English

The use of telemedicine in cardiology in Brazil

André Luís Fernandes dos Santos	Master of Veterinary Medicine, Doctor of Science, Laboratory of Muscle Proteins and Comparative Histopathology Human Genome Study Center. Department of Genetics and Evolutionary Biology Institute of Bioscience - University of São Paulo. Rua do Matão, 106 - lane 13- ZIP code 05508-090 Tel (11) 3091-7966 r 56 **Address:** Rua do Matão, 106 - lane 13- ZIP code 05508-090 **E-mail:** andr_vet@yahoo.com.br **Lattes:** http://lattes.cnpq.br/8542523704354745
Emanuel de Jesus Soares de Sousa	Graduated in Medicine and Master in Human Motricity from the Federal University of Pará (EUPA).
Ana Carolina de Castro Ribeiro Head	Complete high school and graduating medicine from the State University of Pará (UEPA).
Ramona Carvalho Barros	graduating medicine from the State University of Pará (UEPA). Extension Director of the Pará Academic Urgency and Emergency League, director of IFMSA Brazil LC UEPA.
Rodrigo Luiz Martins Pantoj	graduating medicine from the State University of Pará (UEPA).
Kleber Pinto Ladislau	graduating medicine from the State University of Pará (UEPA).

Date of Receipt: September 30, | **Approval date:** November 20, 2019

Abstract

Introduction: *The objective of this article was to analyze the contributions of telemedicine in the diagnosis and treatment of the main cardiopathies in Brazil.* **Method**: *It was used, as data source, journals indexed in Academic Google and in PubMed.* **Results**: *The selection criteria included the prospection of published articles, preferably, between 2000 to 2019, in Portuguese or English, including case reports and other literature revision articles. The telediagnosis, particularly involving Electrocardiography, generates financial economy to the municipalities and can increase the chance of the afflicted by Myocardial Infarcition of surviving.* **Conclusion**: *it is still necessary to improve the connectivity of the municipalities to the internet, but it is possible to observe efforts in this sense.*
Keywords: *Telemedicine; Telediagnosis; Telecardiology; EKG; Electrocardiogram.*

Resumen

El uso de la telemedicina en cardiología en Brasil. **Introducción** *El objetivo de este artículo fue analizar las contribuciones de la telemedicina en el diagnóstico y tratamiento de las principales cardiopatías en el Brasil.* **Metodo**: *Fueran utilizadas, como fuente de datos, periódicos indexados en el Google Académico y en el PubMed.* **Resultados**: *Los criterios de selección incluyeran la prospección de artículos publicados, preferencialmente entre 2000 a 2019, en portugués o inglés, incluyendo relatos de casos y otros artículos de revisión de literatura. El telediagnóstico, particularmente envolviendo el Elehocardiograma genera economía financiera a los municipios y puede aumentar la posibilidad de los acometidos por el Infarto del Miocardio de sobrevivir.* **Conclusión**: *aún es necesario mejorar la conectividad de los municipios a la internet, pero es posible observar esfuerzos en este sentido.*
Palabras-clave: Telemedicina; Telediagnóstico; Telecardiología; ECG; Electrocardiograma.

Resumo

O uso da telemedicina em Cardiologia no Brasil. **Introdução:** *O objetivo deste artigo analisa as contribuições da telemedicina no diagnóstico e tratamento das principais cardiopatias do Brasil. Método: Serão utilizados, como fonte de dados, jornais indexados no Google Acadêmico e no PubMed. Resultados: Os critérios de seleção incluirão a prospecção de artigos publicados, preferencialmente entre 2000 e 2019, em português ou inglês, incluindo relatos de casos e outros artigos de revisão de literatura. O telediagnóstico, particularmente envolvendo o Eletrocardiograma, gera economia financeira para os municípios e pode aumentar a possibilidade de sobrevivência dos indivíduos acometidos por Infarto Agudo do Miocárdio. Conclusão: Ainda é necessário melhorar a conectividade dos municípios à Internet, mas é possível observar esforços nesse sentido.*
Palavras-chave: *Telemedicina; Telediagnóstico; Telecardiologia; ECG. Eletrocardiograma.*

Introduction

Telemedicine is the provision of health services using communication technologies. It is characterized by the presence of a patient and one (or two) health professionals, that are not in the same place. It is of extreme relevance in Brazil, due to the fact that the basic health units and prompt service (UBS and UPA, respectively) and the secondary hospitals are localized in many regions of the national territory, generally distant from the big urban centers, where commonly the centers/specialized institutes (tertiary hospitals) are located[1]. Therefore, the experience of the specialists from the tertiary hospitals can increase the emergency treatment in the so called remote units of service (from the Portuguese URA), giving support to the diagnosis/treatment of the diseased by the non-specialized doctors[2].

Actions in telemedicine can be classified in two groups: clinical-surgical activities and teaching activities. The teaching activities include teleconferences, telecourses and educational internet sites. In what concerns the clinical-surgical activities, they include 1) teleservice (communication between the patient and medical service); 2) teleconsultation (it's the accomplishment of a medical consultation between two remote points, that can be synchronous or asynchronous); 3) telemonitoring (monitoring of the physiological parameters of a patient, as of an electrocardiogram, for example); 4) telesurgery (a procedure where the doctor and patient are in different environments) and 5) telediagnosis (the sending of complementary exams of the patient for evaluation and remote diagnosis)[3].

Telediagnosis had it beginning in 1950, when a radiographic exam was transmitted via fax in the United States[4]; however, it was from the 90s that this diagnosis modality was seen as a way to avoid the difficulty of access to complementary exams in distant areas[5].

The MS Decree nº 2.546 defines telediagnosis as "the autonomous service that uses information and communication technology to support the diagnosis through geographic and temporary distances"[6]. One of the characteristics of telediagnosis is that the complementary exam is carried out in the UBS or UPA and its technical report is carried out in reference centers, without the need of a specialist in the moment of its completion; it is believed that this diagnosis modality can generate decrease in the costs, by avoiding displacement of patients and specialists, in addition to enabling the access of the patients that live in remote areas of the country.

The cardiovascular are the main cause of death in Brazil, accounting for about 30% of the deaths. Although commonly associated to the way of life in the big cities, they are also the main death cause in small and medium cities, where a high prevalence of the cardiovascular risk factors can be observed[7].

The acute coronary syndrome has a high pre-hospital mortality and almost 40% of the afflicted dies before receiving the first aid. That is why cardiology is a fertile field for the application of telediagnosis[8].

The remote monitoring of the cardiovascular parameters, such as blood pressure and electrocardiographic tracing, are fundamental in the emergencies and immediate medical interventions. In these cases, the telediagnosis is fundamental, specially the electrocardiogram (ECG) and the echocardiogram (ECO), in the diagnosis, outpatient treatment, prognosis and definite treatment of severe cardiopathies[3]. The ECG is fundamental for the diagnosis of arrhythmias, of the acute myocardial infarction (AMI) and in the follow-up of the patients in treatment[9]. It has the advantage to be a method with well-established parameters, to have low cost and high sensibility in the detection of the abnormalities of cardiac rhythm[7,8]. The ECG racing was and still can be transmitted via fax or email, in other words, with technologies that are simples than the current ones. The objective of this article was to analyze, from a systematic literature review, the contributions of telemedicine in the diagnosis and treatment of the main cardiopathies in our country. Economic factors linked to the public administration, when relevant, will also be analyzed.

Method

This article is a bibliographic research about telemedicine in Brazil. It was used, as data source, the journals indexed in Academic Google and in PubMed. The selection criteria included the prospection of published articles, preferably, between 2000 and 2019, in Portuguese or English, including case reports and other literature review articles. The used descriptors (in Portuguese and the respective term in English) were: "remote diagnosis"; ECG; electrocardiography; "remote ECG"; "remote electrocardiography"; Telecardiology; "cardiology telediagnosis"; "ECG telediagnosis". It was excluded the articles that didn't have content related to telediagnosis or telediagnosis in Cardiology.

Results

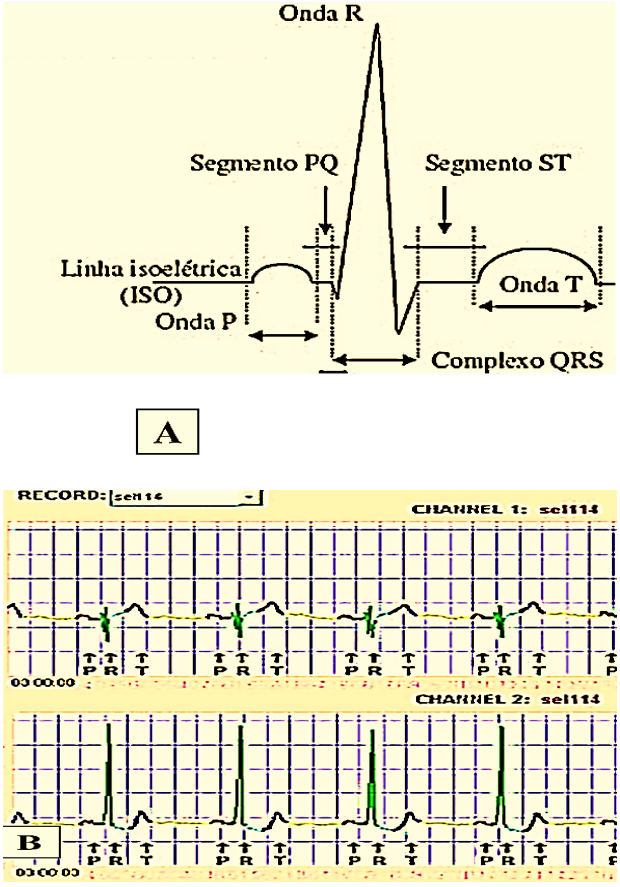
The use of telediagnosis in ECG (tele/ECG) widened its access and reduces the referrals to the emergencies, because many patients could be treated in other care levels determined that the cost-benefit relation of the tele/ECG was always favorable; according to a ECG with the medium cost of R$ 28,92, the authors observed that the economy in the tele/ECG varied between R$ 2,00 to R$ 20,91, depending on the considered built-in costs (in the biggest economy it was considered the transportation costs, the person's opportunity and nutrition)[7,10].

Nowadays a modality that was given highlight is the telemonitoring of patients with chronic heart disease, in order to follow-up the treatment and it evolution, the so called at home Telecardiology. The Telecardiology is a branch of Telemedicine, in which it is studied the application of the

information and communication technologies in the cardiologic pratice[9]. This modality aids the efforts of the at home services that already exist with the more efficient monitoring of the ECG, blood pressure, blood sugar, among others[11].

The Project TeleCardio: Telecardiology at the Service of Patients in Hospital and at Home Environments, developed in the Federal University of Espírito Santo (UFES), proposes the development of a follow-up system of the heart's electric heart activity, in chronic patients. One of its aspects is in the at home monitoring, where the ECG signal is acquired by a holter machine and transmitted by a remote computer, that transmits it to a monitoring central; the specialist doctor of the patient can interact with the system, following the data from a desktop computer, notebook or multifunctional mobile device. In this system it is possible to determine the R-R interval (distance between two consecutive heart beats) and deviations in the ST segments; in the case if the R-R interval it is possible to follow-up the cardiac frequency (CF), that is inversely proportional to the amplitude of the such interval, with the deviation of the ST segment indicates myocardial ischemia (many times in asymptomatic patients)[11]. In figure 1 we have the standard electrocardiographic tracing (A) and a patient's tracing.

Figure 1 – Standard electrocardiographic tracing (A) and a patient's tracing (B)



Source: ANDREÃO; FILHO; CALVI, 2015.

The project Minas Telecardio proposed to implant the Telecardiology in 82 municipalities of the Minas Gerais State and for that carried out a pilot study in 10 municipalities, with all having a conventional electrocardiograph and 40% of them had cardiologists for weekly service. However, the presence of a specialist didn't avoid the referral of patients to other municipalities for the fulfillment of the ECG. One of the expectations of the municipal gestors was with the decrease of costs with the referral of patients; on the other hand, the expectation of the doctors was, in addition to the fulfillment of the telediagnosis, the opportunity of permanent education, since the interaction with specialists in university hospitals was possible[8].

One of the worries of the Minas Telecardio project was also the quality of the connections. To test their quality 22 municipalities were chosen, that were evaluated during 30 days and the connections receives scores in a scale of 0 to 5 (5-great, 4-good, 3-reasonable, 2-bad, 1-awful and 0-didn't test). The ten cities with the best fixed connection were (in brackets the kind of connection and speed, respectively):

Score 5: Buenópolis (radio, 64 Kbps);

Score 4: Augusto de Lima (radio, 128 Kbps); Crucilândia (radio, 128 Kbps); Moeda (satellite, 64 Kbps); Morada Nova (radio, 256 Kbps); Quartel Geral (radio, 256 Kbps);

Score 3: Cachoeira da Prata (radio, 256 Kbps); Inimutaba (radio, 128 Kbps); Pequi (radio, 128 Kbps);

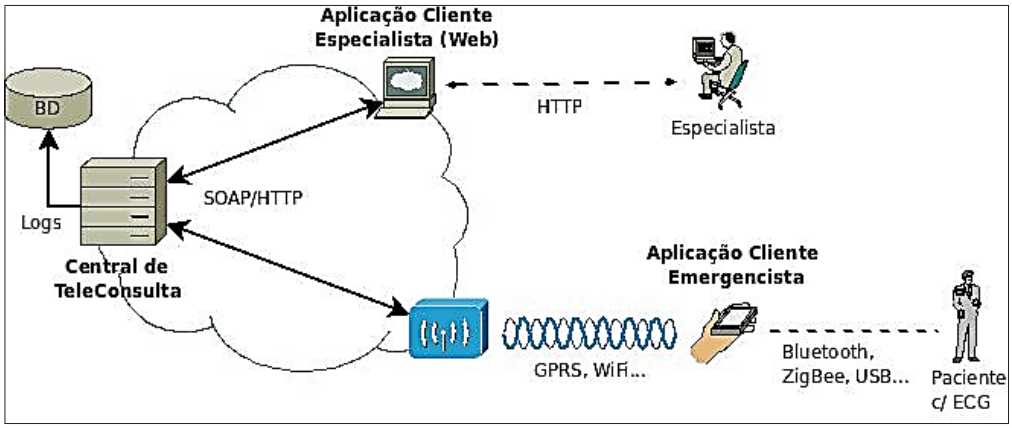
Score 1: Belo Vale (satellite, 64 Kbps)[8].

In the implantation of the project the municipalities listed above presented another reality in terms of connection, product of the orientations given to the gestors by the members that are responsible for the implementation of the project. So much that the municipalities of Cachoeira Paulista and Inimutaba had score 4, while Pequi had score 5[8].

Teixeira IM[12] reported their experience with the AToMS system (AMI Teleconsultation & Monitoring System), that proposes to "take through wireless communication technology the knowledge of a specialist to the place where the patient afflicted by the AMI receives their first attendance emergency team".

The AToMS is a system that is still in evaluation phase, that has the purpose to obtain a reduction in time between the appearance of the first AMI symptoms and the administration of the thrombolytic therapy, fact that increases the chance of therapeutic success in places of difficult access. Its Teleconsultation Center manages the information trade between the emergency team and the specialists; through it, it is possible to receive the analysis requests by the emergency team and refer them to the registered specialists. The patient is an application executed to a PDA or a laptop, connected to a portable device for the acquisition of the digital ECG; this application will compose 1) the attendance register, 2) the patient's clinical information, 3) the capture of the ECG and 4) the sending of chat messages and of the electrocardiographic tracing to the specialists[12]. In figure 2 we have a general vision of the system.

Figure 2: General view of the AToMS system.



Source: (TEIXEIRA IM, 2009)[12].

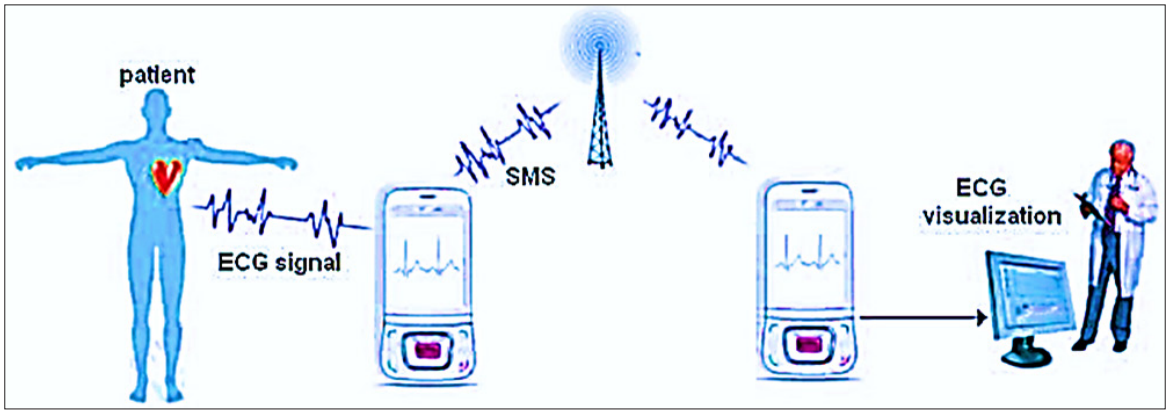
According to Canabarro APF, Cardoso CS (2013)[9], "the digital technologies available for the acquisition and transmission of the ECGs still have a high added value and use equipment that is hardly available in health centers [...]".

With the objective to decrease the costs one can opt to photograph the ECG, with a smartphone or a tablet and to send the image, the so called photo-ECG; however, it is important to guarantee the quality of the acquisition scheme and the visualization of the digitalized images[9].

Canabarro APF, Cardoso CS [9] used fifty ECGs printed in graph paper, acquired from the Board of Health of the Aeronautics Hospital of Canoas-RS, in which it was only registered the sex and age of the patients; these ECG were presented to the doctors in different moments of the photo-ECG, in order to avoid the memorization by the professionals. For the capture of the ECGs two devices were used: a Canon® digital camera (model IXUS 220 HS/resolution 0,3 megapixel) and a cellular telephone Nokia® an attached camera (model 5130/resolution 2,0 megapixel), with the chosen resolutions corresponding to the minimal resolution of their respective devices. It was obtained 50 images with each device, totalizing 100 photo-ECG. The results obtained by Canabarro APF[9] were of 72% of agreement between the printed exams and the ones obtained by the digital camera, and of 74% in those obtained by the cellphone, after analysis carried out by the specialists.

The ECG signals can be transmitted via Short Message Service, known as SMS. The advantages of SMS would be the use of low cost cellphones and the possibility to reach a small income population, peripheral to the big urban centers. The Manager Committee of the Brazilian Internet (CGI.br) carried out a research in the year 2008, with 13.359 people, that noted that half of the Brazilians that had cellphones used text messages and sent, on an average, 10 messages per month. In order for the ECG to be transmitted by SMS it will be necessary to install in the cellphone a device for acquisition and processing of electrocardiographic signals; this signal must be compressed to allow the sending from the patient's cellphone to the doctor's cellphone, that will transfer it to their computer, as schematized in figure 3[13].

Figure 3: General scheme of the mobile ECG Source: (PEREIRA TP, 2010)[13]



Source: (PEREIRA TP, 2010)[13]

In relation to the doctors, LACERDA TC[14], quotes that one of the main causes of low adhesion to telemedicine is the poor performance regarding the usability of a system. With the objective to improve the usability of a system for the elaboration of ECG reports, LACERDA TC[14], changed the interactions ways of the doctor with the free text system (FT) to the so called structured way (SR) and applied satisfaction tests, heuristic evaluations and evaluations based in model; the results showed that the filling of the report in FT is at least 14 seconds bigger compared to the SR; regarding the satisfaction it was used the System Usability Scale questionnaire (SUS, in a scale of 0 to 100), in which the average satisfaction index in the FT system was of 58,85, while the SR one was of 77,5. With the results the authors concluded that the SR interaction is more efficient and satisfactory than the FT interaction.

Conclusion

It can be concluded that, from the consulted studies, the use of telemedicine in the cardiology area is quite promising in our country. The telediagnosis, particularly involving the ECG, generates a financial economy to the municipalities and can increase the chance of the afflicted by the AMI of survival. It is still needed to improve the connectivity of the municipalities to the internet, but it is possible to observe efforts in this sense.

References

1. Junior MTO, Canesin MF, Marcolino MS, Ribeiro ALP, Carvalho ACC, Reddy S. Sociedade Brasileira de Cardiologia. Diretriz de Telecardiologia no Cuidado de Pacientes com Síndrome Coronariana Aguda e Outras Doenças Cardíacas. Arq. Bras. Cardiol. (Supl.1) 2015a;104(5):1-26.

2. Junior MTO, Paula LJC, Marcolino MS, Canesin MF. Resumo Executivo–Diretriz de Telecardiologia no Cuidado de Pacientes com Síndrome Coronariana Aguda e Outras Doenças Cardíacas. Arq. Bras. Cardiol. 2015b;105(2):105-111.

3. Mattos SS, Moser L, Severi R, Hedayoglu F. Telemedicina em Cardiologia Pediátrica e Fetal. Revista Brasileira de Ecocardiografia. 2002;15(2):63-70.

4. Zundel KM. Telemedicine: history, applications, and impact on librarianship. Bulletin of the Medical Library Association. 1996;84(1):71-79.

5. Brasil. Ministério da Saúde e Universidade Federal do Rio Grande do Sul. Manual de Telessaúde para Atenção Básica/Atenção Primária a Saúde. Brasília, 2012

6. Brasil. Ministério da Saúde. Gabinete do Ministro. Portaria nº 2.546, de 27 de outubro de 2011. Redefine e amplia o Programa Telessaúde Brasil, que passa a ser denominado Programa Nacional Telessaúde Brasil Redes (Telessaúde Brasil Redes). Brasília, 2011. Disponível em: <http://www.brasilsus.com.br/legislacoes/gm/110256-2546.html>. Acesso em: 29 ago.2019.

7. Andrade MV, Maia AC, Cardoso CS, Alkmim MB, Ribeiro ALP. Custo-Benefício do Serviço de Telecardiologia no Estado de Minas Gerais: Projeto Minas Telecardio. Arquivos Brasileiros de Cardiologia. 2011;9(4):307-316. Disponível em: http://dx.doi.org/10.1590/S0066-782X2011005000080.

8. Alkmim MBM, Ribeiro ALP, Cardoso CS, Pereira LFS, Lessa PC. (2006). Minas Telecardio-Implantação de Telecardiologia no Serviço Público de Saúde do Interior de Minas Gerais. In: X Congresso Brasileiro de Informática em Saúde, Florianópolis, 2006.

9. Canabarro APF, Schwabert ÂM, Cardoso RB, Valdez CF, Trindade CS, de Oliveira HW, Lamadrid IG, Russomano T. Avaliação do foto-eletrocardiograma como ferramenta de Cardoso CS, Ribeiro ALP, Castro RLV, César CC, Caiaffa WT. Implementation of a cardiology care program in remote areas in Brazil: influence of governability. Rural and remote health, Australia. 2010;10(3):1472.

10. Molinari G, Valbusa A, Terrizzano M, Bazzano M, Torelli L, Girardi N, Barsotti A. Nine years' experience of telecardiology in primary care. Journal of telemedicine and telecare. 2004;10(5):249-253. Disponível em: https://doi.org/10.1258/1357633042026297.

11. Andreão RV, Filho JGP, Calvi CZ. TeleCardio – Telecardiologia a Serviço de Pacientes Hospitalizados em Domicílio. In: X Congresso Brasileiro de Informática em Saúde, Florianópolis, 2006.

12. Teixeira IM, Viçoso RP, Correa BSP, Gomes, ATA, Ziviani A. Suporte Remoto ao Atendimento Médico Emergencial via Dispositivos Móveis. In: Workshop de Informática Médica (WIM), 2009.

13. Pereira TP, Araujo APL, Souza CP. Um método de compressão de sinais eletrocardiográficos para uso de SMS em sistemas móveis. In: La Novena Conferencia Iberoamericana en Sistemas, Cibernética e Informática (CISCI), Orlando, 2010. segunda opinião formativa. Scientia Medica. 2013;23(4):219-225.

Source: Elaborated by the Author.

Financing: Without funding funds

Conflict of interest: The author declares that he has no conflict of interest in the content of this work.

How to cite this article: Dos Santos ALF. The use of telemedicine in cardiology in Brazil/El uso de la telemedicina en cardiología en Brasil. Latin Am J of Telehealth. Brasil. 2019;6(2). 137 - 142.
ISSN: 2175_2990.