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## Virtual epilepsy clinics – A Canadian Comprehensive Epilepsy Center experience pre-COVID and during the COVID-19 pandemic period

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### ARTICLE INFO

#### Keywords:

Epilepsy  
Virtual care  
eVisits  
COVID-19

### ABSTRACT

**Objective:** The objective of this study is to assess the role of prior experience with virtual care (through e-visits) in maintaining continuity in ambulatory epilepsy care during an unprecedented pandemic situation, comparing in person versus e-visit clinic uptake.

**Methods:** This is an observational study on virtual epilepsy care (through e-visits) over two years, during a pre-COVID period (14 months) continuing into the COVID-19 pandemic period (10 months). For a small initial section of patients seen during the study period a physician survey and a patient satisfaction survey were completed (n = 53). Outcomes of eVisits were analyzed using descriptive statistics.

**Results:** Median numbers of epilepsy clinic visits conducted during the COVID-19 period (27.5 new and 113 follow up) remained similar to the median uptake during the pre-COVID period (28 new and 116 follow up). Prior experience with e-visits for epilepsy yielded smooth transition into the pandemic period, with several other advantages. The majority of eVisits were successful despite technical difficulties and major components of history and management were still easily implemented. Results from patient surveys supported that a significant amount of time and money were saved, which was in keeping with our health-economic analysis.

**Conclusion:** Our study is one of the first few reports of fully integrated virtual care in a comprehensive epilepsy clinic starting much before start of the COVID-19 pandemic. The results of our study support the feasibility of using virtual care to deliver specialized outpatient care in a comprehensive epilepsy center.

### 1. Introduction

Traditional telemedicine is a form of medicine that usually involves a fully supported technology setup consisting of dedicated high-fidelity audio-video conferencing equipment, high-speed wired internet, and often the presence of a tele-presenter to help the conduct of the telemedicine visit. Traditional telemedicine for epilepsy care has been shown to be safe and effective in comparison to in-person visits (Bahrani et al., 2017; Haddad et al., 2015; Rajbhandari et al., 2019; Rasmussen and Hartshorn, 2005). It does not increase seizure breakthrough and provides such benefits without a reduction in patient satisfaction.

Virtual care, an off-shoot of telemedicine, is the use of personal video conferencing/email/text messaging for delivering patient care (Dare, 2017). It is novel and provides more flexibility around how care can be administered in comparison to traditional telemedicine. In Canada and the US, there is a growing trend towards the use of virtual care for providing ambulatory care in neurological specialties (Appireddy et al.,

2020, 2019; Kuchenbuch et al., 2020; Sattar and Kuperman, 2020). In recent months, the COVID-19 pandemic has accelerated the uptake of virtual care (Grossman et al., 2020; Kuchenbuch et al., 2020; Majersik and Reddy, 2020; OMA, 2020; Punia et al., 2020; Sattar and Kuperman, 2020). Emerging data shows the promise of virtual care in Epilepsy (Banks et al., 2021; Lavin et al., 2020; Subotic et al., 2020).

Telemedicine has been used at our center for outpatient neurology clinics, including Epilepsy, since 2016 (Appireddy et al., 2020, 2019). We began offering virtual care through the use of eVisits (physician to patient video conference visits) in epilepsy clinics via the official provincial telehealth platform in 2019. Our transition to eVisits was significantly scaled up during the COVID-19 pandemic period.

The objective of this study is to assess the role of prior experience with virtual care (through eVisits) in maintaining continuity in ambulatory epilepsy care during an unprecedented pandemic situation, comparing in-person versus eVisit clinic uptake (number of successful consultations conducted).

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## 2. Methods

### 2.1. Study setting & population

This study was conducted in the Comprehensive Epilepsy Centre clinics at the Kingston Health Sciences Centre (KHSC), an academic hospital affiliated with Queen's University in Kingston, Ontario, Canada. The center serves South-Eastern Ontario and includes a multidisciplinary team of epileptologists, EEG technologists, a neuropsychologist, an epilepsy nurse, neurosurgeons and neuroradiologists. The epilepsy clinics provide eight regularly scheduled half-day clinics per week and additional ad-hoc clinics based on patient demand.

While traditional telemedicine was being used for patients with Epilepsy, since 2016, at our center, between January and December 2019, eVisits were introduced as a quality improvement (QI) project in the epilepsy clinic. Once the COVID-19 pandemic started, the eVisit epilepsy clinic was continued, as several clinics, for non-urgent situations in various specialties had to be cancelled, for several reasons, mainly limited availability of personal protective equipment. In-person visits were held only exceptionally. Consecutive patients with Epilepsy seen through eVisits between January 2019 and December 2020 form the study population.

We define virtual care via eVisits as physician-patient interaction via synchronous video conferencing with the patient using personal internet enabled devices from home or an alternate preferred location. At our center, only a secure, provincially funded platform, the Ontario Telehealth Network ([www.otn.ca](http://www.otn.ca)), was used (OTN, 2020). We refer to these visits as eVisits. During the COVID-19 pandemic period, an additional commercial secure platform, Reacts® (Innovative Imaging Technologies, [www.reacts.com](http://www.reacts.com)), was used to facilitate the simultaneous evaluation of more than one patient when a neurology resident worked along with an epileptologist. Visits that were entirely conducted by telephone were not included in the data as eVisits, except in scenarios where a telephone call was used to offset technical difficulties.

### 2.2. Logistics of eVisits

After ensuring the patients had the necessary skills and access to the technology needed to participate in virtual care, eVisits were scheduled by the Epilepsy secretary, with interested and consenting patients. Physicians performed the eVisits from their private offices. Required hardware included a web camera, microphone and speakers, along with secure hospital computer systems. These were already available to all epilepsy physicians. Patient's pharmacy details were confirmed at every visit and any required prescriptions were faxed directly to the required pharmacy.

The needs of vulnerable populations or those with impaired access was accommodated as best as possible. In the case of this study, some patients relied on family members for interpretation or to help with the technology. Other patients with hearing impairment or disability were already in nursing homes and would have staff help them with the virtual visit. No formal interpreters were hired as Kingston has fairly homogenous population, although this could be considered for larger centres with more diverse populations. For patients with disability, many relied heavily on family members to take time off work. Patients without access to a computer or internet were excluded from our study, although the option of phone call visit was offered. We did not come across a situation where a patient did not have access to a phone.

### 2.3. Data collection & analysis

The data sources include routine administrative data, chart review and a prospective survey collected during the QI phase. The prospective survey was collected on a subset of patients and included two parts, completed by the physician and patient, respectively.

Economic savings for the patients were estimated using the survey

data. The opportunity cost saving for the healthcare system are calculated using the Comprehensive Ambulatory Care Classification System (CACS) developed by Canadian Institute for Health Information (CIHI) and the Ontario provincial outpatient costing data (Ontario Case Costing Initiative Costing Analysis Tool, 2019; Appireddy et al., 2019; CIHI, 2018a). Data was available for CACS codes - E751 and E752 which correspond to a General Signs/Symptoms/Examination/Investigations, and Other Medical and Follow-up Care, respectively (2018a).

This study was approved by the Queen's University Health Sciences Research Ethics Board.

## 3. Results

### 3.1. Initial pre- COVID QI phase

A total of 2404 (589 new visits and 1815 follow-up visits) epilepsy clinic visits took place during the pre-COVID QI period (January 2019 to February 2020). Overall, 253 (14 %) of the follow-up visits were eVisits, while no new patients were assessed via this route.

#### 3.1.1. Patient profile

Patients were classified as those with focal onset epilepsy (57 %), generalized Epilepsy (30 %) or unknown (13 %). Psychiatric comorbidities were present in 32 % and cognitive developmental delay in 19 %. Patients were on a single antiepileptic drug (AED) in 68 %, two AEDs (17 %) and three AEDs (15 %). This is representative of a complicated patient population as over half (57 %) of patients did not have complete seizure-freedom over the preceding six months of the study (defined as one or more breakthrough seizures).

A total of 50 patients consented to provide responses to the satisfaction survey (median age 36 years, range 19–76 years, 66 % female). Some patients had more than one eVisits during this time, such that 53 responses were received.

#### 3.1.2. Physician survey on epilepsy eVisits [survey part 1]

Details of epilepsy history, along with comorbidities, interval change in seizure frequency, adverse effects of medications, medication compliance and pertinent social history, were collected during eVisit encounters. Neurological examination findings pertinent to the epilepsy population (cognition, cranial nerve examination mainly for eye movements and presence or absence of nystagmus or facial symmetry; gross strength of limbs, motor coordination, stance and gait) were also recorded. Management decisions like ordering imaging or lab investigations, reviewing results, as well as medication reconciliation and sending a new prescription to pharmacies were also recorded. For the sub-group which undertook the patient satisfaction survey, specific management details are tabulated to show which components were successfully completed via eVisits (as percentages) (Table 1a).

#### 3.1.3. Patient survey on satisfaction, convenience, cost and time savings: [survey part 2]

In order to come to an 'in-person' visit, most patients required a ride from a caregiver (66 %), some were able to drive themselves (13 %), and others used public transportation (6%) or walked (2%) (Table 1b).

Patients undertook 90 % of the eVisits from home, and an accompanying family member was present for 34 % of visits. Epilepsy patients were able to setup eVisits on their own in 68 % of cases. Each eVisit saved 1.9–470 km (median 84.5 km) of travel for patients. At the time of the study, 72 % of patients did not have a driver's license, and 66 % of the patients relied on a caregiver for transportation to their 'in-person' clinic visits.

Patients spent a median time of 20 min (range 10–60 min) for their eVisits, compared to a median of 171.8 min (range 90–319) for 'in-person' visits, including travel time and time spent in the clinic waiting area. For 'in-person' visits, the median out-of-pocket expenses reported by participants was \$106.25 CAD, including travel, gas, food, loss of pay

**Table 1a**  
Physician survey of eVisits.

Parameter #	Clinical and other parameters assessed	Responses* (n = 53)		
		Yes %	No	N/A (%)
1.	Seizure frequency, overall seizure control and semiology of recent seizures	87	0	13
2.	Anti-Epileptic Drug (AED) side effects	89	6	5
3.	Medication reconciliation	94	2	4
4.	Epilepsy Co-morbidities	75	11	14
5.	Social Issues	72	27	3
6.	Physical Exam Performed			
6a	Cognition	77	15	8
6b	Cranial nerves	58	30	12
6c	Facial weakness	57	30	13
6d	Coordination	55	32	13
6e	Gait	26	60	14
7.	Labs	60	30	10
8.	Imaging	26	57	17
9.	Screen Share	2	91	07
10	Management Plan:			
10a.	AED dose change	31	58	11
10b.	AED discontinued	13	75	12
10c.	AED added	26	62	14
10d.	New diagnostic test	30	64	06
10e.	New consult	15	66	19
11	Additional paperwork	64	25	11

\* Responses to item#1 are not listed as 100 % due to some missing details (e. g., seizure semiology) from survey data prospectively collected following each virtual care clinic. Seizure control (frequency, type) details were collected for all (100 %) patients.

**Table 1b**  
Patient survey of eVisits.

Parameter #	Patient factors evaluated	Responses* (%) (n = 53)	
		Yes	No
1	Employment Status	49	28
2	Time off work required for IP visit	40	49
3	Child Care required for IP visit	9	79
4	Student	13	32
5	Valid Driver's License	25	72
6	Psychiatric Comorbidities	32	60
7	History of Abuse	9	8
8	Cognitive Delay	19	79
9	Physical Disability	6	94

\* Percentage of unavailable responses not shown.

and childcare expenses.

### 3.1.4. EVisit outcomes

There was a high proportion (49 %) of minor technical difficulties (audio/video/internet) experienced during the eVisits. Problems were listed as audio/video/internet related. However, the majority of these technical difficulties could be resolved by the patient and/or the physician. Overall, physicians found 85 % percent of their eVisits to be successful, despite the high frequency of technical challenges. Many unanticipated problems were also encountered; some examples are listed below:

- email regarding appointment arriving in patient's Spam folder, hence, a patient requiring phone reminders at the scheduled time of eVisit,
- patients being skeptical of opening emails from OTN, as these did not have the physician's name in the subject or content,
- patients requiring live guidance to navigate the process of initiation of the eVisit, thereby prolonging visits and reducing the time available for clinical discussion

The telephone was used as a rescue for unsuccessful eVisit encounters. Most (77 %) of the eVisits were followed by subsequent eVisit follow up. Only 8% of visits following virtual care were switched to an in-person visit, possibly suggesting that patients were satisfied with eVisits despite technical difficulties.

### 3.2. Impact of the pre-COVID QI period on Epilepsy clinic functioning

Given the high volumes and success of eVisits during the initial period, two in-person clinics (each spanning a half-day) were converted into eVisit clinics conducted from the physicians' respective offices. The 'in-person' clinic space that was freed up was allocated to newer faculty joining the division, resulting in resource optimization as a result of virtual care. A typical eVisit clinic after the initial QI phase consisted of 8–10 follow-up patients scheduled for 20 min each, over approximately 3 h. During the last four months of the pre-COVID period, eVisit clinic volumes for follow-up patients were comparable to 'in-person' visits and also more efficient than in-person clinics, as no time was lost because of patients moving in and out of clinic rooms and cleaning of rooms between patients.

### 3.3. COVID-19 phase (Mar 2020-Dec 2020)

Following public health advisories, non-urgent and elective clinical services, including ambulatory clinical services, were closed for in-person interaction (CDC, 2020; Public Health Agency of Canada, April 22 2020). Given our existing virtual care clinic services, we were able to smoothly transition to a 100 % virtual epilepsy clinic in early March 2020. While overall clinic volumes were reduced once the pandemic started, most new patients who needed to be seen on priority, as well as follow-up patients requiring frequent periodic review, could easily be followed up through eVisits. Since there was no learning curve to deal with, at this crucial transition, 229 eVisits were scheduled, with 197 (86 %) being successful, 5 (2%) no-shows and 28 (12 %) cancellations, during the initial three-month time period (March, April and May 2020) of the COVID-19 pandemic. This was despite one of the three epileptologists not having clinics booked for these three months in advance due to a planned sabbatical (which later had to be cut short once the pandemic started). The average percentage of no-shows and/or cancellations per virtual clinic during the pandemic period was approximately 10 %. Month-wise details of patients seen in person and through eVisits are represented in Fig. 1. Following this initial period, the number of 'in-person' visits gradually increased. However, most encounters continue to be conducted via eVisits. A total of 262 new epilepsy patients were seen (more than halfway through eVisits), and 1074 follow-up encounters (82.5 % through eVisits) were completed during the COVID period (Table 2). Importantly, the monthly median numbers of new patients and follow-up patients visits during the pre-COVID period (28 and 116 respectively) were not much reduced (as could have been expected), compared to that during the COVID period (27.5 and 113 respectively). The overall number of total visits did decline as one of the epileptologists was on sabbatical during the initial months of COVID.

In addition, neurology residents were able to continue seeing new patients via eVisits as part of their learning. In these cases, visits lasted between 45–90 min.

### 3.4. Economic cost analysis for the provincial health care system

The mean cost of an ambulatory visit classified as E751 and E752 in 2016/17 in Ontario was \$331 and \$397, respectively and is obtained from the Ontario outpatient costing data (2019). The estimated opportunity cost of using virtual care for epilepsy care during the QI phase (n = 253) for these 2 diagnostic codes was \$83,743-\$100,441 CAD. The estimated opportunity cost since the beginning of the COVID-19 pandemic (n = 1139) for these 2 diagnostic codes was \$377,009–

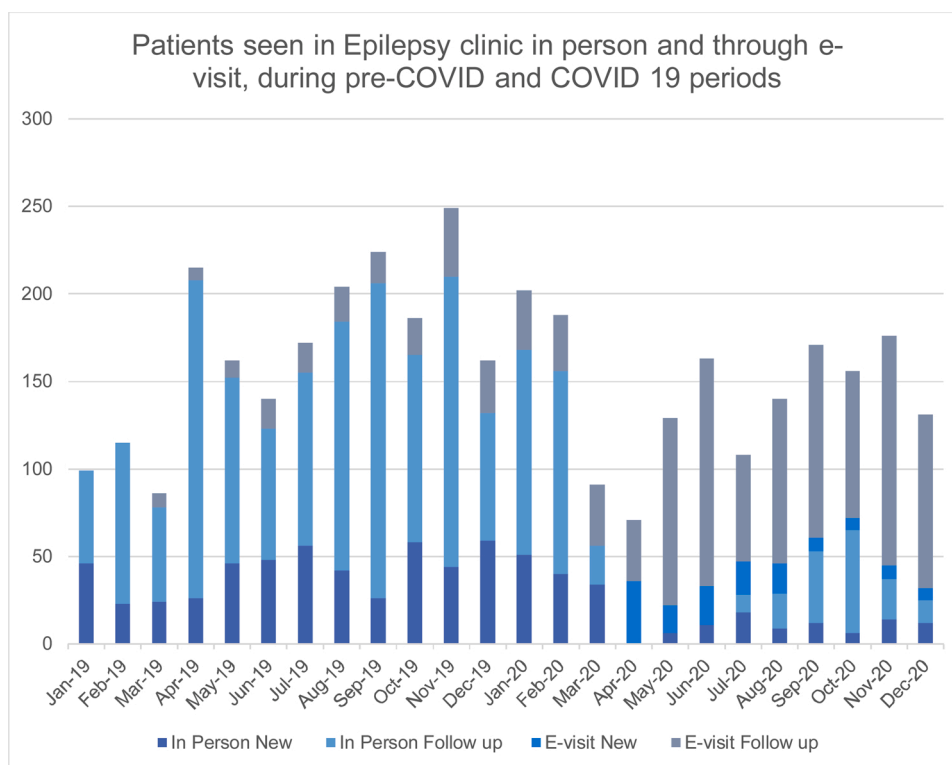


Fig. 1. Chart representing month-wise epilepsy clinic uptake during the pre-COVID QI period and the COVID-19 period.

**Table 2**  
Comparison of 'in-person' visits and eVisits for the KHSC epilepsy clinics.

	Pre-COVID (Jan 2019- Feb 2020)			During COVID-19 (March- December 2020)		
	In-person	eVisit	Median # of total visits per month	In-person	eVisit	Median # of total visits per month
Total # new patients seen	589	0	28	122	140	27.5
Total # follow up visits	1562	253	116	188	886	113
# visits converted from in-person to eVisit on patients' request	0			150		
# visits converted from eVisit to in-person, on patients' request	0			20		
% Patients requesting earlier appointments than scheduled*	10	5		10	5	
Percentage of unscheduled visits*	5	10		0	10	

\* Appointments scheduled two weeks or less, prior to the date of visit, were considered unscheduled.

\$452,183 CAD.

#### 4. Discussion

This study demonstrates that the use of eVisits for ambulatory epilepsy care is clinically effective, convenient and cost-effective, compared to 'in-person' clinics. The experience gained facilitated resource optimization and the subsequent rapid adoption of almost entirely virtual care when the COVID-19 pandemic occurred. The smooth transition provided uninterrupted care delivery to this very vulnerable patient population.

##### 4.1. Improved access and patient-centered care

Virtual care using eVisits offers a more patient-centered approach to Epilepsy by making patient care more accessible, available and affordable. Lack of timely access to specialist care is a well-recognized problem in Canada (Janine, 2016; Kasman and Badley, 2004; Vogel, 2017). Virtual care can play a role by increasing health care access to rural and remote communities, reducing wait times, increasing convenience to patients, reducing the need to travel, and reducing out-of-pocket expenses (Appireddy et al., 2019; Ladino et al., 2016; Morgan et al., 2009; OTN, 2019). The ability of patients to comfortably stay at home, surrounded by family (33 % in our study), aligns with Picker's principles of patient-centered care (Picker Institute, 2018). The implementation of patient engagement models for virtual care can further enhance the patient experience of care (Srinivasan et al., 2020).

'In-person' visits may also be emotionally and physically taxing on both patients and caregivers, particularly for those who travel long distances to attend the hospital. This is specifically relevant to an epilepsy population, in which a large percentage may be under driving restrictions at any given point in time (Chen et al., 2014). Our findings reiterate those from some previous studies that patients value eVisits as they save time and are more accessible (Hatcher-Martin et al., 2016; Powell et al., 2017; Russo et al., 2016).

#### 4.2. Economic case

Virtual Care via eVisits offer significant out-of-pocket expense savings (median savings of \$106 CAD per visit) compared to ~\$ 52 CAD per visit for stroke patients (Appireddy et al., 2019). The higher out-of-pocket expenses are likely due to the demographic profile of the epilepsy patients being younger, of a working-age group with the loss of income, childcare costs and driving restrictions. Any reduction in out-of-pocket expenses will go a long way in alleviating the economic hardships already faced by patients with Epilepsy (Elliott et al., 2020; Hussain et al., 2020; Riechmann et al., 2015). The societal costs associated with healthcare delivery are ever-increasing, and it is important to address this to optimize resource utilization (CHH, 2018b; Hofmeister, 2018). Our study data shows significant opportunity cost savings with virtual epilepsy care and is in line with other data on the economic benefits of virtual care and telemedicine on the healthcare system (Appireddy et al., 2019; Bove et al., 2019).

#### 4.3. Improved efficiency of virtual epilepsy clinics

Data from this study support feasibility of implementation and sustainability of virtual care for epilepsy clinics. It adds to the growing call for virtual epilepsy care facilities (2020; Lavin et al., 2020). Our study data also support improved clinical efficiency with virtual care compared to other neurological specialties (Appireddy et al., 2019). The ability to free up ambulatory care resources (clinic space, clinic staff) due to the transition to eVisits has allowed us to provide clinical care to more patients with no additional infrastructure requirements or costs. This has also allowed our division to accommodate the clinical needs of incoming faculty with minimal effort. Virtual care for epilepsy offers significant flexibility for the physicians and the administrative staff with regards to patient scheduling. Unlike with 'in-person' clinics, eVisit scheduling is not limited by constraints placed due to limited clinic hours, space or human resources. The patient-centered nature of virtual care can also contribute to reduced no-shows and cancellations, thus ensuring timely delivery of care and improving the overall clinic efficiency (Appireddy et al., 2019). Time efficiency during the clinics is also an advantage with eVisits. Time spent on patient movement from waiting areas with or without accompanying caregivers, cleaning of rooms between patients (if needed), nurse evaluation prior to physician consultation during in-person visits is saved with virtual visits. We also feel that virtual care offers the flexibility of scheduling outpatient clinics for clinicians who often have other competing responsibilities like research, hospital in-patient on-call service, administration and teaching. This benefit could potentially result in a reduced risk of physician burnout, although further long-term studies would be needed (Cossantini, 2018).

#### 4.4. Virtual care is ideal for Epilepsy

Data from our study shows that eVisits do not impede a physician's ability to effectively gather information from epilepsy patients through history and physical examination. This is in-line with earlier observations of telemedicine in Epilepsy and virtual care for other neurological conditions (Ahmed et al., 2008; Appireddy et al., 2019). This suggests that at least in the case of patients with Epilepsy, that minimal physical examination data is lost through the medium of eVisits versus 'in-person' visits. In uncommon scenarios, where physicians consider detailed sensory and reflex examination, etc. necessary, the option of in-person visits does exist. In fact, for patients with an intellectual disability or behavioural challenges, encounters can be conducted more smoothly and effectively in the patients' relaxed home setting, especially as patients are spared the discomfort of travel and spending time in the clinic waiting area.

It is known that patients with disabilities and frailty are unable to attend in-person' epilepsy clinics independently without the help of a

caregiver (Chan et al., 2020; Nouri et al., 2020). For this sub-population, virtual care is an extremely useful alternative. Patients may still require some help in setting up devices, but we did not explore this aspect in detail.

#### 4.5. Virtual epilepsy care during COVID-19

Virtual care has been widely embraced during the COVID-19 pandemic (Grossman et al., 2020; Hernando-Requejo et al., 2020; Kuchenbuch et al., 2020; Rockwell and Gilroy, 2020; Schwamm et al., 2020; Srinivasan et al., 2020). Since the epilepsy clinic uptake continued right through the COVID 19 pandemic period, with some reduction in overall numbers, this observation suggests that prior experience using these resulted in a smooth transition into virtual clinics and contributed significantly towards continuity in care. This is extremely important for patients with Epilepsy, who at that time formed one of many patient groups dealing with high anxiety surrounding the ability to access specialized care. Importantly, after transitioning to a full eVisit model during the pandemic, a comparable volume of follow-up patients continued to be seen, as during the pre-COVID period. In addition, this transition facilitated uninterrupted care to new epilepsy patients, seen through eVisits, during COVID-19. Few reports on the utilization of telemedicine for epilepsy treatment prior to and during the current pandemic have been published. A multi-center study evaluating wait-times and improvement of access for pediatric patients with Epilepsy to specialists was conducted using a design similar to ours. A total of 73 visits completed by 61 patients/family members found telehealth visits to enhance access to physicians and reduce cost, missed school hours and missed work hours (Gali et al., 2020). In a Spanish study, authors report their experience with telemedicine services for epilepsy care. No video conferencing was used, and services were offered only through telephone calls as part of this study (Hernando-Requejo et al., 2020). Another recent study surveyed 172 epileptologists, adult and pediatric neurologists regarding the use of telehealth and remote systems for epilepsy care as well as academic activities. Authors found most physicians already having prior experience and also using institutional or personal remote systems for clinical care by significantly higher proportions during the COVID-19 pandemic (Kuchenbuch et al., 2020). One study has suggested that physicians feel less comfortable broaching sensitive topics, such as reproductive health or risk of SUDEP, when delivering care via telephone (Conde-Blanco et al., 2020). Theoretically, the use of video conferencing in eVisits could better support these conversations as it better recreates the environment of an in-person visit.

#### 4.6. Strengths of this study

One of the major strengths of this study is that it was conducted at an academic tertiary care center with a comprehensive epilepsy care program run by three epileptologists. Therefore, the patients included in this study likely represent a complicated population with higher rates of pharmaco-resistance and significant comorbidity. Prospective evaluation of feasibility, effectiveness and patient experience using eVisits for epilepsy clinics remains the major strength of this study. The use of a secure, provincially funded platform for conducting eVisits ensured stringent protection of patient confidentiality. The unique study period demonstrating a hassle-free transition during the pandemic period highlights the important advantages of virtual care via eVisit use for epilepsy care.

The implementation of virtual care in a similar model can easily be recreated at other centres. For other centres looking to implement virtual care, our team suggests first asking patients at in person visits to assess their openness to a virtual visit. From there, working with the IT department to help with equipment setup and training as needed is recommended. Finally, the use of standardized checklists can be helpful for physicians as well as questionnaires for patients to have a source of feedback.

#### 4.7. Limitations of the study

Our study did not have longitudinal data on detailed clinical outcomes to assess the efficacy of virtual care. We specifically did not evaluate the impact of virtual care on building physician-patient rapport/relationship; however, this was not a major concern during the QI period, as the eVisits were used for follow-up after establishing rapport. During the COVID-19 period, most new patients seen through eVisits shared their satisfaction with respective physicians and concerns regarding rapport building was not perceived by physicians. In fact, patients were eager to do eVisits, and none expressed concerns in this regard in the survey, interviews or during routine interaction with the clinic administrative staff or physicians. Patient satisfaction in this regard, was informally assessed by patients' feedback to the epileptologists. Future confirmatory studies would be needed to truly measure patient satisfaction. Furthermore, future studies would also be helpful in reassessing patient satisfaction with virtual care after the stress of a pandemic has subsided.

The rate of technical difficulties is likely an overestimation in the early stages of transitioning to virtual visits and is anticipated to decrease as users become more accustomed to running eVisits. Despite this, the overall success rate of virtual care remained high. However, health care providers must remain cognizant of how technology can serve to exclude patients from using eVisits due to technological illiteracy or unfamiliarity (Powell et al., 2017; Scott Kruse et al., 2018).

Other potential limitations of eVisits may include reduced ability to communicate pre-surgical evaluation plan with surgical candidates; difficulty in monitoring patients more prone to AED adverse events and those who require close coordination with other specialties like rheumatology or cardiology, especially when frequent investigations and parenteral medication administration are required. These aspects need to be studied in a more structured way, through future studies.

#### 5. Conclusion

Our study is one of the first few reports of fully integrated virtual care in a comprehensive epilepsy clinic. The results of our study support the feasibility of using virtual care to deliver specialized outpatient care in a comprehensive epilepsy center. This is evidenced by the transformation to an almost exclusive virtual care model during the initial few weeks of the COVID-19 pandemic (only one clinic remained in person). Future studies should focus on gathering more longitudinal data looking at various factors like clinical and patient-reported outcomes with virtual care for Epilepsy. This will help inform the development of best practice guidelines for virtual Care in Epilepsy.

#### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### Declaration of Competing Interest

Dr. Appireddy reports grants from CIHR; PSI Foundation, Canada Health Infoway towards virtual care research. The remaining authors have no conflicts of interest to declare.

#### Acknowledgements

We extend our thanks to Ann Norton, KHSC Epilepsy clinic secretary, and Sandra Weatherby, our Epilepsy Nurse, for their valuable help towards data collection.

#### References

- Ahmed, S.N., Mann, C., Sinclair, D.B., Heino, A., Iskiw, B., Quigley, D., Ohinmaa, A., 2008. Feasibility of epilepsy follow-up care through telemedicine: a pilot study on the patient's perspective. *Epilepsia* 49, 573–585.
- Appireddy, R., Khan, S., Leaver, C., Martin, C., Jin, A., Durafourt, B.A., Archer, S.L., 2019. Home virtual visits for outpatient follow-up stroke care: cross-sectional study. *J. Med. Internet Res.* 21, e13734.
- Appireddy, R., Jalini, S., Shukla, G., Lomax, L., 2020. Tackling the burden of neurological diseases in Canada with virtual care during the COVID-19 pandemic and beyond. *Can. J. Neurol. Sci.* 1–9.
- Bahrani, K., Singh, M.B., Bhatia, R., Prasad, K., Vibha, D., Shukla, G., Vishnubhatla, S., Patterson, V., 2017. Telephonic review for outpatients with epilepsy—a prospective randomized, parallel group study. *Seizure* 53, 55–61.
- Banks, J., Corrigan, D., Grogan, R., El-Naggar, H., White, M., Doran, E., Synnott, C., Fitzsimons, M., Delanty, N., Doherty, C.P., 2021. LoVE in a time of CoVID: Clinician and patient experience using telemedicine for chronic epilepsy management. *Epilepsy Behav.* 115, 107675.
- Bove, R., Bevan, C., Crabtree, E., Zhao, C., Gomez, R., Garcha, P., Morrissey, J., Dierkhising, J., Green, A.J., Hauser, S.L., Cree, B.A., Wallin, M.T., Gelfand, J.M., 2019. Toward a low-cost, in-home, telemedicine-enabled assessment of disability in multiple sclerosis. *Mult. Scler.* 25, 1526–1534.
- CDC, 2020. Guidance for Outpatient and Ambulatory Care Settings. CDC. @CDCgov.
- Chan, S., O'Riordan, A., Appireddy, R., 2020. Exploring the determinants and experiences of senior stroke patients with virtual care. *Can. J. Neurol. Sci.* 1–23.
- Chen, W.C., Chen, E.Y., Gebre, R.Z., Johnson, M.R., Li, N., Vitkovskiy, P., Blumenfeld, H., 2014. Epilepsy and driving: potential impact of transient impaired consciousness. *Epilepsy Behav.* 30, 50–57.
- CIHI, 2018a. Comprehensive Ambulatory Classification System (CACS). CIHI. @CIHI\_ICIS.
- CIHI, 2018b. Health spending, National Health Expenditure Trends, 1975 to 2018. Canadian Institute for Health Information (CIHI), Ottawa, ON.
- Conde-Blanco, E., Centeno, M., Tio, E., Muriana, D., Garcia-Penas, J.J., Serrano, P., Nagel, A.G., Serratos, J., Jimenez, A.P., Toledo, M., Donaia, A., Manzanares, I., Betran, O., Carreno, M., 2020. Emergency implementation of telemedicine for Epilepsy in Spain: results of a survey during SARS-CoV-2 pandemic. *Epilepsy Behav.* 111, 107211.
- Costantini, R., 2018. Can Virtual Care Help Prevent Physician Burnout? *Bright MD*.
- Dare, F., 2017. Virtual Care: Just what the Consumer Ordered, Accenture Strategy. Accenture.
- Elliott, J., DeJean, D., Potter, B.K., Coyle, D., Clifford, T., McCoy, B., Wells, G.A., 2020. Barriers in accessing medical cannabis for children with drug-resistant Epilepsy in Canada: a qualitative study. *Epilepsy Behav.* 111, 107120.
- Gali, K., Joshi, S., Hueneke, S., Katzenbach, A., Radecki, L., Calabrese, T., Fletcher, L., Trandafir, C., Wilson, C., Goyal, M., Wusthoff, C.J., Le Pichon, J.B., Corvalan, R., Golson, A., Hardy, J., Smith, M., Cook, E., Bonkowsky, J.L., 2020. Barriers, access and management of paediatric Epilepsy with telehealth. *J. Telemed. Telecare*, 1357633X20969531.
- Grossman, S.N., Han, S.C., Balcer, L.J., Kurzweil, A., Weinberg, H., Galetta, S.L., Busis, N.A., 2020. Rapid implementation of virtual neurology in response to the COVID-19 pandemic. *Neurology* 94, 1077–1087.
- Haddad, N., Grant, I., Eswaran, H., 2015. Telemedicine for patients with Epilepsy: a pilot experience. *Epilepsy Behav.* 44, 1–4.
- Hatcher-Martin, J., Anderson, E., Factor, S., 2016. Patient acceptance and potential savings of telereneurology in an academic outpatient movement disorders practice (P1.022). *Neurology* 86, P1.022.
- Hernando-Reguejo, V., Huertas-Gonzalez, N., Lapena-Motilva, J., Ogando-Duran, G., 2020. The epilepsy unit during the COVID-19 epidemic: the role of telemedicine and the effects of confinement on patients with Epilepsy. *Neurologia* 35, 274–276.
- Hofmeister, M., 2018. (Cost-)effectiveness of telemedicine. *Can. Med. Assoc. J.* <https://www.cmaj.ca/content/cost-effectiveness-telemedicine>.
- Hussain, S.A., Ortendahl, J.D., Bentley, T.G.K., Harmon, A.L., Gupta, S., Begley, C.E., Khilfeh, I., Knoth, R.L., 2020. The economic burden of caregiving in Epilepsy: an estimate based on a survey of US caregivers. *Epilepsia* 61, 319–329.
- Janine, C., 2016. Difficulty Accessing Health Care Services in Canada, Health at a Glance. Minister responsible for Statistics Canada.
- Kasman, N.M., Badley, E.M., 2004. Beyond access: who reports that health care is not being received when needed in a publicly-funded health care system? *Can. J. Public Health* 95, 304–308.
- Kuchenbuch, M., D'Onofrio, G., Wirrell, E., Jiang, Y., Dupont, S., Grinspan, Z.M., Auvin, S., Wilmshurst, J.M., Arzimanoglou, A., Cross, J.H., Specchio, N., Nabbout, R., 2020. An accelerated shift in the use of remote systems in Epilepsy due to the COVID-19 pandemic. *Epilepsy Behav.* 112, 107376.
- Ladino, M.A., Wiley, J., Schulman, I.H., Sabucedo, A.J., Garcia, D., Cardona, J.M., Valdes, A., Pedraza, F., Echeverri, R.J., 2016. Tele-nephrology: a feasible way to improve access to care for patients with kidney disease who reside in underserved areas. *Telemed. J. E Health* 22, 650–654.
- Lavin, B., Dormond, C., Scantlebury, M.H., Frouin, P.Y., Brodie, M.J., 2020. Bridging the healthcare gap: building the case for epilepsy virtual clinics in the current healthcare environment. *Epilepsy Behav.* 111, 107262.
- Majersik, J.J., Reddy, V.K., 2020. Acute neurology during the COVID-19 pandemic: supporting the front line. *Neurology* 94 (24), 1055–1077. <https://doi.org/10.1212/WNL.0000000000009564>.
- Morgan, D.G., Crossley, M., Kirk, A., D'Arcy, C., Stewart, N., Biem, J., Forbes, D., Harder, S., Basran, J., Dal Bello-Haas, V., McBain, L., 2009. Improving access to

- dementia care: development and evaluation of a rural and remote memory clinic. *Aging Mental Health* 13, 17–30.
- Nouri, S., Khoong, E.C., Lyles, C.R., Karliner, L., 2020. Addressing equity in telemedicine for chronic disease management during the Covid-19 pandemic. *NEJM Catal. Innov. Care Deliv.* <https://doi.org/10.1056/CAT.1020.0123>.
- OMA, 2020. Virtual Care: Expanded Access to Virtual Care for All Physicians. Ontario Medical Association.
- Ontario Case Costing Initiative Costing Analysis Tool, 2019. Queen's Printer for Ontario Health Data Branch.
- OTN, 2019. Video Visits Enhance Access to Neurology Follow up Care, Virtual Care in Action - Evidence for Virtual Care. OTN.
- OTN, 2020. Virtual Care Organizations. Ontario Health Teams - OTN.ca. Ontario Telemedicine Network, Ontario Health.
- Picker Institute, 2018. Picker Principles of Person Centred Care.
- Powell, R.E., Henstenburg, J.M., Cooper, G., Hollander, J.E., Rising, K.L., 2017. Patient perceptions of telehealth primary care video visits. *Ann. Fam. Med.* 15, 225–229.
- Public Health Agency of Canada, April 22, 2020. COVID-19 Pandemic Guidance for the Health Care Sector - Canada.ca.
- Punia, V., Nasr, G., Zagorski, V., Lawrence, G., Fesler, J., Nair, D., Najm, I., 2020. Evidence of a rapid shift in outpatient practice during the COVID-19 pandemic using telemedicine. *Telemed. J. E Health* 26, 1301–1303.
- Rajbhandari, H., Joshi, S., Malakar, S., Paudel, P., Jain, P., Uppadaya, K., Singh, M., Patterson, V., 2019. Epilepsy field workers, a smartphone application and telephone telemedicine: safe and effective epilepsy care in rural Nepal. *Seizure* 64, 54–58.
- Rasmusson, K.A., Hartshorn, J.C., 2005. A comparison of epilepsy patients in a traditional ambulatory clinic and a telemedicine clinic. *Epilepsia* 46, 767–770.
- Riechmann, J., Strzelczyk, A., Reese, J.P., Boor, R., Stephani, U., Langner, C., Neubauer, B.A., Oberman, B., Philippi, H., Rochel, M., Seeger, J., Seipelt, P., Oertel, W.H., Dodel, R., Rosenow, F., Hamer, H.M., EpiPaed Study, G., 2015. Costs of Epilepsy and cost-driving factors in children, adolescents, and their caregivers in Germany. *Epilepsia* 56, 1388–1397.
- Rockwell, K.L., Gilroy, A.S., 2020. Incorporating telemedicine as part of COVID-19 outbreak response systems. *Am. J. Manag. Care* 26, 147–148.
- Russo, J.E., McCool, R.R., Davies, L., 2016. VA telemedicine: an analysis of cost and time savings. *Telemed. J. E Health* 22, 209–215.
- Sattar, S., Kuperman, R., 2020. Telehealth in pediatric epilepsy care: a rapid transition during the COVID-19 pandemic. *Epilepsy Behav.* 111, 107282.
- Schwamm, L.H., Estrada, J., Erskine, A., Licurse, A., 2020. Virtual care: new models of caring for our patients and workforce. *Lancet Digital Health* 2, e282–e285.
- Scott Kruse, C., Karem, P., Shifflett, K., Vegi, L., Ravi, K., Brooks, M., 2018. Evaluating barriers to adopting telemedicine worldwide: a systematic review. *J. Telemed. Telecare* 24, 4–12.
- Srinivasan, M., Phadke, A.J., Zulman, D., Israni, S.T., Madill, E.S., Savage, T.R., Downing, N.L., Nelligan, I., Artandi, M., Sharp, C., 2020. Enhancing patient engagement during virtual care: a conceptual model and rapid implementation at an academic medical center. *NEJM Catal. Innov. Care Deliv.* <https://doi.org/10.1056/CAT.1020.0262>.
- Subotic, A., Pricop, D.F., Josephson, C.B., Patten, S.B., Smith, E.E., Roach, P., 2020. Examining the impacts of the COVID-19 pandemic on the well-being and virtual care of patients with Epilepsy. *Epilepsy Behav.* 113, 107599.
- Vogel, L., 2017. Canadians still waiting for timely access to care. *CMAJ* 189, E375–E376.