National Telehealth Network for Healthcare Centers in Paraguay

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Abstract

In the context of a scientific and technological assessment of methodological alternatives that facilitate a universal coverage system and the efficient use of available resources in public health, there are valid arguments for considering a Telehealth system advantageous as a tool to improve healthcare in remote populations without access to specialists. This multicenter, observational, and descriptive study conducted by the Telemedicine Directorate of the Ministry of Public Health and Social Welfare (MSPBS) in collaboration with the Department of Biomedical Engineering and Imaging of the Institute of Health Sciences Research (IICS-UNA) and the University of the Basque Country (UPV/EHU) served to evaluate the technical feasibility of implementing a Telehealth system in public health. The results obtained from the telediagnosis system implemented in 80 MSPBS hospitals were analyzed, where remote diagnoses were performed between January 2014 and April 2025, with the majority of cases involving female patients. Of the total telediagnoses performed, 30.40% corresponded to tomography studies, 0.90% to mammography, 66.14% to electrocardiography (ECG), 2.20% to electroencephalography (EEG), 0.22% to Holter monitoring, and 0.14% to ambulatory blood pressure monitoring (ABPM). The overall average age of the patients was 45.2 years. The results obtained in this study demonstrate that it is feasible to implement and sustain telediagnosis projects and remote specialist consultations that strengthen universal coverage of diagnostic services, foster innovation, and ensure the economic sustainability of the public telediagnosis system. Furthermore, it will substantially improve the local diagnostic capacity of hospitals without specialists and the management of scarce human and technological resources in the interior of the country.

Key-words: Telehealth, Telediagnosis, Telemedicine, ICTs in health, Health informatics, Paraguay.

Resumen

Red Nacional de Telesalud para Centros Asistenciales de Salud del Paraguay

En el contexto de una valoración científica y tecnológica de las alternativas metodológicas que facilite un sistema de cobertura universal y el uso eficiente de los recursos disponibles en la salud pública, existen argumentos válidos para que un sistema de Telesalud sea considerado ventajoso como una herramienta para mejorar la atención sanitaria en poblaciones remotas sin acceso a los especialistas. Este estudio multicéntrico, observacional y descriptivo realizado por la Dirección de Telemedicina del Ministerio de Salud Pública y Bienestar Social (MSPBS) en colaboración con el Dpto. de Ingeniería Biomédica e Imágenes del Instituto de Investigaciones en Ciencias de la Salud (IICS-UNA) y la Universidad del País Vasco (UPV/EHU) sirvió para evaluar la factibilidad técnica para la implementación de un sistema de Telesalud en la salud pública. En tal sentido fueron analizados los resultados obtenidos del sistema de telediagnóstico implementado en 80 hospitales del MSPBS, donde fueron realizados diagnósticos remotos entre enero del 2014 y abril de 2025, en los cuales la mayoría correspondieron a pacientes del sexo femenino. Del total de telediagnósticos realizados, el 30,40 % correspondieron a estudios de tomografía, 0,90 % a mamografía, 66,14% a electrocardiografía (ECG), 2,20% a electroencefalografía (EEG), 0,22% a Holter y 0,14% a MAPA. La edad promedio general de los pacientes fue de 45,2 años. Los resultados obtenidos en este estudio evidencian de que es viable implementar y sustentar proyectos de telediagnóstico y consultas de especialistas a distancia que faciliten fortalecer la cobertura universal de servicios diagnósticos, capacidad de innovación y aseguramiento de la sostenibilidad económica del sistema de telediagnóstico público. Además, ayudará a mejorar sustancialmente la capacidad resolutiva local de los hospitales sin especialistas y la gestión de los escasos recursos humanos y tecnológicos en el interior del país.

Palabras clave: Telesalud, Telediagnóstico, Telemedicina, TICs en salud, Telemática en salud, Paraguay.

Resumo

Rede Nacional de Telessaúde para Centros de Atenção à Saúde no Paraguai

No contexto de uma avaliação científica e tecnológica de alternativas metodológicas que facilitem um sistema de cobertura universal e o uso eficiente dos recursos de saúde pública disponíveis, há argumentos válidos para considerar um sistema de telessaúde como uma ferramenta vantajosa para melhorar a assistência à saúde em populações remotas sem acesso a especialistas. Este estudo multicêntrico, observacional e descritivo, conduzido pela Direção de Telemedicina do Ministério da Saúde Pública e Bem-Estar Social (MSPBS) em colaboração com o Departamento de Engenharia Biomédica e Imagem do Instituto de Pesquisa em Ciências da Saúde (IICS-UNA) e a Universidade do País Basco (UPV/EHU), serviu para avaliar a viabilidade técnica da implementação de um sistema de Telessaúde na saúde pública. Nesse sentido, foram analisados os resultados obtidos com o sistema de telediagnóstico implantado em 80 hospitais do MSPBS. Um total de 940.943 diagnósticos remotos foram feitos entre janeiro de 2014 e abril de 2025, 35,5% eram homens e 64,5% eram mulheres. Do total de telediagnósticos realizados, 30,40% (286.050) corresponderam a exames de tomografia, 0,90% (8.509) a mamografia, 66,14% (622.303) a eletrocardiograma (ECG), 2,20% (20.718) a eletroencefalografia (EEG), 0,22% (2.094) a Holter e 0,14% (1.269) a MAPA. A idade média dos pacientes foi de 45,2 anos. Os resultados deste estudo demonstram a viabilidade tecnica de implementar e apoiar sistemas de telediagnóstico e consultas remotas com especialistas que fortaleçam a cobertura universal de serviços de diagnóstico, promovam a capacidade de inovação e garantam a sustentabilidade econômica do sistema público de telediagnóstico. Além disso, ajudará a melhorar substancialmente a capacidade de resposta local de hospitais sem especialistas e a gestão dos escassos recursos humanos e tecnológicos no interior do país.

Palavras-chave: Telessaúde, Telediagnóstico, Telemedicina, TICs em saúde, Telemática em saúde, Paraguai.

INTRODUCTION

Information and Communication Technologies (ICTs) applied to healthcare in dispersed and remote populations offer multiple advantages for diagnostic services and remote consultations[1]. Telemedicine's main strength lies in remote diagnosis and consultation with specialists, making it advantageous for patients, healthcare personnel, and the community, provided it is properly planned[2].

The application of ICTs in healthcare aims to expand the range of services offered to achieve universal coverage and greater equity in the provision of specialized medical services (Alma Ata Declaration of the United Nations)[3], without neglecting the effectiveness and usefulness of the technologies involved. Based on these premises, telediagnosis implemented in countries with limited healthcare resources can be considered a valid tool to improve healthcare for remote populations that lack access to specialists. In this sense, ICTs offer significant opportunities to improve service coverage, more effectively exchange clinical and administrative information, provide staff training, and disseminate scientific information to the affected population[4]. In Paraguay, the legal framework for the use of telehealth was established through Law No. 5482/2015, “Which creates the National Telehealth Program and establishes regulations for its implementation,” in 2015, and the regulations for this law were issued through Resolution S.G. No. 367/2020 of the Ministry of Public Health of Paraguay.

To evaluate the technological alternative of telehealth systems, it is essential to scientifically demonstrate their effectiveness, safety, and quality compared to standard healthcare practices. Also, it is important to develop the technical and methodological aspects that enable the assessment of their social impact through applied research. This research should guide the decision-making process to improve the effectiveness of local healthcare centers in remote and dispersed populations. In this regard, and to investigate the feasibility of systematically implementing telemedicine in Paraguay, the Department of Biomedical Engineering and Imaging of the Institute of Health Sciences Research (IICS) at the National University of Asunción (UNA) has conducted several operational research projects since the late 1990s and early 2000s, utilizing available technologies. In 1999, a pilot test of a satellite-based tele-ultrasound service was conducted at the Ministry of Public Health and Social Welfare (MSPBS) with the support of the Biomedical Engineering Department of the IICS-UNA. This initial experience revealed that satellite technology was not sustainable in the public sector due to the high cost of the bandwidth required to operate the telemedicine system, given the limited budget available within the Ministry of Health and the remote healthcare centers throughout the country that would have to finance the service. Following this experience, the current telemedicine system was launched in 2007, coinciding with the significant expansion of internet services and increased connectivity for institutions and the general population in the country.

The Telemedicine Directorate of the Ministry of Public Health and Social Welfare (MSPBS), in collaboration with the Department of Biomedical Engineering and Imaging (IICS-UNA), conducted multiple projects to assess the feasibility and cost-effectiveness of a telemedicine system in public health. These projects provided objective and independent information regarding the technical viability of implementing and sustaining telemedicine initiatives for remote diagnosis and specialist consultations in healthcare centers across Paraguay.

METODOLOGY

Population: This multicenter, observational, and descriptive study included 940,943 patients who underwent diagnostic imaging studies (CT scans and mammograms) and biological electrical signal recordings (ECG, EEG, Holter monitoring, and ambulatory blood pressure monitoring) between January 2014 and April 2025 at the 80 regional and district hospitals within the health regions of the Ministry of Public Health and Social Welfare (MSPBS). Patients' clinical data were recorded in an electronic file. The images captured, processed, and transmitted from the CT, mammography, ECG, EEG, Holter, and ambulatory blood pressure monitoring departments were sent to the specialist physician via the internet. A non-probability convenience sampling method was used. To ensure the confidentiality, integrity, and consistency of the information, the telemedicine system employed mechanisms such as controlled system access (username/password), prioritized consultations based on user type (secretary, technician, physician, or system administrator), encrypted databases, secure sockets layer (SSL) encrypted communication, and encryption keys for data manipulation and modification, using an encryption protocol that provides secure communication.

Equipment and software used:

The images were obtained using various medical devices. For the CT scanner and mammogram, a dedicated computer was used to download the digital images in DICOM format, which were then processed and stored using proprietary software. For the ECG and EEG, an RS-232 connection was used via the COM port, allowing interaction with the computer through application software that facilitated data acquisition and the subsequent generation of graphs in JPG format. For the Holter and ABPM devices, a capture card was used to access the 24-hour monitoring signal, which was then transferred to the computer for processing. The web application was used by the medical imaging, ECG, EEG, Holter, and ABPM specialties to simplify the process of incorporating the images obtained by the respective diagnostic peripheral equipment into the patient's electronic medical record database. The digital technology used for image transmission in this study is called “store and forward,” where, once the images or biological electrical signals were obtained, the patient's electronic medical record module (standalone or web application) was executed. The “remote specialist” (medical professional specializing in imaging, neurology, and cardiology) accesses the diagnostic system to view the patients' clinical data and attached images/signals for diagnosis. Immediately after the diagnosis is made by the specialist, the report is available for printing and delivery to the patient and/or for transmission by email to the treating physician, as requested.

RESULTS

The results of the technology assessment conducted in this study on the telediagnostic system (tomography, mammography, ECG, EEG, Holter, and ABPM) are applicable throughout the entire life cycle of the National Telemedicine Network. This is because it generates information both before and after the implementation of a remote diagnostic system, helping to support political decisions regarding its public funding, and also assisting in measuring the impact of this technological innovation for remote diagnosis in typical clinical practice settings.

To facilitate the implementation of the Telemedicine System, the Ministry of Health conducted a national assessment of underutilized resources. This assessment included technological resources such as medical diagnostic equipment (CT scanners, mammography machines, electrocardiographs, electroencephalographs, Holter monitors, and ambulatory blood pressure monitors) and internet connectivity. It also evaluated healthcare professionals, including surgical technologists, radiologists, medical technologists, and IT technicians. Additionally, strategic partnerships were formed through agreements with national universities (UNA, UPA), international universities (UPV/EHU from Spain), and public organizations (CONATEL, COPACO, SENATIC). These collaborations facilitated the development and implementation of the Telemedicine System application software. This software was custom-developed by the Department of Biomedical Engineering and Imaging (IICS-UNA) to meet the specific needs of local users in specialized, general, regional, and district hospitals, as well as Family Health Units (USF) and the Ministry of Public Health and Social Welfare (MSPBS).

During the study period from 2014 to 2025, 940,943 telediagnoses were performed across 80 hospitals, covering a population of 5,647,662 inhabitants (92% of the country's population), through the telemedicine system of the Telemedicine Directorate of the Ministry of Public Health and Social Welfare. Of these, 35.5% were male and 64.5% were female, representing the total number of cases with remote diagnoses and medical records relevant to the research. **Table 1** illustrates the average age and gender of the patients for each type of diagnosis performed.

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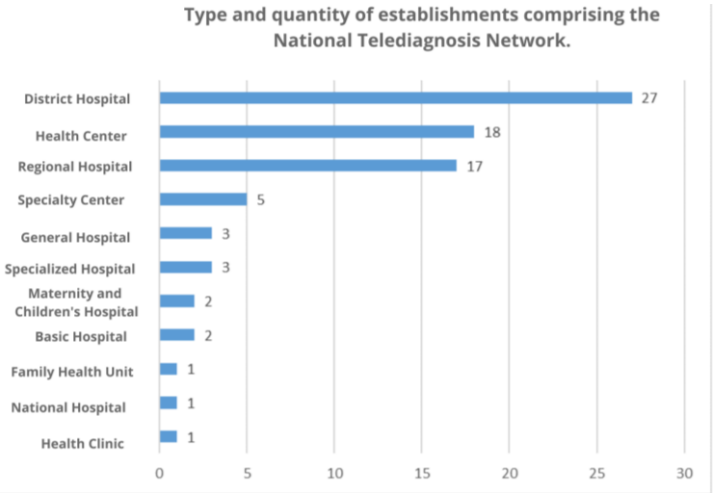
Table 1. Average age and gender of patients for each type of diagnosis (n=940,943)

#	Services	Average Age (years)	Male (%)	Female (%)
1	Electrocardiography	42.0	36.3	63.7
2	Tomography	45.3	50.2	49.8
3	Electroencephalography	27.1	50.4	49.6
4	Mammography	52.0	0.4	99.6
5	Holter monitor	51.2	40.6	59.4
6	Ambulatory blood pressure monitoring (ABPM)	53.7	35.3	64.7
	Overall Average	**45.2**	**35.5**	**64.5**

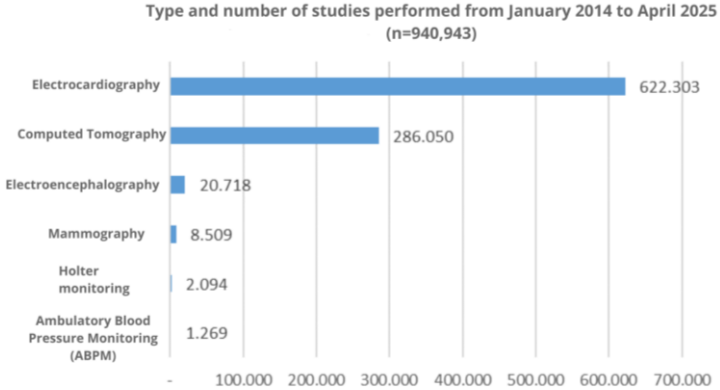
The type and number of healthcare facilities that make up the National Telediagnosis Network can be seen in Figure 1.

Figura 1. Type and number of health facilities comprising the National Telediagnosis Network.



The distribution of the type and quantity of studies performed by the National Telediagnosis Network can be seen in Figure 2.

Figure 2. Type and quantity of studies conducted from January 2014 to 2025 by the National Tele-diagnosis Network. (n=940.943)



The main results of the remotely performed and reported ECG diagnostic studies were normal (64.0%), sinus bradycardia (11.8%), unspecified arrhythmias (deviated axes, conduction disorders, poor R-wave progression, and post-infarction changes) (2.2%), left ventricular hypertrophy (3.3%), sinus tachycardia (4.0%), right bundle branch block (3.9%), ischemia (2.0%), atrial fibrillation (0.8%), and left bundle branch block (1.0%).

Regarding CT scans, most of the studies (55.6%) were of the cranial region, primarily due to motorcycle and car accidents. The remaining studies involved the thorax (14.6%), urology-CT (5.3%), lumbosacral spine (4.5%), abdomen (3.9%), abdomen-pelvis (3.3%), paranasal sinuses (3.1%), cervical spine (2.7%), thoracic spine (2.2%), and face (1.3%), among others.

The electroencephalography studies were primarily performed for epileptic seizures (26.2%), headache (8.5%), traumatic brain injury (1.8%), learning and attention disorders (children) (1.7%), loss of consciousness (1.5%), brain death (0.5%), abnormal movements (0.3%), and sleep disorders (0.2%).

The results of the remote mammography studies were normal (60%), cysts, fibroadenomas and macrocalcifications (33%), and carcinomas (7%).

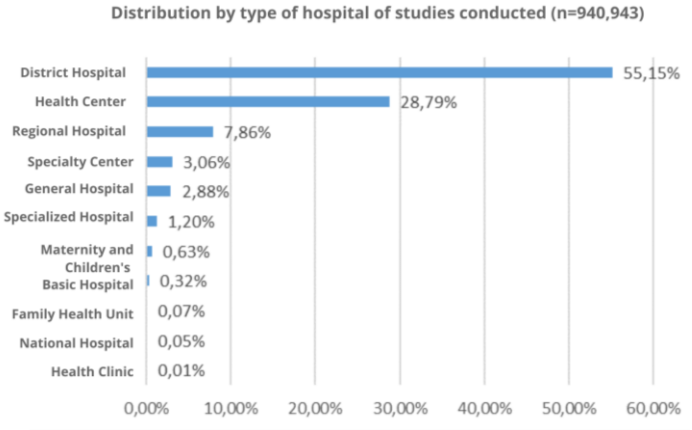
The most frequent diagnoses from Tele-Holter monitoring were supraventricular extrasystoles (34%), normal findings (25%), supraventricular and ventricular extrasystoles (23%), ventricular extrasystoles (9%), atrial tachycardia and atrial extrasystoles (3%), non-sustained ventricular tachycardia (2%), atrial fibrillation (2%), and supraventricular tachycardia (1%).

Regarding the remote ABPM studies, the most frequent diagnoses were pathological 24-hour systolic blood pressure (21.0%), pathological 24-hour diastolic blood pressure (23.0%),

pathological daytime systolic blood pressure (20.9%), pathological daytime diastolic blood pressure (22.2%), pathological nighttime systolic blood pressure (28.0%), pathological nighttime diastolic blood pressure (34.7%), dipper pattern (43.8%), non-dipper pattern (31.4%), extreme dipper pattern (3.2%), riser pattern (13.6%), systolic load ≥ 40% (31.2%), diastolic load ≥ 40% (37.4%), and pathological pulse pressure (32.6%).

The distribution of the number of studies performed by type of hospital in the National Telediagnosis Network can be seen in Figure 3.

Figure 3. Distribution of the number of studies performed by type of hospital from January 2014 to April 2025 using the telediagnosis system (n=19)



DISCUSSION

The results from this study reinforce the evidence that the telemedicine system implemented by the Ministry of Public Health and Social Welfare (MSPBS) shows a promising outlook. It serves as an effective tool for reducing the gap in universal coverage of specialized diagnostic services and enhancing the quality of healthcare in Paraguay. This improvement in medical care and diagnosis is attributable to the standardized services, the reduction in average diagnosis time, and the extension of remote medical services to areas where they are currently unavailable, as evidenced by experiences in other countries. The implementation of this system offers several benefits, including reduced costs associated with medical care and transportation for both patients and specialists. Additionally, it improves equity in access to healthcare technologies in remote populations that have limited access to specialized professionals and equipment. One significant advantage of the telemedicine system is its potential use as a contingency plan for medical assistance during disasters, epidemics, pandemics, or any situation with a large influx of patients. The web-based model of the telediagnosis system allows centralized access from any web browser, eliminating the need for prior installation on the user's computer, which makes it accessible from any platform. This centralized application also simplifies periodic maintenance and software updates. However, the use of specific tools for capturing and processing images, which depend on the operating system, is somewhat limited. The challenges related to human resources identified in this study are expected to be resolved as the involved professionals become more familiar with the new technology and necessary adjustments are made. Nonetheless, incorporating the telediagnosis system into healthcare centers requires a thorough review and analysis of traditional medical procedures. This is important due to the innovative nature of how information (including images and data) is recorded, captured, transmitted, and processed from scientific, legal, and ethical perspectives. To fully realize the benefits of telediagnosis, it is essential to ensure the reliability, interoperability, and security of data transmission. This is particularly crucial for the algorithms that represent, transfer, and compress the information generated by diagnostic equipment. It is important to note that international regulations pertaining to telediagnosis, which encompass all these aspects, are still lacking. However, some algorithms for information representation and transfer already employ communication standards such as DICOM or HL7. While many experiences with telemedicine technology in less developed countries are promising, there are still few studies that support the implementation of this technology to address specific problems in particular regions or countries. Additionally, these studies need to propose applications that are safe, effective, useful, efficient, and sustainable. According to a systematic review of the literature, the available evidence remains insufficient to conclusively demonstrate that telemedicine tools are more cost-effective than traditional "face-to-face" diagnoses. Most of the articles analyzed require more rigorous methodologies that consider the total costs of implementing telemedicine systems compared to the social costs associated with transporting patients to facilities where in-person diagnostic methods are available or establishing the necessary resources for in-person examinations in remote locations. The Telehealth system implemented by the MSPBS offers advantages, such as reduced patient waiting times, faster diagnoses, improved service quality through standardized procedures, continuous remote diagnosis care, opportunities for interconsultation, and the capability to send diagnoses via the internet to treating physicians. However, despite the promising outcomes and limitations of this study, the implementation of a Telehealth system

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should always be preceded by a contextualized investigation into the technological feasibility and diagnostic quality of the system, in line with current methodologies.

CONCLUSION

Based on our findings, we can affirm that it is feasible to develop, implement, and sustain telediagnosis projects and remote specialist consultations that facilitate strengthening universal coverage of diagnostic services, fostering innovation, and ensuring the economic sustainability of the public telediagnosis system. This will contribute to strengthening the integrated network of diagnostic services and health programs by maximizing professional time and productivity, improving quality, increasing access and equity, and reducing costs. Furthermore, this telehealth practice will substantially improve the diagnostic capabilities of hospitals lacking specialists and optimize the management of scarce human and technological resources in rural areas. However, before widespread implementation in the country's healthcare centers, a comprehensive and detailed study of the healthcare systems and the costs of implementation and sustainability must be conducted.

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