English

A case report of the implementation of a telestroke unit in a middle-income country: results and lessons learned from a Mexican pilot.

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Abstract

Objective: To present the results, barriers and facilitators of the implementation of a telestroke network in Mexico. Methods: A telestroke network was implemented to connect a rural hospital to a university hospital with stroke specialists. Patients in the rural hospital were assessed via telemedicine and stroke specialists evaluated and determined the care plan for the patient. The study was conducted from February 2019 to January 2020. Stroke outcomes were measured from patients included in the study, including time to treatment and percentage of patients treated with thrombolysis. Interviews with key stakeholders involved in the program were conducted and analyzed using thematic analysis.
Results: Thirteen patients were admitted during the study period, two (15%) patients were treated with thrombolytic therapy and received the treatment within the first two hours from hospital admission. The thematic analysis revealed four themes that contributed to barriers and facilitators to implementing the program: infrastructure, socio-organizational structure, governance, and financial and non-financial incentives.
Conclusions: This case study provides relevant lessons for countries with similar characteristics, particularly those in the Latin America region. As telestroke networks continue to develop, it is important to consider these lessons to ensure end-users accept the implementation of telestroke without posing further burden while expanding access to thrombolysis in rural and remote areas.

Key words: Telemedicine; Telemonitoring; Stroke; Latin America; Digital health; eHealth Strategies;

Resumen

Implantación de la unidad de teleictus en México: un estudio de caso

Objetivo: Presentar los resultados, barreras y facilitadores de la implementación de una red de teleictus en México.
Métodos: Se implementó una red de teleictus para conectar un hospital rural a un hospital universitario con especialistas en ictus. Los pacientes del hospital rural fueron evaluados a través de telemedicina y los especialistas en ictus evaluaron y determinaron el plan terapéutico para el paciente. El estudio se realizó entre febrero de 2019 y enero de 2020. Se midieron los resultados del ictus de los pacientes incluidos en el estudio, incluido el tiempo hasta el tratamiento y el porcentaje de pacientes tratados con trombólisis. Se realizaron entrevistas con actores clave involucrados en el programa y se analizaron utilizando un análisis temático.
Resultados: Trece pacientes ingresaron durante el período de estudio, dos (15%) pacientes fueron tratados con terapia trombolítica y recibieron el tratamiento dentro de las primeras dos horas desde el ingreso hospitalario. El análisis temático reveló cuatro temas que contribuyeron a las barreras y facilitadores para la implementación del programa: infraestructura, estructura socio-organizacional, gobernabilidad e incentivos financieros y no financieros.
Conclusiones: Este estudio de caso proporciona lecciones relevantes para países con características similares, particularmente en América Latina. A medida que las redes de teleictus continúan desarrollándose, es importante considerar estas lecciones para garantizar que los usuarios finales acepten la implementación de teleictus sin representar una carga adicional a su trabajo al mismo tiempo que se expande el acceso a la trombólisis en áreas rurales y remotas.

Palabras clave: Telemedicina; Telemonitorización; Ictus; América Latina; Estrategias de eSalud;

Resumo

Implementação de Telestroke no México: um estudo de caso
Objetivo: Apresentar os resultados, obstáculos e facilitadores da implementação de uma rede de "telestroke" no México.
Métodos: Uma rede de "telestroke" foi implementada para conectar um hospital rural a um hospital universitário com especialistas em acidente vascular cerebral (AVC). Os pacientes no hospital rural foram avaliados por meio de telemedicina, e os especialistas em AVC avaliaram e determinaram o plano de cuidados para o paciente. O estudo foi conduzido de fevereiro de 2019 a janeiro de 2020. Os resultados do AVC foram medidos nos pacientes incluídos no estudo, incluindo o tempo para o tratamento e a porcentagem de pacientes tratados com trombólise. Entrevistas com os principais interessados no programa foram conduzidas e analisadas usando análise temática.
Resultados: Treze pacientes foram admitidos durante o período do estudo, dois (15%) pacientes foram tratados com terapia trombolítica e receberam o tratamento dentro das primeiras duas horas da admissão hospitalar. A análise temática revelou quatro temas que contribuíram para os obstáculos e facilitadores na implementação do programa: infraestrutura, estrutura socioorganizacional, governança e incentivos financeiros e não financeiros.
Conclusões: Este estudo de caso fornece lições relevantes para países com características semelhantes, especialmente aqueles na região da América Latina. À medida que as redes de "telestroke" continuam a se desenvolver, é importante considerar essas lições para garantir que os usuários finais aceitem a implementação do telestroke sem impor mais ônus, ao mesmo tempo em que ampliam o acesso à trombólise em áreas rurais e remotas.

Palavras-chave: Telemedicina; Tele-monitoramento; Acidente vascular cerebral (AVC); América Latina; Estratégias de Saúde Digital; Saúde Digital.

Introduction

Stroke represents one of the leading causes of mortality and disability worldwide [1]. It occurs when the brain's blood supply is cut off, due to either the blockage of an artery (ischemic stroke) or when a brain vessel breaks open, leaking blood in or around the brain (hemorrhagic stroke). The former represents over 85% of cases [2]. Significant advancements in stroke care have been made over the last few decades, initially through thrombolytic therapy with recombinant tissue plasminogen activator (rt-PA). More recently, further progress has been achieved via mechanical thrombectomy. Both treatments are found to improve long-term post-stroke outcomes [3,4]. Despite this, the timeframe in which these treatments are utilized remains a major limitation in their effectiveness. Rt-PA is frequently limited to the first 4.5 hours, while mechanical thrombectomy is only offered to patients who fulfil specific criteria for up to 24 hours after the onset of stroke [5].

Stroke is reported as the sixth most common cause of death in Mexico [6]. Furthermore, the burden of stroke is on the rise. In terms of disability-adjusted life years (DALYs), the burden of stroke in Mexico saw an increase from 284.75 per 100,000 population in 1990 to 304.76 in 2019 [7]. Unfortunately, stroke remains untreated in many patients. This is mainly due to the narrow treatment window, which is further exacerbated by the often considerable travel times required to reach hospitals with adequate infrastructure [8].

In recent decades, urbanization has increased many patients' access to stroke specialists. However, up to 20% of Mexico's population still lives in rural or marginalized areas. While hospitals in these regions do possess the essential infrastructure to treat patients, they often lack the specialist neurologists and neuroimaging equipment necessary to apply timely and effective stroke care [9].

Telemedicine is proven to reduce the delay in stroke patients receiving access to specialized services, particularly in locations where alternative options are limited. Telemedicine for stroke care (telestroke) aims to treat ischemic stroke patients by evaluating their symptoms and determining whether they meet the criteria for intravenous thrombolytic therapy. Telestroke has been proven to increase the number of successfully treated stroke patients, demonstrating similar outcomes to in-person treatment [10].

With that being said, most of the literature outlining these findings has been produced in high-income countries with more mature stroke care systems [11]. Structural differences in middle-income countries' health systems could influence the implementation and effectiveness of telestroke units, highlighting the need to gather further evidence from these particular countries.

This case report aims to present the results of a telestroke unit pilot implemented in Mexico, a middle-income country according to the World Bank classification [12]. The telestroke unit (Teleictus in Spanish) was implemented through a collaboration between non-governmental organizations (Angels Initiative and Rotary international), the Ministry of Health of the State of Nuevo Leon, and a tertiary university hospital with a stroke care unit and 24/7 stroke consultancy. Alongside the implementation of Teleictus, the first tomography equipment was installed in a rural hospital in the State of Nuevo Leon to make the program possible.

The telemedicine equipment for this case was acquired using a local grant by Rotary International and Rotaract D4130. It consisted of videoconferencing equipment (a high-resolution mobile camera and microphone) and a computer to share the neuroimaging between the rural hospital and the university hospital. Following the installation of the equipment, a joint-strategic group was formed. It consisted of representatives from the university hospital, the Angels Initiative, and the Ministry of Health of the State of Nuevo Leon. This group's job was to prepare and deliver training on stroke care to the rural hospital, as well as to ensure that staff from both hospitals were sufficiently adept at using the telemedicine equipment.

Methods

A telestroke network was implemented connecting a rural hospital to a university hospital with the specialized stroke care unit. The rural hospital is located in the municipality of Dr Arroyo, Nuevo Leon, Mexico, over four hours away from the university hospital. When a suspected stroke patient was admitted to the rural hospital, the university hospital was notified whilst simultaneously performing a computed tomography (CT) scan on the patient's brain. Once the neuroimage was completed, the patient was given care using telestroke. The rural hospital's staff conducted a clinical examination using the National Institutes of Health Stroke Scale (NIHSS) with support from staff from the university hospital. The resultant data was evaluated by the stroke specialist team in order to confirm eligibility for thrombolytic therapy. A description of the telestroke care pathway is presented in Figure 1.

The pilot's participants were patients with confirmed stroke based on clinical and neuroimaging (CT-scan) examinations. Participants must have been 18 or older and admitted to the rural hospital between February and December of 2019. The pilot's data was incorporated into an ongoing stroke registry at the university hospital. The collected data included the following: patients' demographics - age, sex; lifestyle stroke risk factors – tobacco and alcohol consumption; comorbidities - diabetes, hypertension; clinical stroke data - stroke onset/treatment times, stroke severity as measured by the National Instituted of Health Stroke Scale (NIHSS) and the modified Rankin scale (mRs).

This data was provided by the telestroke coordinator (AmG) in the rural hospital, and stored in an electronic database (Castor EDC) by AB, AGA, PT. In addition to the quantitative data, semi-structured, open-ended questionnaires were used to conduct interviews with certain key stakeholders. These individuals were selected based on their contribution to the project's implementation. The interviewees were as follows:

1. The stroke consultant lead at the university hospital
2. The head of the emergency room at the rural hospital
3. The head of telemedicine from the Ministry of Health

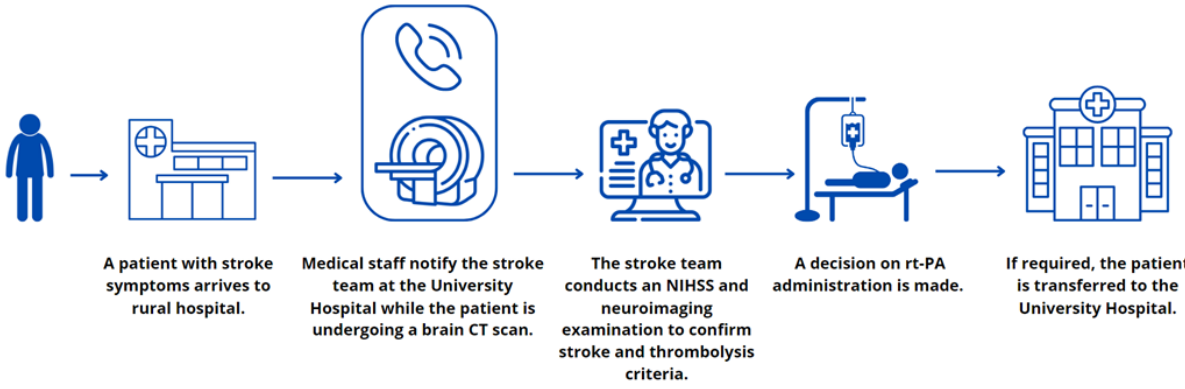

Figure 1. Care pathway for telestroke patients.

The questionnaires asked about the barriers and facilitators encountered when implementing the telestroke project. They were conducted in Spanish and translated verbatim into English by an English-proficient author (AG). The study received ethical approval from the local Research Committee (NR18-0002).

We estimated that a total of 97 ischemic stroke incident cases would occur during the study period. This was based firstly on a previous study reporting an incidence of 56.4 ischemic stroke cases per 100,000 population in Mexico, and secondly on the fact that the population of the rural hospital's catchment area was listed as 58,124[9,13]. However, historical data from the rural hospital only reported between 10 and 20 annual ischemic stroke cases. This was due to patients self-transferring to hospitals in neighboring cities (located 2-4 hours away), or simply not seeking medical care at all.

A descriptive analysis of the patients' demographics and clinical characteristics was conducted. Quantitative variables were presented as mean and standard deviation, or as a median and interquartile range based on the normality of their distribution. The analysis was conducted using SPSS v.24. For the qualitative analysis, data was transcribed verbatim. The transcribed data was analyzed using inductive thematic analysis, and semantic codes and themes were identified to reduce the risk of making any assumptions from the data[14]. Themes were discussed and developed by AG and FGR. Quotes related to the identified themes were extracted and presented for descriptive purposes.

Results

Thirteen patients were admitted to the rural hospital during the study period. The mean age was 66.08 ± 17.12, with most of the patients being male (61.5%). Only three patients (23.1%) reported tobacco and alcohol consumption, while diabetes was prevalent in most of the patients. The NIHSS at admission was 8.77 ± 5.23. The median time from stroke onset to hospital admission was over two hours, with over 25% of the patients arriving after the 19-hour mark. Two (15.38%) patients received thrombolysis treatment, which was administered around 100 minutes after hospital admission (Table 1).

As mentioned, interviews were conducted with the lead stroke consultant from the university hospital, the head of the rural hospital's Accident and Emergency (A&E) department, and the head of telemedicine from the Ministry of Health. The interviews with these key project stakeholders identified themes revolving around infrastructure, socio-organizational structure, governance, and incentives. The codes and themes with their respective examples are summarized in (Table 2).

Variable	N=13
Age	66.08 ± 17.12
Sex, males	8 (61.5%)
Lifestyle risk factors	
Tobacco consumption	3 (23.1%)
Alcohol consumption	3 (23.1%)
Comorbidities	
Hypertension	5 (38.5%)
Diabetes	12 (92.3%)
Dyslipidemia	5 (38.5%)
NIHSS at admission	8.77 ± 5.23
Onset-to-door time, minutes	210 (142.5 – 1170)
Door-to-needle time, minutes	
Patient 1	93
Patient 2	105
Thrombolysis	2 (15.38%)

Table 1. Characteristics of the pilot's participants.

Theme	Codes		Examples
	Barriers	Facilitators	
Infrastructure	• Low quality / unreliable internet in the rural hospital • Ambulance not always available to transfer patients to the university hospital if needed	• CT scans and telemedicine equipment available in both hospitals • The telemedicine equipment in the rural hospital was installed at A&E	SC: "We leveraged the availability of the telemedicine equipment in the A&E in the rural hospital" HRH: "The internet in these areas does not have enough speed and connection, which influenced the quality of the delivery of care"
Socio-organizational structure	• Clinicians perceiving telestroke care as additional workload. • Lack of standardization of stroke care via telestroke • Constant changes in workforce due to clinical rotations • Lack of resources for continuous professional development	• Training delivered timely and as required. • Rural hospital doctors perceiving stroke as beneficial for their patients. • Teleictus can be adapted to provide online learning courses	SC: "The organization within the university hospital was not difficult because it is a teaching hospital. It is relatively easy to involve neurologists in training to deliver the needed support." HT: "For this type of project, we need to work on convincing our colleagues who are the end-users to facilitate and improve the delivery of care to our patients [via telemedicine]"
Governance	• Change of political administration meant starting conversations from zero. • Lack of involvement of key stakeholders (i.e., drug procurement department) • Long process for the acquisition of rt-PA • Missed opportunities to integrate telestroke into similar ongoing initiatives. • Lack of resources to create new jobs	• Commitment from high-level officials from the Ministry of Health • Trust between the University hospital and the Ministry of Health	SC: "The are a lot of administrative changes […], and we need to start over again as if nothing was done before." HT: "In addition to telestroke, there were other initiatives that could have been worked out with the same technological infrastructure." HT: "The lack of involvement of key staff from the procurement department made it not be prioritized to have the drug on the stock."
Incentives and payment of services	Lack of income to hire dedicated personnel. Lack of financial and non-financial incentives to increase healthcare personnel motivation	The University hospital is a teaching hospital, and neurologists in training were allocated with overseeing telestroke patients as part of their training	SC: "There is a financial limitation behind everything. There are a lot of meetings, agreements, and photos, but there is no new post. And this [telestroke] requires a new post." HRH: "For example, an incentive like offering scholarships for training on carotid ultrasound scan or transcranial doppler ultrasound would be excellent."

Table 2. Themes, semantic codes and verbatim quotations from the interviewees.
HT: head of telemedicine, HRH: head of A&E from the rural hospital, SC: stroke consulta

Discussion

Implementing this telestroke pilot between a rural hospital and a tertiary university hospital was made possible through the collaboration of academics, non-governmental organizations, and stakeholders at the Ministry of Health. During the first year of the project, two patients (15%), benefited from thrombolysis under the supervision of stroke specialists. The share of patients receiving thrombolytic therapy was higher than previously reported in the country [13]. The program did indeed achieve its goal of providing thrombolytic care in a rural hospital through the use of telemedicine. However, there were notable barriers and facilitators highlighted by key stakeholders concerning infrastructure, socio-organizational structure, governance, incentives, and payment of services.

When implementing a telestroke unit, it is vital to ensure that adequate infrastructure is available, particularly in rural or remote hospitals. While the telemedicine equipment was available in both participating facilities, staff from the rural hospital highlighted poor connectivity that hindered the delivery of quality care. This is an important factor to address. After all, evidence shows that healthcare professionals employing new technologies expect them to be fast and efficient in order to improve the patient's workflow [15].

Other middle-income countries have also reported infrastructure as a limitation when introducing telemedicine units[16]. In the region of the Americas, for example, countries with large territorial extensions like Brazil[17] and the United States[18] have reported that regional disparities in the access to broadband data network deters the implementation of telemedicine programs. While one of the arguments behind delaying the upgrade internet networks is usually based on financial expense, telestroke has proven to be cost-efficient in other middle-income countries, reducing healthcare costs overall if implemented properly[19]. Economic evaluations of telestroke – such as cost-effectiveness and cost-minimization analyses – in Latin American countries are needed to provide evidence and facilitate the discussion among policymakers to upgrade internet networks and implement telestroke program in remote and rural areas. To the authors knowledge, such type of studies has not been carried out in the region. However, countries like China[19] and Australia[20,21], have conducted economic analysis on telestroke demonstrating its cost-saving effects, thus, providing evidence to inform decisions on the development of national telestroke strategies.

Socio-organizational structure was another factor that influenced the project. The context in which the pilot was conducted actually assisted in its implementation, which should be considered by future stroke teams aiming to introduce similar telestroke units elsewhere. Adding telestroke care to neurologist training program will help future specialists navigate these technologies, allowing them to adapt to the rapid spread of telemedicine following the COVID-19 pandemic [22].

It should be further noted that the ease of integrating the telestroke system between the two hospitals was down to a longstanding trust between key stakeholders from the university hospital and the Ministry of Health. Building strong relationships is fundamental when implementing a telestroke network, particularly when resources are limited.

Governance also played a crucial role, representing one of the major limitations in the pilot's implementation. While the strategic committee was built as a multidisciplinary team, not all of the key stakeholders were included. Additionally, further issues were presented in the procurement of the rt-PA. The long, bureaucratic process for the acquisition of the thrombolytic drug proved to be a hindrance. In the Mexican health system, states are responsible for acquiring the medical supplies and equipment for their own facilities. This is not always a quick or easy task.

It is worth mentioning, of course, that this issue alone does not indicate a failure in the concept of the decentralization of power to individual state authorities. After all, it was decentralization that made the pilot's implementation possible in the first place. In fact, the lack of stroke treatment coverage by the National General Law is a far larger barrier towards acquiring relevant drugs than any state-level legislation. National care coverage is limited to diagnostic procedures[23]. This is one policy that must evolve, especially as evidence for the cost benefit of thrombolytic therapy continues to mount [24].

Lastly, there is a clear lack of incentives and established purchasing/reimbursement mechanisms for delivering telestroke services. This inevitably compromises the self-sustainability of the program. Before the COVID-19 pandemic, telemedicine services were usually provided without a clear purchasing or reimbursement procedure. However, once the pandemic began, health systems saw a rapid increase in care delivery through telemedicine. This was due to imposed mobility restrictions and the grave risks and consequences of infection. This quickly led to a far wider understanding and acceptance of the benefits of telemedicine. Purchasing mechanisms for services delivered through telemedicine also benefited from the pandemic, as countries soon implemented specific codes and prices to deliver these services[25]. Similarly, the Pan-American Health Organization (PAHO) developed a tool for providers to evaluate the maturity of telemedicine services, which included a financial component to ensure these services are adequately and transparently covered[26].

Proper purchasing and reimbursement mechanisms would go a long way towards securing the income needed for the administration of telestroke. However, providing incentives is also vital in speeding up more generalized telestroke acceptance. In line with the thoughts of one of our interviewees, the use of incentives has been previously proven to increase the motivation to adopt telemedicine[27]. Before deciding on the types of incentives, it is important to consult with end-users. After all, non-financial incentives (i.e., scholarships or specific training) could be more relevant and beneficial than financial ones, as shown in our case.

This case study proves that introducing telestroke services in Latin American countries can enhance access to specialized care in rural and remote areas. While the lack of equipment is often seen as the main obstacle in delivering these services, our case study demonstrated that the truth is far more complex and multifaceted. Factors relating to infrastructure, socio-organizational structure, governance, incentives, and payment of services can all serve as either barriers or facilitators towards the program's success.

Our findings suggest that, when implementing telestroke services in countries in the region, certain steps should always be taken to foster the best possible chance of success. These include ensuring adequate internet connectivity, providing comprehensive training to end-users, standardizing stroke care via telemedicine, involve all key actors while building trust between them, and create financial contracts to hire sufficient additional staff to avoid work overload. As our telestroke network expands, we encourage stroke teams from countries with similar characteristics as ours to refer to the lessons learned shared in this case study to increase the acceptability and success of new telestroke units to ensure stroke care is available to everyone.

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González-Aquines A: Conceptualization, funding acquisition, investigation, methodology, writing – original draft, writing – review & editing; Masoud Mohammadnezhad: Methodology, writing – review & editing; De la O-Cavazos M, Treviño-Garza C, González- Treviño JL, Puga-Colunga RA, Marroquín-Escamilla AR, Chávez-Luévanos BE: Resources, validation;
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