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## RESEARCH ARTICLE

# Telemedicine and Epilepsy. Experience of the Central Hospital "Dr. Ignacio Morones Prieto" During and Post-pandemic COVID-19

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## ABSTRACT

**Background:** Telemedicine is a real-time interactive communication that enables providers to join with patients and consultants across challenging geographic distances in a cost-effective, accessible manner. Telemedicine is helpful in the treatment of epilepsy and other neurological disorders. This work aims to share the use of telemedicine in the management of patients with epilepsy belonging to suburban communities during the COVID-19 pandemic and its post-pandemic follow-up.

**Material and Methods:** A retrospective, descriptive, and analytical study was conducted. The Telemedicine database in our hospital underwent a retrospective analysis. The inclusion criteria encompassed patients who had an initial consultation during the confinement period (2020-2021) and had at least one videoconference in the post-confinement period (2022-2023). Various parameters, including the number of consultations received, city of origin, treatment, etiology, type of epilepsy, comorbidities, and treatment outcomes, were gathered to facilitate a comparison between the two periods. Statistical analyses were performed using IBM SPSS Statistics V.25 for Mac.

**Results:** Ninety-eight patients with an initial consultation between 2020 and 2021 were identified, discarding 41 due to loss of follow-up during post-confinement, resulting in N=57 cases for analysis.

**Conclusions:** During the COVID-19 confinement period in our hospital, Telemedicine emerged as the sole feasible option for providing care to patients in remote communities. It demonstrated remarkable success in monitoring the short and midterm progression of epileptic patients. The decrease in seizure frequency was sustained during the midterm.

**Keywords:** Telemedicine, focal seizures, generalized seizures, epilepsy, antiseizure drugs.

## Introduction

Telemedicine (TM) is the term employed to describe remote healthcare, utilizing telecommunication technologies for the provision of medical care<sup>1</sup>. Since the inception of the telephone, this mode of communication has been integral to delivering healthcare services. The TM healthcare system finds application in emergency situations and patient monitoring. In critical scenarios requiring prompt attention, TM facilitates faster and more timely care delivery through ambulances, helicopters, and airplanes<sup>1</sup>. In rural health centers lacking specialized professionals, TM plays a crucial role in offering timely care to an underserved population that would otherwise face hours of travel or struggle to access adequate and prompt medical attention<sup>2</sup>. Among the various medical fields where TM has been instrumental, Neurology stands out. In this domain, the remote evaluation of patients with acute stroke is possible<sup>3</sup>, and in the case of epilepsy, accurate management becomes achievable with a proper assessment of seizure semiology, especially in the early stages<sup>4</sup>.

With the advent of the 2019 coronavirus pandemic (COVID-19), TM became an even greater area of opportunity needed in the diagnostic and treatment approach process for us and many others<sup>5,6</sup>. The situation we experienced in our institution was significantly adverse, not only because the hospitals were overwhelmed, but because of the health emergency; the outpatient clinic was practically closed, which forced us to seek strategies to maintain the care and control of our patients, an area within Neurology that we had to address was that of patients with epilepsy.

Periodic evaluation of a patient with epilepsy is expensive, especially when they have to travel a long distance or live in a rural area with poor communication<sup>7</sup>, which is frequently the case in our state. In the era of the COVID-19 pandemic, the situation became even more complicated with the closure of the outpatient clinic in our institution, which made videoconferencing the most convenient alternative to sustain patient monitoring, stimulate adherence to anti-crisis treatment and achieve a better quality of life, with a favorable reduction in costs, in addition to not increasing the wear and tear on the health professional who was facing a critical time.

This alternative can be beneficial to all<sup>8</sup>. It allows physicians to diagnose and treat patients in a remote or even nearby area at a time like the pandemic. It is improving the likelihood of follow-up. It reduces missed appointments and optimizes therapeutic outcomes for patients. TM technologies are not exempt from the need to keep a medical record to manage the treatment process properly. The significant limitation is that it is not possible to perform a complete neurological physical examination<sup>9</sup>. This is the major impediment to not using it in patients who can attend their routine consultation once the pandemic has passed<sup>2</sup>.

In a recent review aimed at identifying all Cochrane Systematic Reviews (CSRs) on Telemedicine (TM) in healthcare and evaluating its current utility, the authors discovered numerous studies that applied TM to various aspects of healthcare. Notably, they chose to exclude reports related to diagnostic TM or those employing automated text, voice-text, or self-managed care. Despite these exclusions, the review identified 10

CSRs that investigated a diverse range of diseases. While the available evidence may be insufficient to determine the specific types of interventions where TM proves effective, it generally demonstrates success in providing patients with standard treatment<sup>10</sup>.

Reports of Telemedicine (TM) utilization in epilepsy include a study conducted by Rasmussen et al.<sup>11</sup> in collaboration with the University of Texas Medical Branch (UTMB) and the Epilepsy Foundation of Southeast Texas. The study involved the evaluation of all their patients (n = 155) over a three-month period in 2004. Notably, no significant differences were observed in demographics or outcome measures between the control group and the TM group. The authors concluded that TM stands as an excellent alternative for delivering care to patients in rural and geographically isolated areas. Beyond mitigating risks associated with travel, reducing costs, and saving time, TM offers patients the opportunity to access personalized and high-quality care with the necessary frequency and follow-up.

In a retrospective analysis of Telemedicine (TM) seizure visits conducted by Haddad et al.<sup>12</sup> between January 2009 and January 2012, the researchers identified key parameters such as age, sex, epileptic syndrome, seizure types, and outcomes for each subject. The analysis also encompassed details on antiseizure drug (ASD) regimens, surgical cases, and monitoring. Notably, two-thirds of the patients were either seizure-free or showed improvement at the last visit, and the no-show rate was a mere 11%. The study's conclusion highlights that TM significantly enhances access to specialized care for patients with epilepsy residing in rural areas.

Kissani et al.<sup>13</sup> conducted an analysis with the aim of underscoring the significance of utilizing Telemedicine (TM) to address various facets of epilepsy, encompassing scientific aspects such as research, education, care, and management, as well as social aspects including awareness and support for associations. The authors identified a substantial gap in the understanding and application of TM, particularly noting disparities between developed and developing countries. Considering epilepsy's status as a chronic condition contributing to 1% of the global burden of disease, affecting over 50 million people, barriers to adequate care persist due to shortages in human resources (physicians), medical facilities (hospitals), and cultural and economic resources. Notably, 80% of individuals with epilepsy reside in low- and middle-income countries, a circumstance unfortunately reflected in our country. TM emerges as a potential solution to alleviate resource scarcity, offering improved access to individuals with epilepsy globally by facilitating medical education and patient care.

In a clinical trial conducted by Licchetta et al.<sup>14</sup>, which aimed to assess seizure control and monitor levels and side effects of ASDs, TM emerges as a crucial tool providing invaluable support for patient follow-up. This ensures the prompt availability of an expert team to care for individuals with epilepsy. To establish robust data on the efficacy, safety, and costs of TM in the context of epilepsy, the trial, named TM for Epilepsy Care (TELE-EPIC), evaluated the effectiveness of TM in comparison to usual care. Additionally, the trial incorporated quantification of ASD serum levels using a digital puncture as an alternative to venipuncture sampling.

Outpatients from two Italian epilepsy centers were prospectively included in the study, with the primary outcome focusing on non-inferiority in seizure control over an 18-month follow-up period. The assessment also revealed no significant difference in serum levels of ASD. Notably, this project is registered at ClinicalTrials.gov.

A study conducted by Banks et al.<sup>15</sup> amidst the onset of the COVID-19 pandemic, which aimed to assess the concerns and preferences of individuals attending and receiving consultations, served as a pilot study for the widespread implementation of Telemedicine (TM) across various medical disciplines. In Ireland, the advent of COVID-19 provided a unique opportunity to document these perceptions both before and after the pandemic. Data were extracted from the National Electronic Epilepsy Patient Register (EEPR) from two epilepsy centers in Dublin. Between December 23, 2019, and March 23, 2020 (pre-COVID era), a total of 1180 patients underwent 1653 clinical encounters. Remarkably, there were no appointment delays or disruptions in the continuity of care attributable to the pandemic. Physicians expressed a high degree of satisfaction, although some raised concerns regarding the adequacy of the service, particularly for surgical candidates. Patients reported positive experiences with TM, which compared favorably with face-to-face encounters. The survey findings indicate that TM proves to be an effective and satisfactory method for outpatient care among patients with this disease.

In our hospital, we have used TM for more than two decades to get closer to patients living in rural areas. Still, really, during the

pandemic, it was a fortunate and obligatory resource, not only to attend to patients of marginalized regions but also to those who required it due to the closure of the outpatient clinic caused by the COVID-19 pandemic.

## Methods

Retrospective, descriptive, analytical study. The Telemedicine database in our hospital underwent a retrospective analysis. We included only patients with an initial consultation in the confinement period of pandemic (2020- 2021) and at least one videoconference in the post-confinement period (2022-2023) for this analysis. The number of consultations received, place of origin, treatment, etiology, type of epilepsy, comorbidities, and treatment answer and outcome were obtained to compare the two periods. The statistical analyses were conducted with IBM SPSS Statistics V.25 for Mac.

## Results

Ninety-eight patients with an initial consultation between 2020 and 2021 were identified, discarding 41 due to loss of follow-up during post-confinement, resulting in N=57 cases for analysis. The statistical analyses were conducted with IBM SPSS Statistics V.25 for Mac.

In Figure 1, we show the distribution by sex and age. The masculine population was lightly significant. Most of the included subjects were productive and of reproductive age. Communities were grouped by distance from their community to the Hospital Central, localized downtown in the city of San Luis Potosi, the state's capital of the same name in the center of the Mexican country, and the

percentage of patients in each group of age (Figure 1) and the distance from the

communities to our hospital was shown in Figure 2.

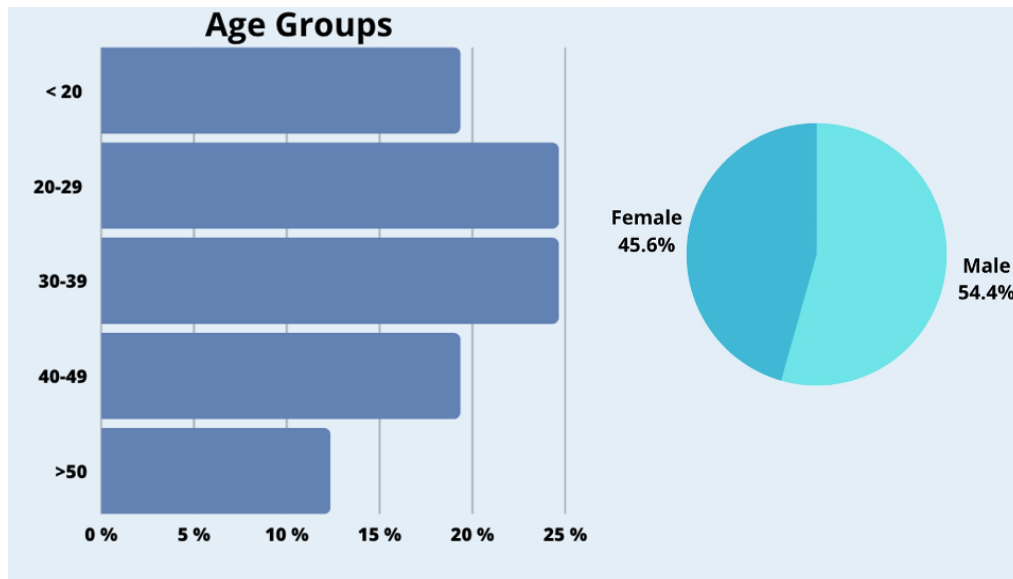


Figure 1. Distribution by age and sex of the population studied.

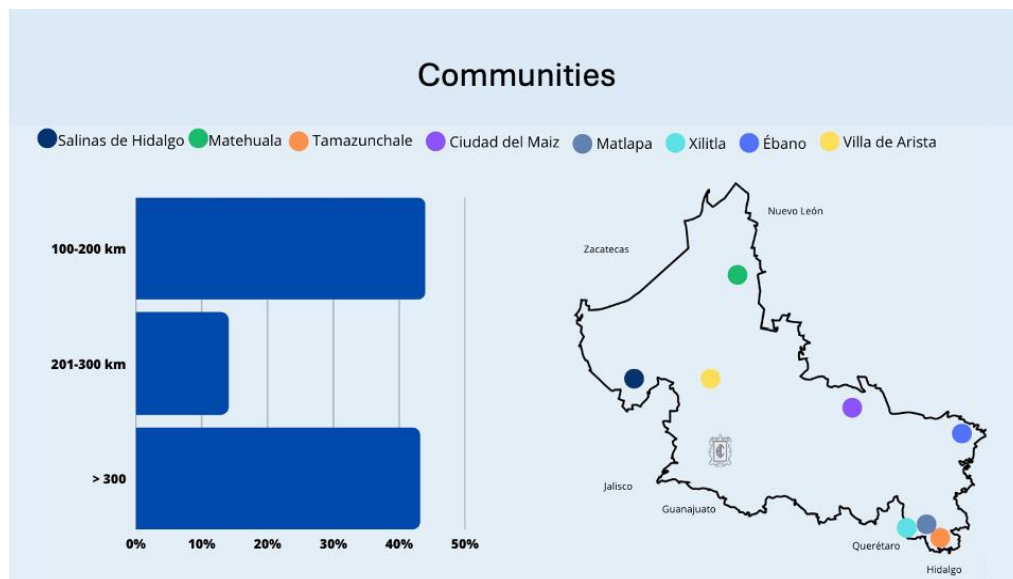


Figure 2. Distance in kilometers from the communities of the participating patients to our hospital center.

72 % of the patients had focal epilepsy, and 9 % generalized; almost 20% had not classified epilepsy (with the elements reduced by the type of interview and study limitations by the season that we were living at that time).

Related to the etiology of epilepsy, we found that in the most, we let the unknown explanation with our resources in the most

(68.4 %), autoimmune in 3.5 %, structural problem in 22.8 %, and it was possible to integrate an epileptic syndrome in 3.5 % of the cases. By the time that we were living, the possibilities to make complementary studies were limited; then, we had EEG in almost 2/3 of the study population (57.9 %), MRI in nearly 1/5 (17.5 %), and CT in practically 1/3 (28.1 %); Figure 3.

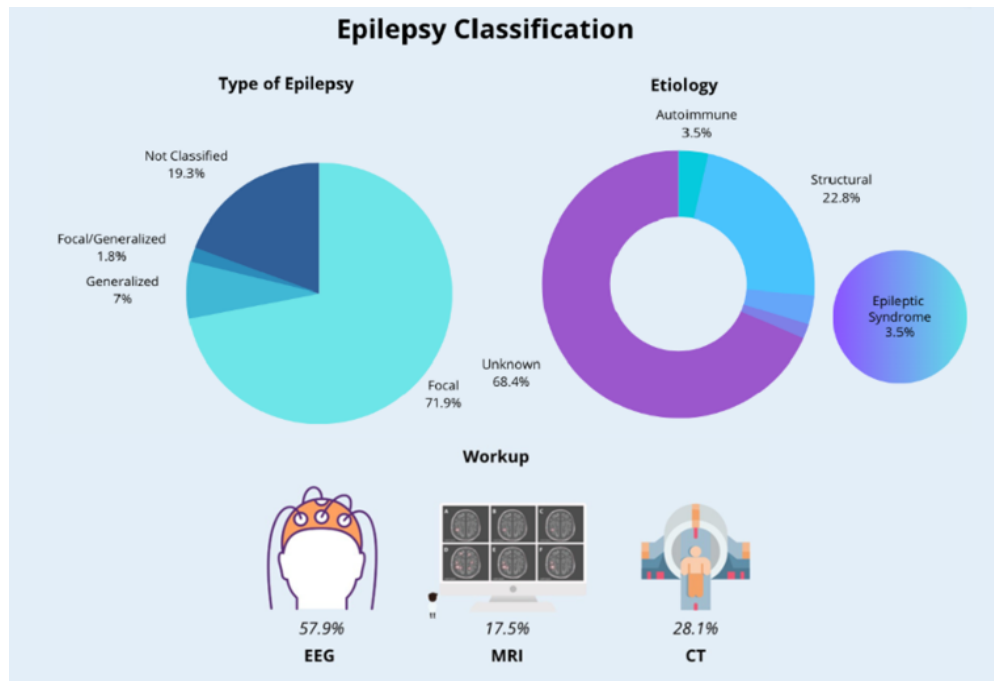


Figure 3. Here we show the type of seizures, the etiology and the percentage of image and electroencephalography studies performed.

The principal's comorbidities are expressed in Figure 4; half have suffered another medical problem besides epilepsy, and almost 1/3 of the patients had an intellectual disability.

Interestingly, we found less than 5 % of the presence of psychogenic non-epileptic seizures.

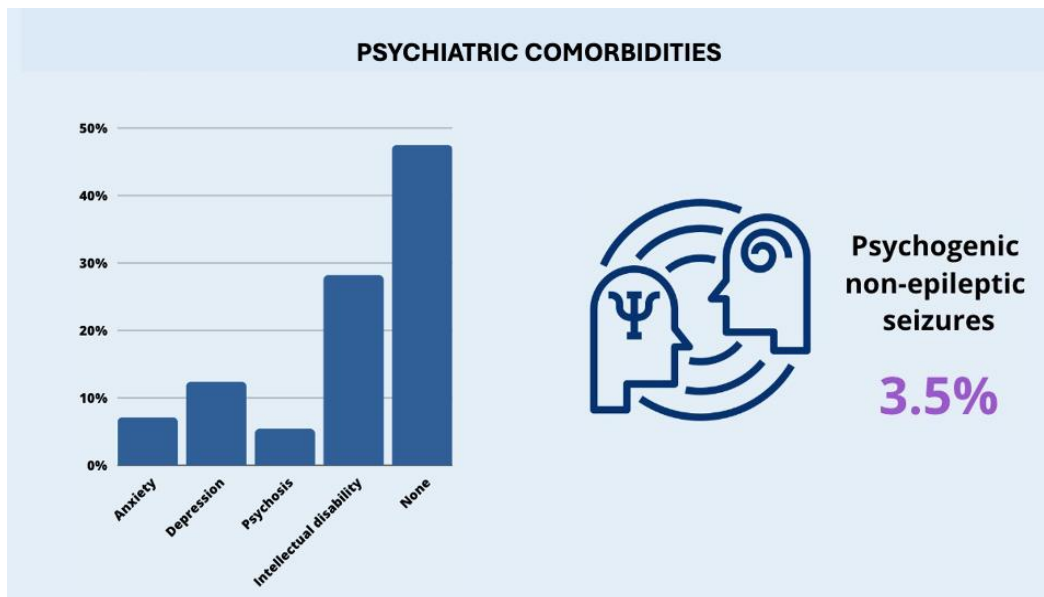


Figure 4. Main psychiatric comorbidities in our patients.

The consultations on average by the patient was 1.8 (2020-2021) Vs. 2.96 (2022-2023); this difference is easy to explain regarding the

confinement change; it is possible to observe the seizure control during and post-confinement (Figure 5). It is interesting to see



how the percentage without seizures during the confinement of 35.1 % changed in the post-confinement to 47.4 %. With ten or more seizures by month, we found a reduction of seizures from 8.8 % to 3.5 % from the confinement to the post-confinement. There is a clear tendency to improve the control of seizures after the confinement, but we do not obtain a significative value ( $p = 0.08$ ) Figure 6.

About the number of ASDs, 61.4 % were in monotherapy, 28.1 % in dual therapy, and 10.5 % with three or more drugs, Figure 7.

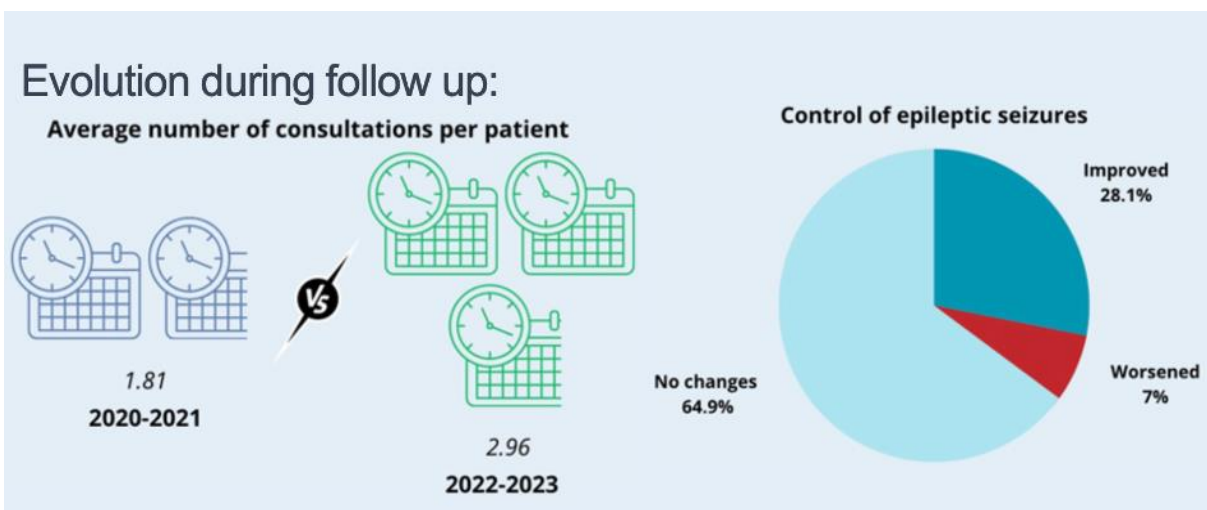


Figure 5. Average number of confinement and post-confinement consultations. Percentage of crisis management achieved.

**Comparison of crisis control during and post-confinement**

*Post-confinement*

		0/month	1-3/month	4-6/ month	7-10/ month	>10/ month	Total	
<b>During confinement</b>	0/month	n	19	1	0	0	20	
		%	33.3%	1.8%	0.0%	0.0%	35.1%	
	1-3/month	n	8	17	1	1	27	
		%	14.0%	29.8%	1.8%	1.8%	47.4%	
	4-6/month	n	0	2	0	0	3	
		%	0.0%	3.5%	0.0%	0.0%	5.3%	
	7-10/month	n	0	2	0	0	2	
		%	0.0%	3.5%	0.0%	0.0%	3.5%	
	>10/month	n	0	3	0	1	5	
		%	0.0%	5.3%	0.0%	1.8%	8.8%	
		n	27	25	1	2	2	57
		%	47.4%	43.9%	1.8%	3.5%	3.5%	100.0%

*McNemar-Bowker Test* **p 0.085**

Figure 6. Percentages of crisis control during and after confinement.

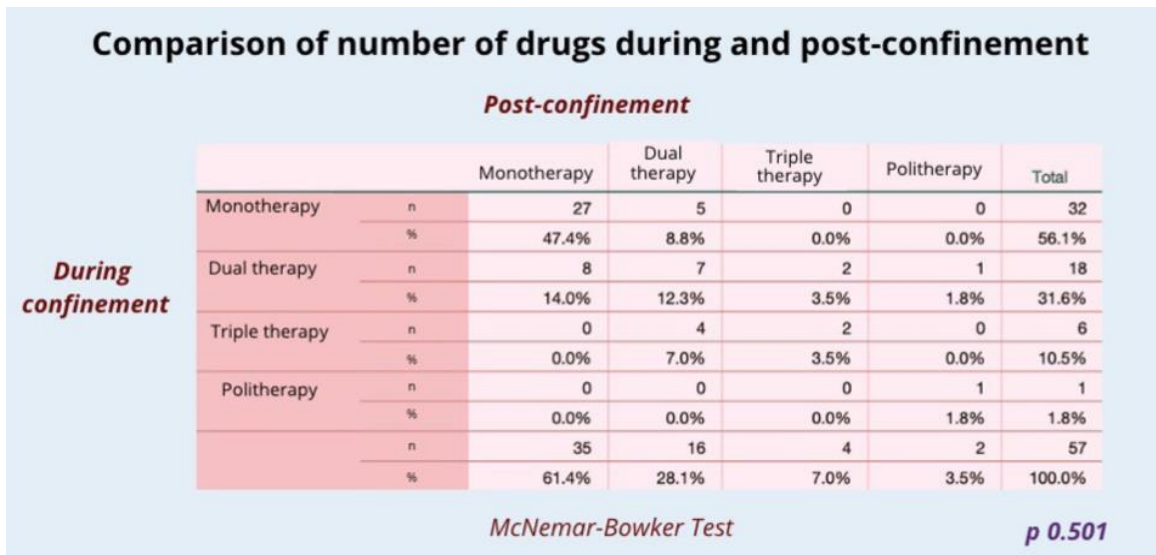


Figure 7. The number of drugs used by patients during and after confinement.

## Discussion

Epilepsy is a disorder of the brain characterized by a predisposition to epileptic seizures with neurobiological, cognitive, psychosocial, and social consequences<sup>16</sup>. A seizure is a transient, usually stereotyped, short-lived, and unpredictable episode of signs and symptoms due to the brain's excessive and synchronized neuronal activity. Epileptic seizures affect at least 10% of the world's population with at least one event and cause epilepsy (two or more seizures) in 1-2% of people worldwide<sup>17</sup>.

Epileptic seizures are defined according to their onset as focal, generalized, or of unknown or unclassifiable pattern. "Focal" replaces the former term "partial." The time "generalized" has remained unchanged. A generalized-onset seizure occurs when critical activity co-occurs in both hemispheres (potentially asymmetrical) at seizure onset. "Unknown" beginning refers to the semiology of start even though other manifestations are known<sup>18</sup>.

Since epilepsy is a heterogeneous disorder whose manifestations can be controlled to a

certain extent, it is essential to classify the type of seizures and to try to recognize the etiology. Significant differences exist between countries and even within the same country in incidence and prevalence due to variable etiology (e.g., prevalence of cysticercosis). A universal view of all etiologies (genetic/structural/metabolic) facilitated a classification for both the developing and developed world and simplified epidemiological statistics<sup>19</sup>. However, once the diagnosis of epilepsy has been established, it is now essential to identify the etiology more precisely. That was one of the goals of the 2017 ILAE classification of epilepsies, so the etiologic groups were divided into structural, genetic, infectious, metabolic, immune, and unknown etiology. The groups are not necessarily exclusive. The etiology of a patient's seizures can also be classified into more than one group<sup>20</sup>.

Electroencephalographic (EEG) recording localizes the generators of abnormal neuronal activity in the brain of the patient with epilepsy. However, the origin of the interictal activity may be discordant with the source of



the seizures, although ictal EEG data can help determine the seizure onset zone and provide valuable clinical information, so it is always helpful to have this assessment tool in every patient with epilepsy<sup>21</sup>.

Neuroimaging has had a significant impact on the understanding of epilepsy, facilitated treatment, and helped improve therapeutic outcomes. Structural evaluation should ideally be done with magnetic resonance imaging (MRI) rather than computed tomography (CT) and ideally complemented with functional studies such as positron emission tomography (PET) and magnetoencephalography (MEG), especially for pre-surgical evaluations<sup>22</sup>.

Although the pharmacological arsenal against epilepsy includes more than 30 different anticonvulsants, about one-third of epileptic patients, fail to achieve sustained seizure freedom with currently available medications. However, many people with epilepsy have improved over the years when given an appropriate regimen by maximizing efficacy and tolerability<sup>23</sup>.

In this review, we will discuss the experience of the Epilepsy Clinic in a hospital located in central Mexico. The clinic serves a population who lack access to health services and aims to restore the quality of life of those who have epilepsy, especially during the pandemic. We were forced to use TM as a tool to continue attending to those who have epilepsy.

The affected population was slightly more male (54.4%), in their productive age (70%), and lived over 60 to 200 miles from the center. This distance limited their ability to complete their diagnostic study. Although through the semiology, we were able to determine that more than 70% of the patients had focal onset

seizures, 7% had generalized seizures, 2% had focal and generalized seizures, and in almost 20%, we were unable to determine how the seizures started (not classified). Focal seizures are the predominant seizure type in both children and adults. Of the focal seizures, those causing altered consciousness account for 36% of all persons with seizures<sup>24</sup>. However, generalized tonic-clonic seizures are the most reported due to a lack of recognition and diagnostic tools. We consider it essential to determine whether the onset of the seizure is focal or generalized because it helps us to select the most appropriate ASD for the patient and with the best chance of therapeutic success<sup>25</sup>.

We were only able to determine the precise etiology in one out of four patients (26.1%), and in 3.5%, we were able to decide on an epileptic syndrome. Despite the adverse conditions we experienced, 58% of our patients had electroencephalographic recordings, and 45.6% had imaging studies. The International League Against Epilepsy (ILAE) on Nosology and Definitions proposes a classification and definition of epileptic syndromes in the classification of 2017, is to support the diagnosis of epilepsy and to emphasize the importance of classifying epilepsy in an individual by both syndrome and etiology. Semiology is the specific etiology of epilepsy that is associated with a clearly defined, relatively uniform, and distinctive clinical phenotype in most affected individuals, which correlates with EEG, neuroimaging, and consistent genetic testing<sup>16</sup>. Although the percentage of epileptic syndromes determined in the population we studied is low, we must insist that the patients we approached were in pandemic times. We

needed the economic and social resources to complete their study.

More than half of our patients had some psychiatric comorbidity, and only 3.5% of patients were able to demonstrate that they had psychogenic seizures in addition to epileptic seizures. Psychiatric comorbidities, mood, anxiety, and psychotic disturbances are common in epilepsy, occurring at rates 2-3 times or higher than in the non-epilepsy population<sup>26</sup>. Psychiatric comorbidity is frequent and is reported in our study and by others in up to 50% or more of people with epilepsy<sup>27</sup>. The mean frequency of psychogenic non-epileptic seizures (PNES) in patients with epilepsy is present at around 12% (22); we found it to be three times lower.

In India, a country with strong similarities to our own, the COVID-19 pandemic and the limited access of people with epilepsy to anticonvulsant drugs and healthcare facilities. They quantitatively assessed the impact of the COVID-19 pandemic on epilepsy care. TM was almost nonexistent in India before this pandemic, and both large hospitals and neurologists implemented teleconsultation, which reduced the need for monitoring epilepsy patients attending hospitals. Three-quarters of the patients also stated that they were willing to be tele-consulted, and for them, as for us, this experience can bring epilepsy care to the most remote corners of their country and thus improve the treatment gaps of these patients<sup>6</sup>.

Most of our patients achieved satisfactory seizure control during confinement (absolute: 35 %, 1-3 seizures per month 47.4 %), but it was higher after post-confinement (absolute 47.4 % and with 1-3 seizures 43.9 %), reaching

a significant trend with a  $p= 0.08$ , which is possibly related to the fact that the situation we experienced affected the epileptic patient in a secondary way, similar to other reports from China indicating that the mental health of epileptic patients deteriorated during the pandemic<sup>28</sup>. Also, in Brazil, during the first wave of the pandemic, people with epilepsy reported worsening seizure control, psychosocial stress, and deterioration of mental health<sup>29</sup>. Although others report that most people with epilepsy did not experience a significant change in their clinical condition during the COVID-19 pandemic<sup>30</sup>.

Another aspect of commenting is that most of our patients were in monotherapy (56.1 %) or dual therapy (31.6 %) during confinement, but practically did not change after the confinement: monotherapy (61.4 %), dual therapy (28.1 %).

## Conclusions

In our hospital, during COVID-19 confinement, TM represented the only viable option for caring for patients in remote communities. This situation must have been experienced in many parts of the world. For us, it proved to be a successful and valuable strategy for monitoring the evolution of epileptic patients in the short and medium term. The reduction in seizure frequency could be maintained during the pandemic, and although control was better after confinement, we did not find a significant difference between both periods.

**Conflict of Interest Statement:**

AM-M received honoraria for consulting activities, serving on advisory boards, and as a speaker from Pfizer and Eli Lilly. IR-L received honoraria for consulting activities, serving on advisory boards, and as a speaker from Allergan-AbbVie, Pfizer, Eli Lilly, and Carnot de México. All other authors declare that the elaboration of this paper was conducted without any commercial interest or financial relationships with a pharmaceutical company that could be construed as a potential conflict of interest.

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