in 3.2.8, this project was conformed by two different subprojects in Colombia, both making reference in their objectives to one of the indicators described in 2.2.1, **(10) improving**

accessibility to higher quality health care system.

Telemedicine network between Cali and Costa Pacífica attended 439 cases in its 12 months of operation. In all cases, teleconsultation was used for diagnostics confirmation, in 25% there were uncertainty among specialists, but at the end, only in 3 cases diagnosis was changed. Then, the real impact of the project on **(10) improving accessibility to higher quality health care system** was very low, since in the vast majority of cases remote doctors knew already how to diagnose. What this project allowed was a more precise diagnosis of malaria cases: all the 280 cases occurred were precisely classified. In addition to this, the system also served for improving health care staff skills due to continuous training. However, the system was not as robust as it can be expected and failed many times due to power supply instability, lack of sufficient bandwidth or theft of devices. No details are provided regarding the occurrence of these failures, hence, these references to **(2) reliability** can not be considered. The project also had problems when finding financing for continuing its activities since authorities were not willing to continue with the project and no other **(5) economic sustainability** strategies had been developed to assure the future of the project. In any case, results showed above come from a descriptive study, which as pointed out in 2.2.3 possesses insufficient scientific evidence to recommend anything on its behalf.

On the other hand, Telemedicine Network between Bogotá and Guaviare, had a real impact on **(10) improving accessibility to a higher quality health care system**, since in a year of operation at least 10% of diagnosis were changed. However, these data come from the same descriptive study referred above, and its scientific evidence does not allow to make any recommendation. Similarly, it happens to the rest of data referring indicators described in 2.2.1, such as a **(2) reliability** study showing that the 8.26% of errors occurred when transmitting files, the (11) economic effects on the health care centres produced due to the avoidance of 170 patients referrals or the improvement on **(7) the organization process** of the Hospital increasing the presence of dermatology and radiology specialists from once a month to once a week: scientific evidence is too week to allow any recommendation. However, the fact that the project is still on after three years of operation may provide an insight of the great positive impact of this project, although no scientific evidence regarding to it exists.

4.1.9 Fundación Santa Fe de Bogotá

As it was described in 3.2.9, the Fundación Santa Fe de Bogotá is currently working in several projects. Among all of them, Doctor Chat is the only one which counts with some scientific evidence since part of their results were obtained though a descriptive study published in [116], which, according to Section 2.2.2, belongs to Category 7. However, that study contains very useful information for the company but possesses very few regarding the indicators considered in this study, detailed in 2.2.1. Data showed that satisfaction of the users was around 95%. These results may be the cause behind the growing **(4) acceptance of this platform**, increasing its number of users from 270 to 1200 in the last year and a half. According to the authors, the platform may have a great impact on **(8) utility**, since it is used for solving personal doubts instantaneously instead of waiting days for getting an appointment with the general doctor. However, as it was pointed out results come from a study which, according to 2.2.3, possesses insufficient scientific evidence to give a recommendation.

The rest of the projects, such as teledermatology or virtual clinics, does not allow to make any recommendation since no scientific evidence accompany the descriptions present in 3.2.9.

4.1.10 SaludCoop

The Telemedicine project which is currently carried out by SaludCoop, seems to have a great impact on **(10) the accessibility to a higher quality health care system** regarding the more than 20,000 patients attended since its origin. Furthermore, according to Mrs. Arias, this has been accompanied by a great satisfaction on the side of patients, specially from those living in rural areas. This program has also brought about a change on **(7) the organization process** at the reference centre, since every doctor has to carry out shifts which included taking care of teleconsultations from IR. However, as it happened with other projects there are no scientific data to endorse these facts and, therefore no recommendations can be made.

4.1.11 GIB-Universidad EAFIT

The telemedicine pilot project carried out by this group was carried out for assessing the technical viability of a system they wanted to use in a bigger network. In this evaluation of technical feasibility they guaranteed **(2) reliability** using a software called Terminal Service, which was in charge of security, integrity and confidentiality of data. **(1) Effectiveness** of the network was also assessed: a

group of specialists analysed 2023 images transmitted by the network, out of which only 75.38% met the quality criteria established. These data come from a descriptive study, belonging to Category No. 8, hence, it is no possible to give any recommendation since, according to 2.2.3 it contains insufficient scientific evidence. In addition to this, it is worth mentioning that these results were never applied due to institutions in charge of receiving the platform broke their relations, and, hence, wasted all efforts carried out by GIB.

4.1.12 Centro de Telemedicina de Colombia

Despite being the institution from which the highest number or articles has been retrieved, no evidence, neither scientific nor from any other mean, has been found to assess telemedicine in-the-field activities carried out allegedly by the Centre. What it has been found is information about several teleeducation activities taking place in different universities of the country, but no data have been recalled allowing to make recommendations regarding *Centro de Telemedicina de Colombia* activities.

4.1.13 Hospital Universitario La Samaritana

The first teleradiology project carried out in Colombia, had a great impact on **(10) improving accessibility to a higher quality health care system**, since in 9 months of operation it provided attention in 2,754 radiology cases. In this project teleconsultation was outsourced due to the lack of human resources within the institutions involved to attend all the radiology services requested to them. Therefore, due to this project, it was possible to control the demand, and attend a bigger number of cases. In addition to this, results showed in 3.2.13 present a positive **(11) economic effect on the health care centre**, since it increased billing between 22,5% and 25% in the centres involved. However, this project also suffered the effects of being pioneer, such as early distrust from both patients and staff, and lack of a managing system for ordering billing. The latter turned out to be the key factor for abandoning the project, since at that time it was impossible to show the good economic impact the project was having. Although, this last lesson could have served for drawing a recommendation, it is not possible to do so because of information come from an interview an not from a document with scientific contrasted facts to show that. Something similar happens with the rest of positive results presented above; all of them come from a descriptive study which, according

to 2.2.3, bears no scientific evidence.

4.1.14 Ecopetrol

As it was explained in 3.2.14, this projects was never carried out and, therefore, no recommendations can be made regarding its results.

4.1.15 Vision Technology Group

Telemedicine activities carried out by VTG are probably the most successful ones in Colombia, but, even so, it could not overcome the economic crisis present in Colombia at the end of the last decade. Before that happened, two documents containing scientific data corroborate so. The first one is a descriptive study published in [11], which conclude that VTG project with the ISS had a great **(11) economic effect on the health care centres**, since it allowed a reduction of costs around 57% when comparing its methods with traditional ones. In this study, it was mentioned that the system provided attention to 173,725 patients from health care centres where prior to the project teleradiology was not offered. These data showed the great impact VTG had on **(10) the accessibility to higher quality system**. On the other hand, another study published by Finnconsult, [46], shows also the **(11) economic effect on the different health care centres** due to the increase of productivity and the reduction of costs VTG could attend 130% patients more than when using traditional methods. In addition to this documents, data containing less scientific evidence were found regarding **(2) reliability** of the system: only 1.3% of the studies transferred were rejected. All data shown above, together with several specialised training programs, provide VTG projects with great **(4) institutional acceptance**, which was reflected on the increased number of agreements they obtained. However, as described in 2.2.3 none of these sources of information contains sufficient scientific evidence to allow making any recommendation.

4.1.16 Cardiobip Ltd

Cardiobip Ltd telecardiology project had a deep impact on accessibility to a higher quality health care system due to its presence in 113 hospitals of the country. However, according to the proceedings of its board of directors, an economic crisis along the country caused the slowly cease of its operation. During the time it was operative, it carried out a study for evaluating the system. It was showed that it

helped **(6) improving diagnostics capacity** in 34% of the cases. Although these data seem to come from a controlled random trial with big sample that, according to 2.2.2 it would have belonged to Category 2, thus counting with very good scientific evidence, results can not be used to make any recommendation since the source of the information could not be retrieved, and, hence, details of the framework of the system were not available.

4.1.17 GITEM-Universidad Distrital Francisco José de Caldas

It is impossible to make any recommendation regarding projects carried out by GITEM, since no evaluations, neither about impact nor about feasibility, were retrieved during the search process.

4.1.18 GIB–Universidad de los Andes

Research activities carried out by GIB do not allowed to make any recommendations since no in-depth data of its activities have been recalled during the search process.

4.1.19 Facultad de Medicina-Universidad de Antioquía

TeleMAP is still being implemented, and no feasibility studies prior to the beginning of the project have been retrieved, therefore, no recommendations can be made on behalf of this project. It is worth mentioning steps taking regarding to beneficiaries involvement in the project and development of its own technology.

4.1.20 EIT-Universidad Pontificia Bolivariana

Although EIT carried out an extensive work studying different technologies in order to use the best one for fulfilling the constraints imposed for developing the *Red de Telemedicina de Antioquía*, the final election spoiled the future of the project. It was decided to use RDSI, and a lot of time was spent developing applications for this technology. However, a change in technological trends made this effort usefulness and, after eight years the whole project is being redesigned. Although there is no scientific evidence to make any recommendation, facts speak for themselves, and more attention should be given when choosing a technology which needs specific applications.

4.1.21 Asociación Colombiana de Medicina, Informática y Telesalud

As it was described in Section 3.2.21, this is not fully formed yet and therefore it does not allow any recommendation to be made on its behalf.

4.1.22 Esoft Ltd

Esoft platform *Gestión Médica*, seems to have brought about a big impact on **(7) the organization process** inside the hospitals were it is being used; it has modified the way orders are given to the pharmacy and the way many departments communicate. In addition to this, *Gestión Médica* seems to have a big impact on the reduction of failures coming from misunderstanding of reading orders. It has also seems to have improve productivity within the hospitals, since times needed to carry out daily tasks are greatly reduced and in some cases avoided. However, due to confidentiality issues of the company, none of these facts can be confirmed, since, although they have carried out these evaluations, they can not be shared.

4.1.23 Dr. Díaz

Although it seems Dr. Díaz has carried out different telemedicine projects, due to company policy issues, it was impossible to recall their results and no recommendations can be made regarding to them.

4.1.24 ITMS-Colombia

ITMS-Colombia is marked by the huge presence it has acquired in the telemedicina arena the last year. Its activities in 135 health care centres around Colombia, where attention has been provided to 30,000 patients, show its great impact on **(10) the accessibility to a higher quality health care system**. It seems also to have a great impact on **(7) the organization process** due to the use of a software developed by them which allows the specialists to telework. However, as well as it happens with the improve in accessibility, none of these references to indicators posses any scientific validity since both come from an interview. What possesses scientific evidence is the **(1) effectiveness** comparison of electrocardiographics methods described in [44], which, according to 2.2.2, belongs to Category No. 3 and therefore contains sufficient scientific evidence to allow a recommendation, since

it consists of a controlled trial of small sample. It showed that ECG images produced by an Aerotel system were similar to those obtained by traditional methods.

4.2 Summary of the analysis

In Colombia several telemedicine pilot projects have been deployed for providing services in the following specialties: dermatology, radiology, cardiology, internal medicine, ambulatory care, malaria diagnose, etc. A common feature to all of them is the lack of studies for evaluating their performance and real impact. According to this, it is very difficult to replicate these experiences, since there is no scientific evidences to back the promising results pointed out by the directors of the programs. Such is the case of the teleradiology projects carried out by VTG, which attended more than 500,000 cases, or of the telemedicine activities of the *Centro de Telemedicina-Universidad Nacional*, which counts with many years of experience and several projects which have allowed attending around 10,000 people living in remote areas in many specialties. The only two studies which, according to Jovell and Navarro, posses any scientific evidence are focused on technical effectiveness of ECG devices. Although this kind of studies are always necessary, they are not enough for making any recommendation since they are not accompanied by other analysis regarding important factors such as the impact on patient's health.

Therefore, **it is recommended not to carry out new telemedicine projects in Colombia which do not count with a formal plan for evaluating its feasibility and impact, and finance only those which contain a well-designed integral plan for evaluating the project in order to assess their results and, hence, allow to replicate them**.

5 Conclusions

The systematic review of telemedicine projects carried out in Colombia has obtained several conclusions:

The search justify my assumption that the selection of Colombia as model is appropriate, due to primarily that the large number of telemedicine studies that have been in operation for a significant period of time. One of the factors claimed for its election was its dynamism at different levels, which have been corroborated by the heterogeneous group of institutions described in Chapter 3. In that group there are several members from the private sector such as Esoft Ltd or ITMS-Colombia, as well as universities and departmental offices. It is also worth mentioning the key role of the national government in creating a robust framework for the provision of health care services on a telemedicine basis.

The extensive review carried out can be also considered both useful and necessary. It was necessary in the way that it updates and extends earlier studies with new information and insights. It may be useful not only for the recommendations that can be made due to its results, but for its detailed description about twenty four telemedicine initiatives carried out in Colombia, which may help other researches performing similar studies or be used for academical purposes as a reference document.

The search strategy used has been proved to be very efficient in the way it has served to find all the telemedicine initiatives developed in Colombia. This assertion may appear very pretentious, but it is worth remembering that a former member of Colciencias and current Executive Director of Renata was consulted for corroborating every finding. In answer, she only added one extra institution, which was immediately added to the document, thus including all telemedicine initiatives carried out in the country. However, the search process was not as smooth as expected due mainly to two facts; the

difficulty of finding information through the World Wide Web, and the seven hours difference in the time zone between Spain, where the review was performed, and Colombia, which made it almost impossible to carry out any interviews by phone. Due to this fact, email was used for interviewing, which, although slow, provide a reliable source of information.

Telemedicine experiences recalled can be classified in two different groups: those which fail to fulfil its purpose, and those which achieved positive results. Within the first group there are some projects that stand by themselves, such as Red de Telemedicina de Antioquía, carried out by EIT - Universidad Pontificia Bolivariana and the network among Bogotá, San Andrés, Leticia implemented by the Centro de Telemedicina-Universidad Nacional. The first one, failed due to a poor decision when choosing what telecommunication technology, while the failure of the second one was a result of a chain of mistakes. Starting by not taking the beneficiaries into account. Therefore, it seems that a careful revision of the state of the art when choosing the telecommunication technology which will be used in the project, and the involvement of the beneficiaries in the decision making process, may help in the success of a telemedicine project.

On the other hand, there have been several successful initiatives that seems to have had a great impact on the population. This is the case of the projects currently carried out by Centro de Telemedicina-Universidad Nacional or the ones managed by GIT-Universidad de Caldas, which provide health care services to a great number of people living in areas where the health care system is extremely poor. In addition, there are several private initiatives, both in the past such as Cardiobip Ltd and Vision Technology Group, and in the present, such as Fundación Cardiovascular de Colombia, ITMS-Colombia and SaludCoop, which have also obtained very good results.

Nevertheless, neither for the bad experiences nor for the good ones, is there no scientific evidence to back their results, all measurements are simply subjective. Thus, it is impossible to recommend any good or bad practice regarding telemedicine projects in Colombia for its replication in other areas of Latin America. Therefore, the only recommendation possible to conclude this study is:

“Not to carry out new telemedicine projects in Latin America which do not count with a formal plan for evaluating its feasibility and impact, and finance only those which contain a well-designed integral plan for evaluating the project in order to assess their results and, hence, allow to replicate them”.

A

Reference Framework

A.1 Definitions of the telemedicine terms used

Given the wide range of medical specialties and technologies which can be used for the provision of a health service on a telemedicine basis, a definition of terms is provided in order to help the reader to understand the rest of the document. Terms are classified in three different groups according to the classification in [72]. These groups are time, specialties and medical application used in the telemedicine system. Furthermore, the most common standards, DICOM and HL7, will be explained at the end of the section.

A.1.1 Classification as a function of time

Classification of function of time makes reference to the moment when either the remote medical intervention or the communication between involved agents happens.

Non-real time

In this mode the client of the telemedicine service is not directly communicating with the provider of the service. It is known as store-and-forward because the provider stores requests from different clients and at any given moment he can retrieve them and forward the results to the clients. Most telemedicine applications use non-real time procedures since they are easier to coordinate, require less communication infrastructure, systems are cheaper and they adapt better to real needs.

Real Time

Real time makes reference to the fact that client and provider are simultaneously connected to the same system which allow them to communicate directly. This mode allows a better interaction among the two participants, which can be more effective than the non-real time mode. However, it requires broadband services, which are more expensive and that both participants have to connect simultaneously using the real time application.

A.1.2 Classification as a function of the kind of service

Depending on the way health services are provided on a telemedicine basis, there are different terms of use;

Teleconsultation

A consultation is provided through a telecommunication system between a qualified Doctor and a competent person. This consultation can be general or specialised and may have a diagnostic examination associated with it.

Telediagnosis

Diagnosis through telemedicine is the result of either a consultation in the case of patient without physical access to the national health service or for a second opinion consultation. It the last case it can be motivated as a result of a consultation between doctors or a new diagnosis requested by a dissatisfied patient.

Telecare

This is the discipline that occurs when care is provided to patients located in remote areas through the use of telecommunication systems. It can be used for warning people who care for people in remote areas, for educational purposes or to prevent complications in ambulatory patient care.

Telemonitoring

This allows remote monitoring of vital signs with equipments such as electrocardiograms, electroencephalograms, electromyographies, arterial pressure, temperature, pulse, laboratory exams by digital puncture for measuring metabolic diseases which require frequent control, eg Diabetics

Tele-education

Tele-education refers to the applications which allow remote education on medical topics either in real or non-real time. Among the different tasks tele-education allows, there are: remote training, continuing education, support to medical students and nursing staff, training through virtual reality simulators, evaluation and feedback between teacher and student, etc.

Tele-administration

Tele-administration applies to health management systems for remote administration of processes such as citation control, references, billing, inventory, strategic planning, etc.

Telepharmacy

Using different telecommunication systems, it is possible to carry out the prescription process remotely, so dispensing, billing and follow-up prescriptions can be processed without the physical presence of the participants.

A.1.3 Classification as a function of the medical specialty

As in traditional medicine, there are different specialties in telemedicine. In the following paragraphs a description of the most common health services provided on a telemedicine basis are presented.

Teleradiology

Teleradiology is one of the most used health specialties provided on a telemedicine basis. The radiologist does not need to have direct contact with the patient, making it very easy to carry out this

discipline remotely. In addition to this, some of its different modalities are already digital, making process of capturing information even easier.

Telepathology

Telepathology works with images, either digitalized or from a video, obtained directly from the microscope. These images can come from anatomic examinations such as cytologies, biopsies, or autopsies. Furthermore, they can be accompanied by other medical exams such as blood or urine tests to confirm the diagnosis.

Telecardiology

Through different communication systems it is possible to carry out remotely processes such as electrocardiograms, ecocardiograms and record cardiac sounds and then transmit results to the specialist for diagnosis.

Tele-endoscopy

Tele-endoscopy examinations are performed through optic-fiber endoscopy systems, connected to a video conference or an image digitaliser system which provide doctors with the same view of the damaged area that they would see if the patient was in the same room. Three main examinations composed this specialty: Tele-ORL – othorhinolaryngology (ORL) examining ear nose and throat, Telegastroscopy , examining throat, esophagus and stomachand Telecolonoscopy examining large bowel.

Teledermatology

Teledermatology consists of remote consultations more than remote procedures. Within this discipline the dermatologist uses video conferencing and digital pictures to get a good image of the problem that concerns the patient, who is in a remote health center.

Tele-ophthalmology

Ophthalmology practice can be carried out partly through ophthalmoscopes connected to video conference systems for a better diagnosis of the back of the eye, which is very useful for the prevention

and follow-up of metabolic diseases. The systems are very similar to those used for the endoscopies

Telesurgery

This term refers to surgery assisted by robotised systems which provides more security and precision in surgical procedures.

A.1.4 Main international telemedicine standards

Due to the wide range of telemedicine applications and devices that exist in the market, it is advisable to have a common tool which enables communication in order to facilitate the exchange of medical information and data among specialists. These tools are called standards and the most common ones used in telemedicine are DICOM for exchange of information and diagnosis data and HL7 for communication between telemedicine systems.

HL7

HL7 is a standard created by the American National Standards Institute in order to allow messaging among disparate telemedicine systems within clinical environments for the interchange of clinical messages. HL7 stands for Health Level 7 and it is the most recognized and used standard for this purpose. The HL7 standard addresses issues such as the definition of the data which is going to be exchanged and the timing of the exchanges [109].

DICOM

DICOM which stands for Digital Imaging and Communications in Medicine is a standard created by the National Electrical Manufacturers Association for facilitating the interchange and processing of medical images in digital format. Thank to this standard different devices from different vendors working with image archives such as diagnostic imaging workstations and image acquisition devices can be interconnected into a common information infrastructure for image interchange and integrated with other information systems [109].

A.2 Colombia

Colombia is one of the four countries which sprang up after the 1830 dissolution of the Bolivar's dream nation Gran Colombia, which comprised Colombia, Venezuela, Ecuador and Panama, but it was not until 1886 that the Republic of Colombia was founded. It is located in the north part of South America, bordering with the Caribbean Sea between Venezuela and Panama, bordering with the Pacific Ocean between Panama and Ecuador and bordering Peru and Brazil in its southern part[10]. Colombia is divided administratively into 32 areas and the capital district is Bogotá[28], the total population is 41.468.384, with 28,08% in rural areas[35].

In recent decades, the Colombian political and economic stage has been influenced by the clash between military forces and the guerrillas. The conflict has caused deterioration in the already difficult situation of many areas of the country, especially in the period from 1995-2001[54]. This factor has caused thousands of internal displaced people, fleeing from rural areas to the suburbs of the big cities. Contrary to what would be expected in a country living with such conflict, poverty has decreased greatly in the last 20 years, going from a Human Poverty Index of 12.8 in the early nineties[112], to its current 7.9[111]. However, as it is showed by its current Gini Index of 58.6, the distribution of income is far from equal, placing Colombia as second to last in its region[111].

Despite of the recent improvement in health statistics, Colombia still has to face diseases typical of developing countries and tropical regions. The improvements hide the wide differences among regions, rural and urban areas and social strata[93]. Malaria, with 150.000 cases per year, Dengue Hemorrhagic Fever with an incidence of 18.9 cases per 100.000 inhabitants, Tuberculosis with 25,2, or HIV with 10,62[94], continue to put the Colombian population at risk, especially those living in rural areas. Furthermore, diseases typical of developed countries such as ischemias and vascular failures both in brain and heart are top in mortality cause ranking[35]. Additionally, the rate of violent deaths in the country is one of the highest on the continent. Therefore, the health care system in Colombia faces a very complex and heterogeneous situation.

A.2.1 Health care System

The health care system in Colombia is governed by the General System of Social Security in Health (Sistema General de la Seguridad Social en Salud, SGSSS) which is managed by the government through the Social Security department of the Health National Council (Consejo Nacional de

la Seguridad Social en Salud, CNSSS) [54]. This is stated in Law No.100 (1993), which defined the normative framework for the provision of health care as a public right. This law introduced a radical reform in the health care system and since then it has been compulsory to affiliate to the SGSSS in order for the government to achieve universal coverage for health care [49]. Everybody within the system has the right to receive a Basic Attention Plan (Plan de Atención Básica, PAB), which includes services in emergencies, acute hospitalisation, consultation and medicine [72]. Two different modalities of affiliation were created: affiliates to the contributory regime and affiliates to the subsidised regime [13].

The contributory scheme is a Compulsory Health Plan (Plan Obligatorio de Salud, POS) for those with the ability to pay. They have to enroll in a Health Promotion Plan (Empresa Promotora de Salud, EPS) with a monthly payment of 12% of their salary in order to assure the provision of POS, and enhanced PAB. The EPS may be chosen from a wide range of public, private and mixed plans. Furthermore, those affiliated to the contributory scheme with higher salaries contribute with an extra 1% to the Solidarity and Guarantee Fund (Fondo de Solidaridad y Garantía, FOSYGA), which is used to finance the subsidised regime [49].

People with a lower income or no ability to pay, who are selected through a system called Sisben, are covered by the subsidised regime. Those on this scheme have to register with a Manager of the Subsidised Regime (Administradora del Regimen subsidiado, ARS), who is in charge of assuring the POS of the subsidised regime (POSS). This POSS contains the services included in the PAB plus the provision of health care in a high cost illness, but this provides less health coverage than the POS and it is financed mainly by public funds, either from the government or the municipalities, and from FOSYGA [49]. In this way resources are channeled to EPS and ARS in order to balance the contribution of each beneficiary to his or her insurer. This fixed payment is called the Capitation Payment Unit (Unidad de pago por Capitación, UPC) and eliminates price competition. People affiliated to this regime who need service at a greater level not covered by the POSS have to pay separately for each service [13].

The goal of universal coverage with Law No. 100 was meant to increase the number of affiliates to the contributive regime until it met 70% of the system by 2000 [54]. However, at the end of 2006 according to data from the Ministry of Social Protection, the number of affiliates to the contributive regime was 34.27% of the total population (16.029.505 inhabitants) and to the subsidised regime it was 42.99% (20.107.223 inhabitants) [84]. Thus, in spite of the efforts made to achieve equality in

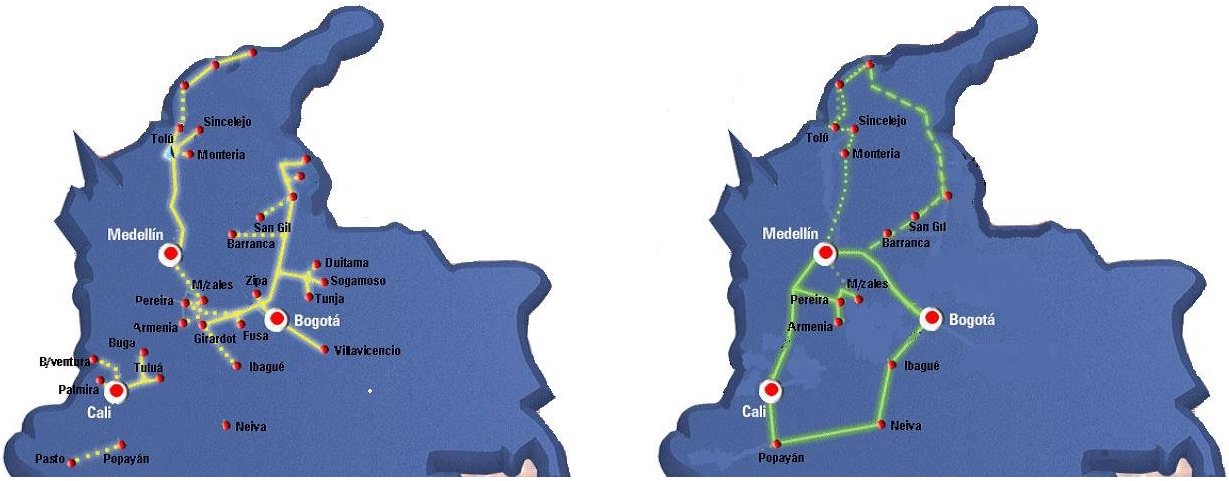
health care, around 20% of the population still don't have a health care plan. This setback entailed the passing of Law No. 1122 (2007) which introduced changes in the way health care is provided. The changes included: the creation of a institution called the Health Regulatory Commission (Comisión Reguladora en Salud, CRES) which takes over from the CNSSS; an increase in the payment from affiliates to the contributory regime of 0.5%; a change in denomination of the ARS, which is now known as the EPS in the subsidised regime (EPSS); and modifications to the way the ESE is financed [105].

Both EPS and EPSS contract the provision of the services contained in the two POS through a network of Service Provider Institutions (Instituciones Prestadoras de Servicios, IPS). In rural areas and small municipalities the IPS provide services through State Social Companies (Empresas Sociales del Estado, ESE), the name for public hospitals. The ESE not only offer services to the IPS, they also do so to those not included in any of the schemes, this is called "linking". However, the ESE has no more funding from government and its financing depends on the type and amount of services provided [49].

The IPS and ESE are structured in three levels according to the complexity of the services offered. The first level is mainly dedicated to activities related to health promotion and the prevention of disease. It provides external consultation and hospitalisation in general medicine. Among all public IPS in the country, 84% of them belong to this level of health care. The second level of care focuses on external consultation, general surgery, gynecology and obstetrics, internal medicine and surgical specialties that do not require a high level of hospitalisation. 13.45% of public IPS are on this level. The third level of health care is similar to the second, but also provides all surgical specialties, including those which require a high level of hospital care. Furthermore, there exists a protocol known as the 'reference and counter reference', which enables the correct reference of patients from one level to another. This ensures correct management and makes efficient use of resources among different health centres [5]. However, these institutions are not equally distributed geographically, more than 50% of them are located in three areas: Bogotá (26.75%), Antioquía (16.05%) and Valle (11.83%). More than 70% of the IPS are municipally managed, which creates a big difference among the IPS due to the unequal distribution of resources [54].

A.2.2 Telecommunications Infraestructure

Nowadays, telecommunication infrastructure in Colombia allows the development of telemedicine projects in many areas. Since the 1990's the telecommunication sector has developed constantly in Colombia, currently the main cities have a wide coverage of fibreoptics within and around them A.1(b). There is a digitalised microwave national network coverage for providing connectivity through satellite links to telecommunication service providers A.1(a) [72]. In addition to this there is a high-speed network which interconnects higher education institutions, such as universities and research centres throughout the country, the National Network for Advanced Technology (Red Nacional de Tecnología Avanzada, RENATA) which is supported by the Ministries of Communications and Education [99].



(a) *Microwave Coverage.* (b) *Optic fibre coverage*

Figure A.1: *Telecommunications Infrestructure in Colombia [41].*

However, connectivity data from the beginning of the decade shows that most of the lines contracted were located in the 23 major cities, leaving line density in the rest of the country at around 6% [72]. This can be seen also in Figure A.1, where a wide area of the country is not covered by any telecommunication infrastructure. In order to solve this unfair distribution, the Colombian Regulation Committee for Telecommunications started to expand services to rural areas to support education, security and health [119]. The plan called "The Connectivity Agenda" started in February 2000 and consists of a set of strategic plans carried out in sectional programmes. It aims to get most of the country covered by ICT, thus promoting economic, social, politic and cultural development [1].

Within the Connectivity Agenda, the Ministry of Communications defined a programme called

Compartel (from Compartir Telecomunicaciones, which means Share Telecommunications). This programme was first designed in 1999 and became part of the Agenda in 2001 [125]. The main goal is to allow low income communities living in isolated areas of the country to benefit from ICT with rural telephony and Internet access. These services are provided by nine different providers through three different sub-programmes: Community Rural Telephony, Social Internet and Connectivity for Public Institutions and they are financed by the Communications Fund. There is a fourth sub-programme which supports the maintenance and replacement of existing networks [97].

Within the connectivity for public institutions, there is a section assigned for health care centres. institutions are selected differently according to the different phases of the subprogram. In the first phase, which started in 2004, the institutions selected were among those located in isolated areas with difficult access, which were already taking part in a telemedicine program. In the second phase, which started in 2006, those selected had a real commitment to paying for the connection once the free period of the program was finished [97].

The programme includes installation, maintenance costs, and a free period of connectivity, so institutions only have to pay for the connection once this period is over. The maximum price of these services has been fixed by the programme in order to guarantee competitive prices. These costs have been set at around 5% of the total cost of the installation which was approximately 44.5 cop. Furthermore, operators have to comply with the high quality standards required by the programme, such as an overbooking factor of 1:4 and training courses and materials for the beneficiaries [97].

In addition to the training programmes described above, university students performing their social service are sent to rural communities for six months to provide training and technical support to local organisations and individuals [125]. The government is also contributing to the cost of training health professionals. Law no. 1164 (2007) enforces the implementation of a pilot program for continuous medical education through free virtual courses. This pilot has been developed in 875 IPS in the regions of Nariño, Cauca, Córdoba, Boyacá and Meta [80].

To summarise, as of December 2007 the Compartel section of the Connectivity Agenda (2001), relating to healthcare provision in rural areas via telemedicine to public institutions has benefited 793 out of the 2470 public IPS in the country, which represents only 32% [97].

A.2.3 Telemedicine Legislation

The government of Colombia has developed telecommunication infrastructure over the last few years to facilitate telemedicine provision, it has also carried out extensive work designing the legal framework.

In July 2004 the Ministry of Social Protection passed Resolution 2182, in which the conditions for IPS authorization for the provision of health services on a telemedicine basis were defined. To do so, it defined telemedicine first: *"it is the remote provision of health [...] with the purpose of facilitating access to these services for the population who have limitations on the provision of these services in their geographical area[82]*[1]". Furthermore, it defines the two institutions involved in the process: Referring Institution (from Instititución Remisora, IR) and reference center (from Centro de Referencia, CR).

The IR is *"an IPS located in an area with access problems or without resolutive capacity in one or more services, which is provided with the technology for transferring data to an institution with higher resolution capacity for solving these needs[82]*[2]". The CR is defined as an *"IPS with the technology resources and the resolution capacity for providing support [...] to one or more referring institutions[82]*[3]". This support can only be given when the service cannot be provided with the physical presence of the specialist[82][4]. Furthermore, a signed consent from the patient is needed in order to guarantee that he or she has been informed of benefits and risks of using telemedicine services[82][5].

The Resolution also establishes the technical conditions both the IR and the CR has to satisfy the authorities that they can provide the services contracted[82][6]. Furthermore, they have to adopt all the steps needed to provide security during the transfer and storage of data, since losing this would pose a great threat to the process involving the care of a patient, and thus to his or her health[82][7]. The security is important in two different ways: forbidding access to non authorised people and avoiding the loss or damage of data. The Resolution also states that "*if any of the institutions cannot comply*

[1] Article No.2, page 1.
[2] Article No.2, page 1.
[3] Article No.2, page 2.
[4] Article No.3.
[5] Article No.12.
[6] Article No.10.
[7] Article No.14.

with these specifications, it has to stop providing the service on a telemedicine basis"[82][8].

In addition to this, the Resolution defines the responsibilities of the provision of health on a telemedicine basis. The professional who asks for a second opinion is responsible for the final treatment applied to the patient, but the expert is responsible for the quality of the advice, which has to include all the details concerning proper application[82][9].

However, this Resolution applied until its abolition with the decree 1043 passed in April 2006[85], due to a change in the process for IPS authorisation for providing health on a telemedicine basis. This legal vacuum was filled a month later by Resolution 1448[27]. This new resolution defined the specifications for IPS authorisation for the provision of health on a telemedicine basis under the new legislation, but for the rest, Resolution 1448 is equal to 2184 described above[83]. Currently, adding a slight technical modification introduced in 2007 by the Resolution 3763[86], is Resolution 1448 which applies for regulation of telemedicine activities in Colombia.

Apart from creating the legal framework for practicing telemedicine described above, the government has included the telemedicine in the Law No. 1122 from 2007 described in section A.2.1, which currently regulates the provision of health. In the law, telemedicine is referred to as the tool for increasing quality in diagnostics and reducing costs when improving access to particular medical specialties in those areas with limited resources. Furthermore, it points to the ESEs as the IR to be equipped for the provision of these specialties on a telemedicine basis. Complementary the CNSSS, through the Agreement No. 357 passed the assignment of 8 billions COP to provide services of medium and high complexity through telemedicine in 9 departments of the country[80]. This project, known as Caprecom, due to the name of the EPS which is coordinating the project, will be described later in this chapter.

[8] Article No.7, page 3.

[9] Article No.13, page 6.

B

Contacts with Institutions Involved

C

Contact Information of Institutions Involved

Ministerio de la Protección Social-Caprecom

Person: Blanca Luz Hoyos

Position: Member of the group for Emergencies Atention and Disasters

Telephone: 0057 (1) 330 50 00 Ext 1713

email: bhoyos@minproteccionsocial.gov.co

Person: Luis Fernando Correa

Position: Coordinator of the group for Emergencies Atention and Disasters

Fixed Telephone: 0057 (1) 330 50 00 Ext 1710

email: lcorrea@minproteccionsocial.gov.co

GIT-Universidad de Caldas

website: `http://telesalud.ucaldas.edu.co`

Person: Dr. Mauricio Arbelaez Rendon

Position: Coordinator of the Group

Fixed Telephone: 0057 (6) 878 15 00 Ext 11110

email: mar@ucaldas.edu.co

Centro de Telemedicina-Universidad Nacional

website: `http://www.unal.edu.co/telemedicina/`

Person: Dr. Eduardo Romero

Position: Director of the Centre

Fixed telephone: 0057 (1) 316 54 91

email: edromero@unal.edu.co

Person: Jorge Alejandro Bermúdez

Position: Telemedicine Coordinator

Fixed telephone: 0057 (1) 316 54 91

email: jabermudezbe@unal.edu.co

Fundación Cardiovascular de Colombia

website: `http://www.fcv.org/`

Person: Dr. Nadim Miserque

Position: Director of the centre

Fixed Telephone: 0057 (7) 639 67 67 / 639 92 92

email: nmiserq@yahoo.com

Subprogram EHAS – Colombia

website: `http://git.unicauca.edu.co/ehas/`

Person: Dr. Álvaro Rendón

Position: Director of GIT (Grupo de Ingeniería Telemática)

Fixed Telephone: 0057 (2) 820 98 00 Ext 2124

email: arendon@unicauca.edu.co

GNTT-Universidad del Cauca

website: `http://www.gntt.unicauca.edu.co`

Person: Dr. Edgar Castillo

Position: Former director of the group

email: castilloe@lycos.com

Person: Virginia Solarte

Position: Responsible until 2007

Fixed Telephone: 0057 (2) 820 98 00 Ext.2154

email: vsolarte@unicauca.edu.co

Facultad de Ingeniería Electrónica-Universidad del Cauca

Person: Dr. Rafael Rengifo

Position: Responsible of the network

Fixed telephone: 0057 (2) 820 98 00 Ext.2125

email: rrengifo@unicauca.edu.co

T@lemed

website: `www.alis-telemed.net`

Person: Dr. Leonardo Yunda

Position: Director of the Group Telebio de la Universidad Santiago de Cali

Fixed Telephone: 0057 (2) 5183000 Ext 346 and 314

email: leyunda@usc.edu.co / leyunda@ieee.org

Fundación Santa Fe de Bogotá

website: www.fsfb.edu.co

Person: Dr. José Ignacio Valenzuela
Position: Director of Special Projects
Fixed Telephone: 0057 (1) 603 03 03 Ext 5721
email: jose.valenzuela@fsfb.edu.co

Salud Coop

website: http://www.saludcoop.com.co/

Person: Dr. Rubi Patricia Arias
Position: Training and Special Programs Coordinator
Fixed telephone: 0057 (1) 600 10 50 Ext 1611
email: rparias@saludcoop.coop

GIB-Universidad EAFIT

website: http://www.eafit.edu.co/EafitCn/Investigacion/Grupos/Ingenieria/GIB/IndexGIB.htm

Person: Alvín García
Position: Director of the Telemedicine branch of the group
Fixed Telephone: 0057 (4) 4440555 Ext 407
email: algarcia@eafit.edu.co

Centro de Telemedicina de Colombia

Person: Jorge Alberto Velez

Position: Director of the Centre

Fixed Telephone: 0057 (2) 667 75 80

email: javelezb@hotmail.com

Person: Andrés Adolfo Navarro

Position: Co-director until 2007

email: anavarro@puj.edu.co

Ecopetrol

Person: Jorge Alberto Velez

Position: Responsible of the telemedicine program.

Fixed Telephone: 0057 (2) 667 75 80

email: javelezb@hotmail.com

Hospital Universitaro La Samaritana

Person: Jeffrey Torres

Position: Director of the research group GINIC of the Hospital Universitario La Samaritana

Fixed Telephone: 0057 (1) 407 70 75 Ext 10820 / 10249

email: jefferytorres@hotmail.com

Person: Alberto Kopec

Position: Scientific Manager of the Hospital 1995-1999

email: cirugiaestetica@yahoo.com

Vision Technology Group

website: www.bernardotavera.com

Person: Bernardo Tavera

Position: Director of the Company

email: tavera@marinamedical.com

CardioBip Ltda

Person: Jean Claude Bessudo

Position: Former Director of the company

email: jbessudo@aviatur.com.co

GITEM-Universidad Distrital Francisco José de Caldas

website: http://gemini.udistrital.edu.co/comunidad/grupos/gitem

Person: Lilia Edith Aparicio Pico

Position: Director of the Research Group

Fixed Telephones: 0057 (1) 3239300 Ext 2405 and 2500

email: medicina@udistrital.edu.co

GIB-Universidad de los Andes

website: http://ingbiomedica.uniandes.edu.co/

Person: Antonio Jose Salazar

Position: Director of the telemedicine branch of the group

Fixed Telephone: 0057 (1) 339 4949 Ext 3360

email: ant-sala@uniandes.edu.co

Faculty of Medicine-Universidad de Antioquía

Person: Jorge Iván López Jaramillo

Position: Director of the program

Fixed Telephone: 0057 (4) 219 219 6045

email: simulacion@medicina.udea.edu.co

EIT-de la Universidad Pontificia Bolivariana

website: `www.upb.co/eit/`

Former Responsibles:

Person: Sergio Mejia M.

email: smejia.cmd@gmail.com

Person: Oscar J. Cardona Villegas

Fixed Telephone: 0057 (4) 415 90 20 Ext. 9595

email: ocardona@upb.edu.co

Current Responsibles:

Person: Dr. John Bustamante Osorno

email: john.bustamante@upb.edu.co

Person: Ing. Diego Cuartas Ramírez

email: diego.cuartas@upb.edu.co

Asociación Colombiana Medicina Informática y Telesalud

Person: Alberto Kopec

Position: President of the Association

email: cirugiaestetica@yahoo.com

Esoft Ltda

website: `www.esoftltda.com`

Person: Carlos Mauricio Parra

Position: Projects Director

Fixex Telephone: 0057 (1) 450 2599

email: info@esoftltda.com

Dr. Díaz

website: `www.drgdiaz.com`

Person: Gonzalo E. Díaz Murillo

Position: Company Director

Fixex Telephone: 0057 (1) 540 2794

email: info@doctorgonzalodiaz.com

ITMS-Comlombia

website:`www.itms.cl`

Person: Patricio Zeballos S.

Position: Company Director

email: p.zeballos@itms.cl

Expert

Person: Martha I.Giraldo Jaramillo

Position: Renata Executive Director

Fixex Telephone: 0057 (1) 6258 480 ext. 5002 (No. 130)

email: migiraldo@renata.edu.co

D

Glossary

Asociación Colombiana de Medicina, Infomática y Telesalud: Colombian Association for Medicine Informatics and Telehealth.

Cámara de Industría y Comercio Colombo-Alemana: German-Colombian Chamber of Indsutry and Commerce.

Centros de Ateneción de Ambulatoria: Centres for Ambulatory Attention.

Centro de Diagnóstico Radiológico: Centre of Radiologic Diagnosis.

Centro de Educación Virtual y Simulación: Centre of Virtual Education and Simulation.

Centro de Resonancia e Imágenes: Centre of Resonance and Images.

Centro de Telemedicina de Colombia: Telemedicine Centre of Colombia.

Centro de Telemedicina-Universidad Nacional: Telemedicine Centre-National University.

Centro de Telesalud: Centre of Telehealth.

Centro Internacional de Vacunas: International Vacunation Centre.

Enlace Hispano Americano de Salud: Hispanic American Link for Health.

Equipo Interdisciplinario de Telemedicina (EIT) - Universidad Pontificia Bolivariana: Telemedicine Interdisciplinary Team-University Pontificia Bolivariana.

Escuela de Ingeniería de Antioquía: Engineering School of Antioquía.

Eventos Catastróficos y Accidentes de Tráfico: Catastrophic Events and Transport Accidents.

Facultad de Ingeniería Electrónica-Universidad del Cauca: Faculty of Electronic Engineering-University of Cauca.

Facultad de Medicina-Universidad de Antioquía: Faculty of Telemedicine-University of Antioquía.

Facultad de las Ciencias de la Salud: Faculty of Health Science.

Fundación Cardiovascular de Colombia: Cardiovascular Foundation of Colombia.

Fundación Santa Fe de Bogotá: Santa Fe de Bogotá Foundation.

Gestión de Salud para el Distrito Capital: Health Management for the Capital District.

Gestión Médica: Medical Management.

Grupo de Atención en Emergencias y Desastres: Group for Attention in Emergencies and Disasters.

Grupo de estudios de Tuberculosis: Group of Studies about Tuberculosis.

Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones (GNTT) -Universidad del Cauca: Research and Development Group of New Technologies in Telecommunications-Univeristy of Cauca.

Grupo de Ingeniería Biomédica (GIB)-Universidad de los Andes: Group of Biomedical Engineering.

Grupo de Ingeniería Telemática: Group of Telematic Engineering.

Grupo de Investigación en Bioingeniería: Research Group of BioEngineering.

Grupo de Investigación en Bioingeniería (GIB)-Universidad EAFIT: Research Group of BioEngineering (GIB)- University EAFIT.

Grupo de Investigación en Ingenería Clínica – Hospital Universitario La Samaritana: Research Group of Clinical Engineering - University Hospital La Samaritana.

Grupo de Investigación en Telemedicina (GITEM)-Universidad Distrital Francisco Jose de Caldas: Research Group of Telemedicine (GITEM)-Distrital University Francisco Jose de Caldas.

Grupo de Investigación en Telesalud (GIT)-Universidad de Caldas: Research Group of Telehealth-University of Caldas.

Grupo de Investigación, Desarrollo y Aplicación en Telecomunicaciones: Group for Research, Development, and Appication of Telecommunications.

Grupo de Sociedad y Salud: Group of Sociecty and Health.

Grupo de Tecnologías de la Información: Group of Information Technologies.

Herramientas Tecnológicas para la prevención y atención a víctimas de MAP – MUSE: Technical tools for prevention and attention of land mines victims.

Ingeniería en Sistemas y Computación: Systems Engineering and Computation.

Instituto de Alta Tecnología Médica de Antioquia: Medical High Technology Institute of Antioquía.

Instituto de la Seguridad Social: Social Security Institute.

Ministerio de la Protección Social: Ministry of Social Protection.

Ministerio de Comunicaciones: Ministry of Communications.

Programa de Investigación y Desarrollo en Redes de Acceso Universal para la teleducación y la telemedicina: Research and Devlopment Program about Univeral Access Networks for Teleducation and Telemedicina.

Programa Galaxia: Galaxy Program.

Red de Telemedicina de Antioquía: Telemedicine Network of Antioquía.

Red Piloto de Teleasistencia Sanitaria (ReTAS): Pilot Network of Sanitary Telecare.

Red Telemática para la Prestación de Servicios de Telesalud y Telemedicina: Telematic Network for providing Telehealth and Telemdicine services.

Secretaría de Salud: Secretrariat for Health.

Servicio Nacional de Aprendizaje: National Learning Service.

Telemedicina y Simulación Médica: Telemedicine and Medical Simulation.

Bibliography

[1] Agenda de Conectividad. www.agenda.gov.co. Accesed August 6th 2008.

[2] American Association of Telemedicine. http://www.atmeda.org/. Accesed 3rd May 2008.

[3] D. Angel, R. Alfonso, M. Faizal, O. Ricaurte, J. Baez, A. Rojas, P. Barato, M. Patarroyo, and M. Patarroyo. Cutaneous tuberculosis diagnosis in an inhospitable amazonian region by means of telemedicine and molecular biology. *J Am Acad Dermatol*, 52(5 Suppl 1):S65–8, 2005.

[4] Anonymus. Methodological progress. *The Economist*, 344(8036):89–90, 1997.

[5] L. E. Aparicio. *Fundamentos para desarrollo de Telemedicina*. Universidad Distrital Francisco José de Caldas, Bogotá, Colombia, 2001.

[6] L. E. Aparicio, J. H. Angulo, and J. A. Gónzalez. *Sistema de gestión de salud para el distrito capital*. Universidad Francisco José de Caldas, 2004.

[7] M. Arbelaez. El aporte de la telemedicina de la Universidad de Caldas en el fortalecimiento de redes sociales y académicas en el marco de la sociedad del conocimiento. In *V Foro Académico de Diseño*, Manizales, Colombia, 2008.

[8] Association of Telehealth Service Providers. www.atsp.org/. Accesed May 3rd 2008.

[9] C. Ávila, E. Barrientos, T. Caballero, and C. Gonzales. *Telemedicina.* Escuela de Ingeniería de Antioquía – Ingeniería Biomédica, 2006.

[10] A. Barone, F. Cataluccio, F. Milone, V. Orilia, L. Pellegrini, L. Paladini, and C. Sapulli. *Geographica. El Hombre y la Tierra, Vol. X*. Editorial Plaza y Janes, Barcelona, 1976.

[11] H. Benítez. Experiencia del seguro social colombiano en telerradiología. *Rev Salud Pública*, 3(Suppl 1):187–193, 2001.

[12] N. Botero. La historia médica va en el bolsillo. *El colombiano*. Accesed August 7th 2008.

[13] R. Britan and W. C. Yip. Review of health care provider payment reform in selected countries in Asia and Latin america. major applied research 2, working paper 1. *Partnerships for Health Reform, Abt Associates Inc*, August 1998.

[14] J. C. Caicedo, F. A. González, and E. Romero. Content-based medical image retrieval using low-level visual features and modality identification. *Lecture Notes in Computer Science*, 4993:51 – 60, 2008.

[15] J. Campos. Proyecto andino-europeo de telemedicina para la amazonía. *Rev salud publica*, 3(1):182–186, 2001.

[16] O. Cardona, S. Mejía, J. Castrillón, D. Giraldo, A. Jaramillo, and J. Bustamante. Interfaz para equipos de monitoreo médico (Red de Telemedicina de Antioquía). In *VI Congreso de la Sociedad Cubana de Bioingeniería*, Habana, Cuba, 2005.

[17] Centre for Reviews and Dissemination.

[18] Centre for Reviews and Dissemination. *Undertaking Systematic Reviews of Research on Effectiveness: CRD Guidelines for those carrying out or commissioning reviews (CRD Report No. 4).* NHS CRD, New York, 1996.

[19] Centro de Telemedicina de Colombia. Centro de Telemedicina de Colombia presentation at 1st National Telemedicine Meeting, avalaible at `www.minprocsoc.gov.co`. Accesed June 7th 2008.

[20] Centro de Telemedicina-Universidad Nacional de Colombia. `http://www.unal.edu.co/telemedicina/`. Accesed July 20th 2008.

[21] CINAHL. `http://www.cinahl.com/`. Accesed 3rd May 2008.

[22] Cochrane Library. http://www3.interscience.wiley.com/cgi-bin/mrwhome/106568753/HOME?CRETRY=1&SRETRY=0. Accesed 3rd May 2008.

[23] Colciencias. www.colciencias.gov.co. Accesed July 15th 2008.

[24] Colciencias. www.colciencias.gov.co. Accesed July 20th 2008.

[25] Colciencias. www.colciencias.gov.co. Accesed July 19th 2008.

[26] Colciencias. Rafael Rengifo's curriculum. www.colciencias.gov.co. Accesed June 15th 2008.

[27] A. G. S. Colombia. *Boletín Jurídico*, No. 34, September de 2006. available at www.ags.com.co, accessed 8th August 2008.

[28] Congreso de la República. *Constitución Política de Colombia*. Congreso de la República, Colombia, 1991.

[29] Consejo Nacional de la Seguridad Social en Salud. Acuerdo no. 378 de 2008. *Diario Oficial*, No. 46.896, February 8th 2008.

[30] Consejo Nacional de la Seguridad Social en Salud. Acuerdo no. 357 de 2007. *Diario Oficial*, No. 46.625, May 11th 2007.

[31] Counseil d´évaluation des technologies de la santé du Québec. *Telehealth and Telemedicine in Québec: Current Issues(CETS 98-7).* Counseil d'évaluation des technologies de la santé du Québec., Montreal, 1999.

[32] Critical Reviewers Advisory Group (CRAG) – School for Health and Related Research (ScHARR). *Introduction to Systematic Reviews.* ScHARR, 1996.

[33] CUIDEN. http://www.doc6.es/index/. Accesed 3rd May 2008.

[34] Current Contents. http://scientific.thomsonreuters.com/products/ccc/. Accesed 3rd May 2008.

[35] Departamento de Administración Nacional de Estadística (DANE). www.dane.gov.co/. Accesed August 4th 2008.

[36] Department of Guaviare. Department of Guaviare presentation at 1st National Telemedicine Meeting, avalaible at www.minprocsoc.gov.co. Accesed June 7th 2008.

[37] Diego Moñino Ramírez. *Evaluación del impacto del uso de tecnologías apropiadas de comunicación para el personal sanitario rural de países en desarrollo.* PhD thesis, Universidad Carlos III de Madrid, 2006.

[38] Dinero.com. La mira en la salud. *Dinero.com*, 290. Accesed August 7th 2008.

[39] Dirección de Relaciones Corporativas y Comunicaciones del Seguro Social. El IS S, primero con servicios de teleradiología en Suramérica. *Boletín externo*, 58. Accesed July 19th 2008.

[40] D. r. Díaz. www.drgdiaz.com. Accesed August 4th 2008.

[41] Empresa de Telecomunicaciones de Bogotá (ETB). ETB presentation at 1st National Telemedicine Meeting, avalaible at www.minprocsoc.gov.co. Accesed June 7th 2008.

[42] Enlace Hispano Americano de la Salud (EHAS). www.ehas.org. Accesed July 20th 2008.

[43] Equipo Interdisciplinario de Telemedicina Universidad Pontificia Bolivariana. Estructura pagina web del proyecto de investigación red de telemedicina de antioquia. www.upb.edu.co. Accesed February 5th 2008.

[44] E. Escobar, P. Adriazola, P. Castro, E. Montaner, R. Mendez, V. Rossel, M. Seguel, M. Vejar, A. Arribada, and R. Domenech. Tele-electrografía – experiencia preliminar. In *Congreso Chileno de Medicina Interna*, 2003.

[45] Esoft. www.esoftltda.com. Accesed August 7th 2008.

[46] Finconsult. Feasibility study of outsourced teleradiology service versus traditional subcontracted radiology service in Colombia. www.bernardotavera.com, January 1999. Accesed July 19th 2008.

[47] Fraunhofer Institute. Experiences with telemedicine in Latin America. www.igd.fhg.de. Accesed June 15th 2008.

[48] Fraunhofer Institute. T@lemed: Evidence based telemedicine for remote and rural underserved regions in la using e-health platforms. www.igd.fhg.de. Accesed June 15th 2008.

[49] O. Fresneda Bautista. La focalización en el regimen subsidiado de salud: elementos para un balance. *Revista Gerencia y Políticas en Salud*, 5:44 – 75, December 2003.

[50] M. Frydman. Beneficios de la telemedicina. El cuidado de la salud a distancia. *El hospital*, 3, February 2008.

[51] Fundación CardioVascular de Colombia. `http://www.fcv.org/`. Accesed July 17th 2008.

[52] Fundación CardioVascular de Colombia. Convenio Caprecom – FC V. reporte del trabajo desarrollado en cada IP S. `http://www.fcv.org`. Accesed July 17th 2008.

[53] Fundación Santa Fe de Bogotá. `www.fsfb.org.co`. Accesed July 20th 2008.

[54] Fundación Telefónica. *Las TICs y el Sector Salud en Latinoamérica*. Editorial Arial, España, 2008.

[55] A. García, J. Isaza, U. Zapata, and S. Roldán. Ejecución de un sistema piloto de tele-radiología en Medellín, Colombia. *Colombia Médica*, 37(3), 2006.

[56] E. J. Gómez. La ingeniería biomédica en el siglo XXI. *Fundeltel*, 5:32 – 44, Febrero 2001.

[57] Governor's Office of Cundianamarca. Governor's Office of Cundianamarca presentation at 1st National Telemedicine Meeting, avalaible at `www.minprocsoc.gov.co`. Accesed June 7th 2008.

[58] Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones Universidad del Cauca. `http://gntt.unicauca.edu.co/`. Accesed July 20th 2008.

[59] Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones Universidad del Cauca. *Programa de Investigación y Desarrollo en Redes de Acceso Universal para la Teleeducación y la Telemedicina*. Universidad del Cauca, Popayán, Colombia, 2000.

[60] Grupo de I+D en Nuevas Tecnologías en Telecomunicaciones-Universidad del Cauca. Aplicaciones al servicio de la salud. universidad del cauca. *Telecomunicaciones & Sociedad*, 2, 2004.

[61] Grupo de Investigación en Bioingeniería-Universidad (EAFIT). GIB-Universidad EAFIT presentation at 1st National Telemedicine Meeting, avalaible at www.minprocsoc.gov.co. Accesed June 7th 2008.

[62] Grupo de Investigación en Telesalud. http://telesalud.ucaldas.edu.co. Accesed July 15th 2008.

[63] Hospital Universitario La Samaritana. www.hus.org.co. Accesed July 19th 2008.

[64] IEEExplore. http://ieeexplore.ieee.org/Xplore/guesthome.jsp. Accesed 3rd May 2008.

[65] Instituto de la Seguridad Social. Reconocimiento internacional al seguro social. *Seguro Social*, 1. Accesed July 19th 2008.

[66] International Society for Telemedicine. http://www.isft.net. Accesed 3rd May 2008.

[67] ITMS. www.itms.cl. Accesed September 18th 2008.

[68] ITMS. http://www.chm.cl/itms1. Accesed September 18th 2008.

[69] A. J. Jovell and M. D. Navarro Rubio. Evaluación de la evidencia científica. *Medicina Clinica*, 105:740 – 743, 1995.

[70] A. J. Jovell, M. D. Navarro Rubio, M. Aymerich, and Serra-Prat. Metodología de diseño y elaboración de guías de práctica clínica en atención primaria. *Atención Primaria Prim*, 5:259 – 266, 1997.

[71] S. Kiefer. Telemedicine for rural and remote zones. In *Ministerial Forum on Information Society*, 2006.

[72] A. Kopec and A. Salazar. *Aplicaciones de telecomunicaciones en salud en la subregión andina: Telemedicina.* Organización Panamericana de la Salud. Oficina Regional de la Organización Mundial de la Salud, Washington DC, 2002.

[73] C. Lewin. *Research Methods in the Social Sciences.* Sage Publications, London, 2004.

[74] LILACS. http://www.bvsalud.org/php/index.php?lang=en. Accesed 3rd May 2008.

[75] A. Martínez. *Evaluación del impacto del uso de tecnologías apropiadas de comunicación para el personal sanitario rural de países en desarrollo.* PhD thesis, Universidad Politécnica de Madrid. Escuela Técnica Superior de Ingenieros de Telecomunicación, 2003.

[76] A. Martínez, J. Seoane, V. Villarroel, and F. Del Pozo. A study of a rural telemedicine system in the Amazon region of Peru. *Journal of Telemedicine and Telecare*, 10(4):219 – 225, 2004.

[77] A. Martínez et all. *Bases metodológicas para evaluar la viabilidad y el impacto de proyectos de Telemedicina*. Organización Panamericana de la Salud. Oficina Regional de la Organización Mundial de la Salud, Washington DC, 2001.

[78] H. Matiz Camacho. El futuro de la medicina con equidad en colombia: La telemedicina / the future of medicine with equity in colombia: Telemedicine. *Rev Colom. Cardiol*, 14(1):1 – 8, 2007.

[79] Medline. http://www.ncbi.nlm.nih.gov/pubmed/. Accesed 3rd May 2008.

[80] Ministerio de Comunicaciones. *Plan Nacional de Tecnologías de la Información y Comunicaciones 2008 - 2019*. Ministerio de Comunicaciones, May, 2008.

[81] Ministerio de la Protección Social. Telemedicine opera en 9 departamentos del país. www.minprocsoc.gov.co, December 2007. Accesed July 6th 2008.

[82] Ministerio de la Protección Social. Resolución 2184. *Diario Oficial*, No. 45611, July 16th 2004.

[83] Ministerio de la Protección Social. Resolución 1448. *Diario Oficial*, No. 46332, July 17th 2006.

[84] Ministerio de la Protección Social. *Informe de Actividades 2006 Ministerio de la Protección Social*. Ministerio de la Protección Social, Bogotá, Colombia, July 2007.

[85] Ministerio de la Protección Social. Resolución 1043. *Diario Oficial*, No. 46271, May 17th 2006.

[86] Ministerio de la Protección Social. Resolución 3763. *Diario Oficial*, No. 46791, October 24th 2007.

[87] N. I. Miserque. Programa Galaxia Fundación Cardiovascular de Colombia Floridablanca – Santander. Departamento Nacional de Medicina área de Telemedicina. *Revistaesalud.com*, 1(4), 2005.

[88] N. I. Miserque. La psicopatología de la telemedicina: una realidad virtual. *Revistaesalud.com*, 4(14), 2008.

[89] N. I. Miserque, P. Camacho, W. Arenas, R. Quiroz, and J. Rueda. Estudio Simil EC G: Estudio de concordancia entre la electrocardiografía convencional y la electrocardiografía digital utilizando internet y la web como medio de transmisión en telemedicina. *Revistaesalud.com*, 2(7), 2006.

[90] P. L. Moser, H. Hauffe, I. H. Lorenz, M. Hager, W. Tiefenthaler, H. M. Lorenz, G. Mikuz, P. Soegner, and C. Kolbitsch. Publication output in telemedicine during the period January 1964 to July 2003. *Jorunal of Telemedicine and Telecare*, 10:72 – 77, 2004.

[91] A. A. Navarro, C. J. Hernández, J. A. Vélez, L. E. Munera, G. B. García, C. A. Gamboa, and A. J. Reyes. Virtual surgical telesimulations in otolaryngology. *Stud Health Technol Inform*, 111:353–5, 2005.

[92] Organización Panamericana de la Salud. Oficina Regional de la Organización Mundial de la Salud. (OPS/OMS). *Bases metodológicas para evaluar la viabilidad y el impacto de proyectos de Telemedicina.* OPS/OMS, Washington DC, 2001.

[93] Organización Panamericana de la Salud. *La salud en las Américas*. Organización Panamericana de la Salud, Washington, 1998.

[94] Organización Panamericana de la Salud. *Situación de Salud en Colombia 2006*. Organización Panamericana de la Salud, Washington, 2006.

[95] P. Ossa. Telemedicina en colombia: ¿peligro u oportunidad? *Periódico El Pulso*, 102, March 2007.

[96] Prensa. Universidad del Cauca entregó proyecto de telemedicina en Guapí. *Universidad Hoy*, 79. Accesed June 15th 2008.

[97] Programa Compartel. `www.compartel.gov.co`. Accesed July 6th 2008.

[98] F. L. Quintero. Médicos de Bucaramanga atendieron por internet a niña que llegó de urgencias a hospital de Quibdó. *El Tiempo*, February 4th 2008.

[99] Red Nacional de Tecnología Avanzada (RENATA). `www.renata.edu.co`. Accesed August 6th 2008.

[100] A. Rendón, A. Martínez, M. Dulcey, J. Seoane, R. Shoemaker, and V. Villarroel. Rural telemedicine infrastructure and services in the Department of Cauca, Colombia. *Telemed J E Health*, 11(4):451 – 459, August 2005.

[101] Royal Collegue of General Practitioners. `http://www.rcgp.org.uk/`. Accesed 3rd May 2008.

[102] I. Sachpazidis, S. Kiefer, P. Selby, R. Ohl, and G. Sakas. A medical network for teleconsultations in Brazil and Colombia. In *Second IASTED International Conference on Telehealth*, pages 16 – 21, Banff, AB - Canada, 2006.

[103] I. Sachpazidis, G. Konnis, S. Kiefer, K. Rohm, A. Lozano, L. Yunda, P. Selby, A. Binotto, L. A. Messina, and G. Sakas. T@lemed: Medical imaging tele-cooperation technologies providing medical services in Latin America. In *EMBS/ITAB 2006*, 2006.

[104] Scielo. `http://www.scielo.org/php/index.php?lang=en`. Accesed 3rd May 2008.

[105] L. A. Tafur. Controversia a la reforma de la ley 100 de 1993, ley 1122 de enero de 2007. *Colombia Médica*, 38 No. 2, 2007.

[106] B. Tavera. `www.bernardotavera.com`. Accesed July 19th 2008.

[107] B. Tavera. Indicadores de gestión. `www.bernardotavera.com`. Accesed July 19th 2008.

[108] B. Tavera. Modelo de aplicacion mundial para una red de servicios de teleradiologia. `www.bernardotavera.com`. Accesed July 19th 2008.

[109] Technical Working Group for Telemedicine Standardization Department of Information Technology. Ministry of Communications and Information Technology. *Recommended Guidelines and Standards for Practice of Telemedicine in India.* 2003.

[110] Telemedicine Information Exchange. `http://tie.telemed.org/`, 2008. Accesed 3rd May 2008.

[111] United Nations Development Program. *Human Development Report 2007/2008*. United Nations Development Program, New York, 2007.

[112] United Nations Report Office. *Colombia: Human Development Progress towards the Millennium Development Goals*. United Nations Report Office, Washington, June 2003.

[113] Universidad del Cauca. Universidad del Cauca presentation at 1st National Telemedicine Meeting, avalaible at `www.minprocsoc.gov.co`. Accesed June 7th 2008.

[114] Universidas de Caldas. `http://decanosalud.blogspot.com`. Accesed July 15th 2008.

[115] X. Urtubey, E. Prieto, H. Hope, R. Rodrigues, and R. Van West Charles. *Telehealth in the Americas.* ITU and OEA and OPS, 2004.

[116] J. Valenzuela, A. Arguello, J. G. Cendales, and C. A. Rizo. Web-based asynchronous teleconsulting for consumers in Colombia: a case study. *J Med Internet Res*, 9(4), October 2007.

[117] J. A. Vélez. Panorama y tendencias de la telemática en salud, hablando de telemedicina. sistema & telemática. *Universidad ICESI*, pages 107–122, 2003.

[118] J. A. Vélez. Panorama y tendencias de la telemática en salud, hablando de telemedicina. *Sistemas & Telemática*, 2:107 – 123, 2004.

[119] J. A. Vélez and A. A. Navarro. A Latin American telemedicine social perspective from a Colombian telemedicine center initiative. *Telemed J E Health*, 11 (5):616 – 619, 2005.

[120] J. A. Vélez and A. A. Navarro. Una perspectiva de e-salud en Colombia. *RevistaeSalud.com*, 1 (4), 2005.

[121] J. A. Vélez and A. A. Navarro. A virtual educational strategy on telemedicine and medical simulation. *Telemed J E Health*, 11 (4):496 – 499, 2005.

[122] J. A. Vélez, A. A. Navarro, and G. Ricur. Telemedicine in the Latin American and Caribbean regions: the Cartagena telemedicine conference. *J Telemed Telecare*, 13(4):210 – 211, 2007.

[123] V. Villarroel and M. Camino. *Informe de evaluación EHAS-@LIS*. Ingernierí a Sin Fronteras, 2007.

[124] M. Von Baratta. *Fischer's World Almanac 2003*. Fischer, Frankfurt am Main, 2002.

[125] Winrock International and Telecommons Development Group. *Rural Connectivity and Energy Initiative. Draft Report for Comments*. Inter-American Agency for Cooperation and Development Organization of American States, 2002.

[126] R. Yin. *Case Study Research: Design and Methods*. Sage Publications, London, 2003.