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Telemedicine in neurosurgery during SARS-CoV2 Pandemic

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Summary

Introduction and purpose

First large scale introduction and research of telecommunication in medicine was conducted in year 1977. However, until current SARS-CoV-2 Pandemic, telemedicine has been used only in emergency interventions or in cases in which only remote healthcare provision services were available. Healthcare was forced to implement telemedical changes in a scale broader beyond imagination, in order to limit the risk of COVID transmission and preserve the scarce healthcare resources. Especially in surgical fields, such as neurosurgery, which strongly depend on on-site procedures, this time has been extremely demanding. The aim of the study is to present the current views and effectiveness of implementation of telemedicine in neurosurgery during SARS-CoV2 pandemic. Substantial articles on implementation and challenges of telemedicine in neurosurgery from period 02.2020-09.2020 were analyzed.

Current state of knowledge

Within 581 articles of PubMED database, 15 substantial articles on advancements of telemedicine in neurosurgery during SARS-CoV2 Pandemic were included in the review. 60% of the articles discussed telemedicine implementation and improvements made, 40% of the articles discussed the legislative changes, telemedicine recommendations and good pratices. Most of the articles noted the significant increase in provision of services using telemedicine and high satisfaction of patients and professionals from the remote visits.

However, many challenges of the technology has been encountered including difficulties in conducting proper remote examination, lack of standarized protocols, concerns of the ethical and social matters, such as patient's confidentiality and privacy concerns, digital illiteracy in patients, and the need for more advanced hardware and more secure software for the provision of high quality services.

Conclusions

Reviewed research presents significant improvements in introduction of telemedicine in neurosurgical field in times of COVID Pandemic, however due to many multidisciplinary concerns regarding telemedicine implementation, face-to-face examination and communication still should take priority over the telemedicine interventions in the non-emergency future.

Keywords: Telemedicine; telehealth; neurosurgery; SARS-CoV2

1. Introduction

1.1 Beginnings of telemedicine

Telemedicine is the advancement of the modern medicine, which originated from the perspective of provision of equal healthcare services to the patients in geographical areas underrepresented in the face-to-face healthcare facilities. The introduction of the telephone invention in 1876 by A.G.Bell opened the possibility of instant communication with distant places for various purposes, and nearly a century later medicine became a part of that communication revolution as well. [1] It is difficult to trace the beginnings of the concept origin, however, the first mention of telemedicine in PubMed database can be found in 1962 article of mobile health services for migrant families. [2] First large-scale studies were performed in primary care settings no later than 1977 by Dunn et al., with 1015 patient-physician consultations held with telephone and television means of communication. The results indicated over 50% of identical number of diagnoses were made with both remote and face-to-face consultations. [3] The majority of research regarding telemedicine has been performed in United States, including 1971 Alaska research on improvement of health care in remote villages with telecommunication methods, and first telemedicine program by NASA in 1989 after the Soviet Republic of Armenia earthquake (NASA SpaceBridge to Armenia/Ufa). [1]

1.2 Modern nomenclature and application of telemedicine

Nowadays, the term telemedicine indicates the provision of clinical information in health care via telecommunication and other information technologies, which can support diagnosis, consultation or patient's care. [1;4] Telehealth, as a broader term, incorporates the needs of long-distance clinical care, as well as public health and professional health-related education and awareness and heatlh administration. The information can be provided via analog or digital transmission, as a store-and-forward format or the real-time consultation. The use of telemedicine enabled even establishing a specific branch, telerehabilitation, which allows self-rehabilitation of patients with help of physical therapists from a distance. [1]

Telemedicine has been considered a vital mean of provision of primary care, specialist referral, remote patient monitoring, access to electronic medical records and continuous medical education. [5]

1.3 Telemedicine in neurosurgery before COVID-19

Neurosurgery has also been one of the disciplines which started to successfully incorporate the telehealth interventions even before the current pandemic. The first neurosurgical application of telemedicine is told to be the evaluation of candidates to thrombolysis in stroke management. [6] The incorporation of telemedicine included not only successful post-operative follow up consultations, but also evaluation of possible referral to the hospital, programming of neuromodulation devices, guidance of thrombolytics administration for stroke patients. It has been concluded in the review by Eichberg et al. that among 52 studies included in the success rate analysis, the 99.6% success rate of telemedicine inclusion in neurosurgical practice has been observed. Among observed unsuccessful practices, the main reasons involved technology failures and necessity to perform additional in-person assessment of the patient. [7]

1.4 Telemedicine and SARS-CoV-2 pandemic

The SARS-CoV-2 pandemic paralyzed the whole world in terms of provision of services. Medical services has to fight two battles - one, against the unpredictable enemy - coronavirus, and the second - against the known risks of diseases of the humanity in a new, scarced, remote settings. In the face of drastically limited admittance to the departments, restrictive triage of only-emergency patients being treated during face-to-face consultations, as well as the work restrictions, limited working hours, 2-week self-isolation breaks and therefore, limited on-site human resources, health care had to incorporate the new technologies in order to monitor and maintain the care for the chronic and non-emergency patients. Introduction of new technologies could bring in this setting additional benefits to the patients, who could avoid travel and admittance to the hospital, therefore lower risk of outside exposure to the virus. [8]

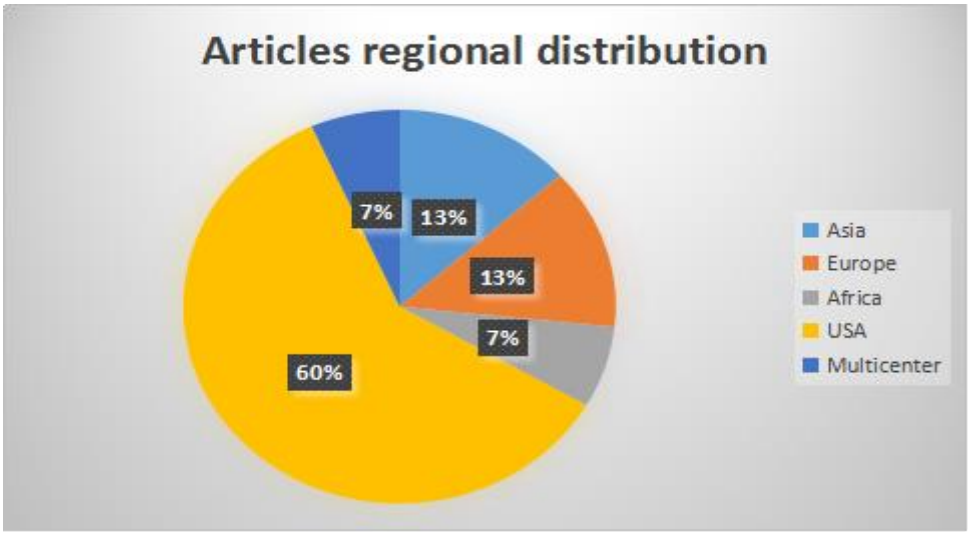
2. Purpose of the study

The aim of the study is to present the current views and effectiveness of implementation of telemedicine in neurosurgery settings during SARS-CoV2 pandemic.

3. Methods

Substantial articles on telemedicine in neurosurgery during COVID-19 from period 02.2020-09.2020 in the African, American Asian and European regions have been analyzed. Among 581 articles in PubMed Medline database, 15 articles were selected for analysis.

4. Description of the state of knowledge



Graph 1.Regional distribution of research. Prepared by authors.

Among 15 articles, there was a certain variety of topics discussed regarding introduction of telemedicine in neurosurgery settings. We decided to focus on:
- telemedicine implementation and improvements made (9 articles)
-legislative changes, telemedicine recommendations and good pratices (6 articles)

4.1 Institutional neurosurgical experiences during SARS-Cov-2 pandemic

Study/ Observation	Country	Type of study	Study group	Results	Advancements	Challenges
Ashry et al. (2020)	Egypt	Virtual post-op consultations effectiveness	30 patients evaluated for 30 days (total 67 visits) Smooth, no post-op complications expected	90% satisfaction rate in patients, 95% satisfaction rate in doctors	Pain management, seizures control, wound infection, hydrocephalus	Lacks security standards, risk of patient's privacy exposure
Mouchtouris N. et al. (2020)	USA	Comparison of telemedicine usage before and after start of pandemic	10746 interventions (757 telemedicine consultations)	40-fold increase in telemedicine appointments	39,8% of new patient's visits via telemedicine - not only follow ups	New technology or AI application is required for more sufficient use

Glauser et al. (2020)	USA	Introduction of telehealth to the department workflow	New and return patient visits (Feb-April 2020)	In 5th week of implementation 99% of outpatient consultations performed with telehealth	High patient and physician satisfaction along with improvements of the procedure	Possible to miss important pathologies which manifest subtly in the physical examination
Eichberg et al, Basil et al. (2020)	USA	Introduction to telehealth in department workflow	Telehealth vs in-person visits	72% of visits held by telehealth in 4th week	Spinal services more often used telehealth than brain tumor services	Certain barriers to telehealth acceptance noted
Blue et al (2020)	USA	Introduction to telehealth in department workflow	Telehealth vs in-person visits	99% of new patients, 87% of returning patients consultations held with telemedicine	Overall satisfaction quite positive	Verbal delay in communication - technical issue; some examinations difficult/impossible to perform
Yoon JW et al. (2020)	USA	Remote virtual spinal evaluation	695 virtual consultations	Ability to maintain the follow-up visits schedule	Possibility to perform the physical assessment	Triage system is needed

Ghimire P. et al. (2020)	United Kingdom	Patient's satisfaction /experience scale with the telephone consultations	50 patients - follow-up consultations	50% participants preferred face to face consultations, 1/3 of participants - telephone consultations	Possibility of introduction of a hybrid model of consultation	Communication language deficit patients difficult, not a substitution
Zhang et al. (2020)	China	Remote DBS post-op evaluation	Patients with prior mental health diseases	Possible tele-processing and refinements of the parameters	Possibly beneficial in DBS management	N/A

In Ashry et al. study from Egypt, the virtual post-operative outpatient clinic has been introduced with means of Facebook Messenger post-operative evaluation. Patients with no expected complications were checked in terms of clinical progress, return to work, wound status (with pictures provided by the patients), pain control, complications, treatment modification. In the end of the virtual visit the decision if next virtual/face-to-face/emergency visit is required was made. Regardless of the decision, all patients were equipped with the emergency contact number in case of a serious complication. The satisfaction questionnaires revealed high satisfaction with provided services both in patients and doctors groups (patients group: 100% respect privacy, saved time and money, met medical needs, 90% prefer telemedicine in future; doctors group: 90% satisfation with audio/visual applications, images provided by patients, 80% performed satisfying remote examination, overall satisfaction 95%). Only 6% of patients required an emergency visit in the hospital after making the emergency call. [9]

Study from USA by Mouchtouris et al. highlighted the differences between the application of telemedicine before and after the beginning of COVID pandemic. The Department observed over 40-fold increase of telemedicine usage (50 in 2019 to 707 in 2020) with home office devices and software, which enabled physicians to view the hospital records remotely from home environment, as well as videoconferences with the patients and nursing staff.

Excluding several technical issues, the promising results of the study allowed to schedule all future outpatient vistis via telemedicine means, not only as a follow up visit but also for new patients of the department. [10]

Another study from the USA by Glauser et al. introduces a telemedicine outpatient clinic system, which requires the attendance of the clinic coordinator, who equips patients with technical knowledge on the virtual procedures, scheduling of the visit, upload of the imaging to the BlueJeans system, and is responsible for coordination of the visit - from the virtual waiting room, through the history of present illness performed by the resident, to the main consultation performed by neurosurgeon. After the introduction of this complex system, the Department noticed in the 5^{th} week that the telehealth consultations consisted of 99% of all performed consultations. [11]

The study by Eichberg et al. and later addition with correspondence by Basil et al. from the same center also observed the significant increase in telehealth visits from 19% in week 1 to 72% in week 4. There were also significant differences noted between the spinal and brain tumor visits - spinal consultations converted to telehealth in 60%, while brain tumor consultations only in 30%. Among several reasons for this state, the incidental discovery of brain tumor, therefore more comprehensive examination in brain tumor patients vs higher awareness of symptoms in spinal disorders patients, as well as the reduction of services in neurology and oncology which may hypothetically lead to lesser discovery or new brain tumors, were noted. [7;12]

In study by Blue et al, there has been also observed a significant increase in provision of telehealth consultations (99% of new patients, 87% of returning patients consultations), with new challenges including various examinations which are difficult or impossible with means of telehealth (eg assessment of corneal reflex, visual fields, reflex testing etc), as well as verbal delay in communication as another possible technical difficulty to be considered. [13]

In another study from USA by Yoon et al. the protocol for the full virtual spinal examination has been presented. Prior to the consultation the patients should be equipped with the instructions, videos and diagrams of the examination movements and maneuvers, the physician should be provided with the electronic medical record. During the examination, the assistance of the family member or the caregiver would be necessary in some cases. The examination includes all the possible means to assess neurological symptoms virtually in real time or via video recording. This advancement allowed the Department to continue care for their patients (695 telemedicine visits and sporadic, emergency-only offline consultations). [14]

In correspondence from the UK by Ghimire et al, the patient's satisfaction was measured after 50 follow-up consultations held with telemedicine means. 50% of patients still prefered the face-to-face consultations, and only 1/3 of participants would prefer to have telehealth consultations instead. These outcomes may allow to introduce a hybrid consultation system in the future, which however has to think of a way of addressing the main challenge: communication with patients with language deficits. [15]

In correspondence from Zhang et al., the importance of telemedicine in Deep Brain Stimulation (DBS) management and follow-up was highlighted. Telemedicine proved to be an efficient tool in checkup of the parameters, batteries and mental health symptoms with tele-processing, virtual consultations and self-report assessment scales. Especially in these difficult times from the mental health perspective in terms of self-isolation and stress induced by the pandemic, mental health patients are a particularly vulnerable group which requires constant monitoring. Apart from the clinical assessment, patients could receive the psychological assessment and post-operative follow-up. In one presented case, unfortunately DBS failed to become a sufficient pharmacotherapy substitute, however it was possible to assess the needs and prescribe the new treatment with the telemedicine means. [16]

4.2 Legislative changes and recommendations on telemedicine in neurosurgery during SARS-CoV-2

In order to ensure the proper implementation of telemedicine, rapid legislative changes had to be made in certain countries. In neurosurgical literature, the legislative changes are described in two countries, USA and Poland. In the US example, with the declaration of the national public health emergency, the legislative changes- Coronavirus Preparedness and Response Supplemental Appropriations Act including the 1135 waiver authority, enabled American citizens to receive telehealth services in current circumstances, and waive or reduce the cost-sharing for those visits. [17-19] Three types of the telehealth services are considered: medicare telehealth visits for new and established patients, brief virtual check-ins to decide if in-person consultation is needed and e-visits through an online portal - both for previously established patients. [23] In study from Poland by Szmuda et al, the legislative changes regarding telemedicine changed on 11.03.2020 with a special decree of Ministry of Health which enabled the reimbursement of the telehealth visits held. However, as the decree still serves as the measure for the emergency state, existing laws are still not updated to the modern conditions. Excluding COVID-19 emergency, remote provision of services is considered a possibility only in emergency situations, according to Polish Code of Medical Ethics. The laws do not include the modern technology and possibilities which come with the advancements in field of telemedicine in recent years. [20]

A multicenter study by Mihalj et al. considers application of telemedicine not only in follow up of the chronic diseases, triage before admission, but also as a mean of preoperative assessment of the patient. Patient self-assessment of the basic measurements of temperature, blood pressure, heart rate, followed by remote monitoring of ECG, heart murmurs or glucose level, can help in minimizing time spent at the hospital for preoperative diagnostics as well as enable to modify the medication before surgery and monitor the following changes. Additionally, telehealth consultation could be a good solution to provide more detailed and efficient information about the surgery, which could allow more full understanding of the informed consent. The necessary imaging and laboratory tests should be scheduled and be performed in as short time as possible to minimize the amount of time patient has to spend at the hospital. [21]

5. Discussion - Concerns and Solutions

Telemedicine brings plenty of hope as well as plenty of concerns of medical, ethical, social and technical nature. Starting from the medical difficulties, multiple studies considered lack of proper training for physicians in performing remote examination, which can result in poor or improper results. [3;9] Standarization and validation of the virtual tests, scales and examinations is needed as only a few centers undertook the effort to construct and conduct original remote examination [17] It was noted that the US National Institute of Health Stroke Scale can serve as the sufficient base for the neurooncology remote examination, however for skull base abnormalities the more detailed cranial nerves examination as well as specific, more detailed extremities examination depending on the preexisting pathology, are needed additionally to the main examination. [22] Blue et al described following limitations of telemedicine examination: difficulties in corneal reflex and visual fields assesment, neuromuscular pathologies: difficulties in examination of tone, rigidity, peripheral strength, subtle signs of Parkinson's disease - rigiditiy, retropulsion pull testing; impossible to perform HINTs exam for vestibular syndrome and Dix-Hallpike for cerebellar examination. [13] Neurooncology is challenged with neuro-cognitive and linguistic deficits, which results in more difficult communication with the patients, with increased difficulty during the remote consultation [15] In spinal surgery it was noted by several authors that virtual spinal examination can miss the subtle neurologic deficits, only possible to examine and assess during face-to-face consultation [11;14] Additionally, it was mentioned that in order to limit the non-necessary emergency calls, the checklist of warning symptoms should be prepared and provided for patients, who can assess the necessity of emergency call themselves with the help of the checklist [9]

Speaking of ethical concerns, the main concern is related to the risk of disclosure of the sensitive data and violation of patient's privacy. [9] Depending on the countries technical resources, the virtual clinics have been conducted via hospital encrypted platforms, such as BlueJeans or MyChart, or the regular, non-encrypted messengers, like Facebook Messenger or Zoom. In the beginnings of the telemedicine in 1977 the diagnosis and recommendations were not disclosed until the in-person meeting, however, in recent situation it is important to forward the diagnosis or opinion as soon as possible, as the schedule of in-person consultation is hard to define. [3;14]

In the USA, the Coronavirus Preparedness Act enabled use of Google Hangouts, Facebook Messenger and other means of communication without the threat of violating Health Insurance Portability and Accountability Act (HIPAA) - however, for future use and in order to fully serve for all patients' rights and purposes, introduction of technical advancements is a vital step in telemedicine. [17;19] Ethical issues depend also on cultural differences, in various cultures female patients refuse telemedicine consultations also due to the lack of trust in privacy protection. [9] If the usage of telemedicine is incorporated in future health care, the important aspect should include patient's wishes and needs while offering this form of consultation, leaving the final choice of the mean of communication to the patient.

Every technological advancement leads to societal changes, and telemedicine is no exception. Following the will of the patient, the state of e-readiness is crucial for the patient and the system, to be willing to use this mean of communication. Two factors, which should occur for the change to happen, are the capacity to change, as well as the perceived need for change. [12] Education should play a vital role in enabling the change, as it was noted by many studies that so far the highest amount of concern was related to telemedicine as a technical challenge both for physicians and for patients. Socioeconomic factors may also contribute to the possible participation or lack of participation in the telehealth, both in terms of the states as well as in terms of individual patients, as the high-speed internet, various equipment and software is required. [10;12] This, however should not prevent the patients who lack technical resources, come from high illiteracy rate regions or lack technological skills, to receive the professional and efficient healthcare. [9] Telemedicine can also improve the workflow by optimizing the schedule of surgeons and other healthcare professionals, reduce the necessity for examination room spaces, front desk staff; yet it may also possibly increase the amount of no-shows, which lead to waste of health care resources. [10;17;23] It was also concluded that in the comparison studies, the remote physicians performed nearly twice more tests than the clinic physicians, which may lead to defensive style of practice and again, the uneven allocation of resources. [3] The laws should also be more flexible in terms of capacity to change, as they have shown to be the important limitation to the telemedicine introduction - from 2017 the multistate legislature on telehealth is available in United States however, it has been implemented only in 26 of the states and the licensing procedures fees have to be covered by the physicians themselves. [17] Changes in the legislature in terms of licensure, national funding of telehealth frameworks, and insurance coverage, should preceed telehealth introduction and pave the way for health care to conduct the best care possible. [4]

Telehealth, however, can bring also additional advantages apart from the disease treatment and management. It also brings the possibility for better education of physicians-observership opportunities for residents who can observe more diverse communication and management examples in virtual clinics, as well as the department can obtain the expertise of most experienced and knowledgeable retired neurosurgeons, who due to various circumstances could not be able to consult patients in person [6;13]

Mihalj et al proposed 5 factors vital to successful introduction of telemedicine in preoperative assessment, however, these factors can be the indicators for multiple and diverse use of telemedical services.

1) Ensured technological resources
2) Safe running software and internet platform
3) Healthcare trained in proper telemedicine use
4) Educated patients on telemedicine use
5) Elderly and patients with cognitive impairments properly addressed with special telemedicine means (or change to other means of communication) [21]

6. Conclusions

Telemedicine proved to be an efficient tool for the post-operative follow up as well as neurosurgical examination of new and returning patients in these difficult pandemic setting. It significantly reduced the risk of SARS-CoV-2 infection in neurosurgical patients, saved time, money and scarce resources. Future advancements can bring Artificial Intelligence, logic flows to schedule virtual visits, coordinate the virtual consultation, perform screening and even diagnostics, however authors agree that recently no virtual visit can replace the face-to-face communication, which is vital for successful doctor-patient relationship. Face-to-face visits strengthen this privileged relationship to become more multidimensional than just a symptoms check, and allow more detailed and more accurate examinations, which are not possible via telemedicine. Plenty of challenges of medical, ethical, social and technical concerns have to be solved before this technology is introduced in wider scale.

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