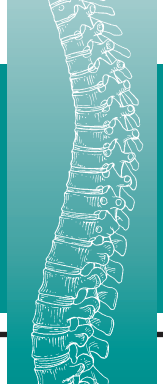
Contemporary Spine Surgery

VOLUME 22 ■ NUMBER 1 ■ JANUARY 2021



Telemedicine in Spine Surgery: Current Concepts and Future Directions

Roberto J. Perez-Roman, MD, Jason I. Liounakos, MD, and Michael Y. Wang, MD

LEARNING OBJECTIVES: After participating in this CME activity, the spine surgeon should be better able to:

1. Describe the critical components of a telemedicine encounter.
2. Explain the basic steps of performing a physical examination remotely.
3. Identify the disadvantages and future directions of telemedicine in spine surgery.

Key Words: Physical examination, Surgery, Telemedicine

From early attempts at transmitting electrocardiograph data over telephone wires in the early 20th century to the present day's rapid reorganization of health care delivery during the coronavirus disease-2019 (COVID-19) pandemic, advancements in telemedicine have risen to fulfill the needs of health care practitioners.[1] Telemedicine, defined as "the use of electronic information and telecommunications technologies to support long-distance clinical healthcare" continues to play a vital role in the care of patients across multiple medical specialties.[2] The ability to evaluate patients and construct treatment plans remotely remains an invaluable asset in the circumstances of the current COVID-19 pandemic. Our department initially reported a 96% decrease in clinical volume by the first and second weeks of April 2020, at the height of the COVID-19 pandemic. Recognizing the need to adapt to the current environment, we implemented a telemedicine program and by 1 month post-initiation we had recouped 70% of our previous clinical volume.[3] Modern-day telemedicine practices for neurologic disease build upon previous reports that demonstrate the ability of telemedicine to diagnose and treat multiple neurologic conditions, including stroke.[4]

Although telemedicine literature exists for a subset of medical specialties, well-designed studies addressing telemedicine protocols related to spine surgery, particularly with regard to safety and efficacy, are lacking.[5,6] Nevertheless, utilization has surged[3] due to the current worldwide health care crisis and telemedicine will likely become a permanent fixture in our practices. Therefore, we must all be prepared to adapt and innovate, as we have so many times before.

OPTIMIZING TELEMEDICINE FOR THE SPINE SURGERY PRACTICE

Coordination of a successful telemedicine encounter requires proper patient selection and understanding of the critical components required, herein divided into 5 discrete components (Figure 1). The first 3 are related to optimal preparedness for the impending clinical encounter. The initial component centers on appropriate patient selection for the telemedicine encounter. Although any patient may have the potential to benefit from telemedicine, the ideal candidate is one who falls in the middle of the spectrum of "neurosurgical acuity." For example, a patient with a recent onset radiculopathy without danger symptoms (bowel or bladder dysfunction, progressive or profound motor deficit) who has not undergone any conservative management may be an ideal candidate for a first encounter via telemedicine. In most cases, this patient would be prescribed a regimen of conservative management, while allowing adequate time for the potential resolution of symptoms before considering surgical intervention. Conversely, a patient with a foot-drop and/or bowel and bladder dysfunction should either be referred for an urgent in-person

Dr. Perez-Roman is a Resident, Dr. Liounakos is a Resident, and Dr. Wang is Professor, Department of Neurological Surgery, University of Miami Miller School of Medicine, Lois Pope Life Center, 1095 NW, 14th Terrace (D4-6), Miami, FL 33136; E-mail: mwang2@med.miami.edu.

The authors, faculty, and all staff in a position to control the content of this CME activity, and their spouses/life partners (if any), have disclosed that they have no financial relationships with, or financial interests in, any commercial organizations relevant to this CME activity.

Lippincott Continuing Medical Education Institute, Inc., is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. Lippincott Continuing Medical Education Institute, Inc., designates this enduring material for a maximum of 1.5 *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity. To earn CME credit, you must read the CME article and complete the quiz and evaluation assessment survey on the enclosed form, answering at least 70% of the quiz questions correctly. This activity expires on December 31, 2022.

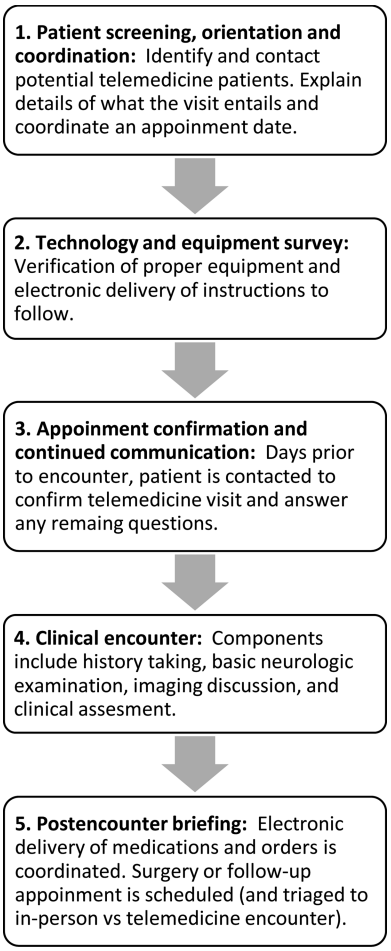


Fig. 1 *Telemedicine encounter timeline.*

visit or to a nearby emergency department, depending on the severity of the symptoms. At the other end of the spectrum, a patient referred for symptoms of axial back pain without any radiographic pathology may be best served by diversion to a different specialty. In the end, the decision is left to the provider's discretion; however, a refined method of triaging patients through coordinated efforts between clinic staff, surgeons, and mid-level practitioners may improve clinical efficiency and productivity.

The second component involves ensuring adequate technology and equipment availability on both sides of the encounter. For providers, this ideally includes an integrated teleconferencing platform within the electronic medical record. Although several teleconference platforms exist, our institution used Zoom, which was adapted to integrate with our electronic medical record. On the patient side, the simplest barrier to care—the availability of a high-definition camera—is negligible for the majority of patients with the inclusion of cameras in virtually all cellular phones and laptop computers.

It is the responsibility of clinic staff to communicate with the patient and ensure that the appropriate equipment, connectivity, and applications are available and downloaded before the visit. Communication remains a primary directive of the clinic staff in the days leading up to the encounter, ensuring that all questions are answered and the patient is prepared for the visit (component 3).

This continuing education activity is intended for orthopaedic and neurologic surgeons and other physicians with an interest in spine surgery.

Wolters Kluwer

Contemporary Spine Surgery (ISSN 1527-4268) is published monthly by Wolters Kluwer Health, Inc., at 14700 Citicorp Drive, Bldg 3, Hagerstown, MD 21742. **Customer Service: Phone (800) 638-3030, Fax (301) 223-2400, or E-mail customerservice@lww.com.** Visit our website at LWW.com.

Publisher: John Ewers

Suscription rates: *Individual:* US $522; international $683. *Institutional:* US $1142, international $1402. In-training: US resident $169 with no CME, international $193. Single Copies $118. Registration Number: 895524239.

The culmination of the telemedicine preparedness components is the encounter itself (component 4). The patient history, physical examination, and relevant imaging studies represent 3 critical pillars in the evaluation and subsequent treatment of any spine patient. Fortunately, modern telemedicine lends itself well to all 3, with some minor modifications.

The visit is patient-initiated, and a verbal consent should be obtained as Medicare coinsurance and deductibles are applicable. It is recommended to use 2-factor identification, such as name and date of birth, before starting the encounter.[7] Usually, it is beneficial to have a companion present to help with the various tasks of the visit and will act as a witness to the medical discussion. The patient history is obtained in a similar fashion as during an in-person visit. The imaging review is also performed in the same manner as an in-person visit largely due to modern web-based conferencing technology, allowing the physician to share their computer screen with the patient and review the patient's digital imaging along with them. This facilitates the patient's understanding of their condition and directly engages them in their own care. The main component requiring modification, the physical examination, is discussed in the next section.

The final component of the encounter, the "postencounter briefing," serves as a recap and again involves the coordination of clinic staff, physician, and patient to execute a clinical plan. In general, the plan may involve:

1. Conservative management or referral to another provider with follow-up as needed;
2. Scheduling an in-person visit for a thorough physical examination and/or further diagnostic studies as dictated by case complexity; or
3. Direct scheduling for surgery, with final in-person physical examination to be completed the day of surgery.

At the end of the encounter, a formal note should be documented for the usual medical and legal purposes.

NEUROLOGIC EXAMINATION

One of the most critical components of any surgeon-patient encounter is the physical examination. Established dogma dictates that the physician must lay hands on the patient to truly understand their unique human condition. This obviously is not possible through a remote encounter. However, the same innovative thinking that has brought us this far may allow this hurdle to likewise be overcome. Literature exists to support the ability to examine patients through telemedicine.[8] Various studies have confirmed that a basic neurologic examination can be performed via an audio-video platform with excellent interobserver reliability.[9] The imminent value of such remote examinations may be in identifying profound neurologic deficits such as a foot-drop by asking the patient to perform simple maneuvers such as ankle dorsiflexion (Figure 2), either through verbal instruction or even visual cues. Correlating such examination findings with critical patient history such as the presence of bowel and bladder incontinence may allow surgeons to catch urgent and emergent clinical situations and direct patients appropriately. In most cases, however, an adequate examination

Fig. 2 *Basic examination maneuvers during a telemedicine visit. A–C, Evaluation of plantar- and dorsiflexion under a patient's own body weight. D, E, Heel-to-shin test. F, G, Proximal upper and lower extremity can be assessed with simple flexion movements. H–J, Use of a chair can assist in the examination of multiple lower extremity groups.*

even for less obvious pathology may be performed within the constraints of the telemedicine encounter.

The first component of the neurologic examination, the mental status examination, is easily obtained through verbal cues and physician observation of the patient throughout the encounter.

Although completing a cranial nerve examination remotely requires some creativity, obvious and even subtle deficits may be uncovered through both observation and simple verbal cues. The most readily examinable cranial nerves are those involved in motor function where obvious deficits and symmetry can be observed, including the extraocular muscles (III, IV, and VI), facial musculature (VII), palate (X), trapezius (XI), and tongue (XII). Remote evaluation of olfactory (I), optic (II), trigeminal (V), vestibulocochlear (VIII), and glossopharyngeal (IX) nerves is more challenging and requires careful patient history and targeted questioning as a surrogate.

Cerebellar testing may be performed through evaluation of the heel-to-shin maneuver or rapid, alternating finger movements. Similar to the in-person examination, evaluation of symmetry is critical. Posture and gait can be evaluated by having the patient stand and walk while in direct view of the camera. However, caution should be exercised with maneuvers that could potentially result in injury, such as asking a patient with proprioceptive or vestibular dysfunction to perform a Romberg's test.

Although confrontational muscle strength testing is not highly accurate, gross motor examination can be performed over video to ensure proximal upper and lower extremity strength is at least antigravity (Figure 2).[7] A targeted patient history again may serve as a surrogate for more subtle parts of the physical examination including evaluation of fine motor function. A more detailed lower extremity examination can be acquired by asking the patient to stand up from a chair without using the upper extremities and through evaluation of plantarflexion and dorsiflexion against the patient's own body weight. A comprehensive sensory examination can be challenging, but some basic functions can be tested. The ability to discern light touch and pinprick can be assessed by having a companion use an alcohol swab and toothpick, respectively, in different dermatomes of interest; however, the validity of these tests has yet to be established.

PATIENT SELECTION AND BENEFITS

Routine follow-up including initial postoperative visits may also be easily performed through telemedicine. As outpatient surgical procedures become more commonplace and the need to ensure patient safety and well-being after discharge grows,[10] so too will the role of remote follow-ups. Instances of the benefits of this type of follow up are evidenced by Martinez-Ramos et al,[11] who demonstrated that remote wound monitoring after ambulatory surgery has the potential to reduce unnecessary postoperative hospital visits by 50%.

Using this technology as a way to better engage and increase satisfaction among patients is also critical. A recent survey of patients with chronic neurologic conditions demonstrated that 92% favored telemedicine services and viewed them as a way to save significant amounts of time and money, with the majority preferring to continue their care in this manner.[12] Avoiding the typical long wait times in hospitals and clinics, often conflicting with transportation services, may serve to increase overall patient satisfaction metrics and benefit all parties involved.

Several studies have demonstrated that telemedicine may improve clinical outcomes and result in considerable savings in overall costs.[13] Additionally, telemonitoring has demonstrated an ability to not only reduce the number of emergencies and unplanned admission of patients, but also decrease the burden of visits to hospitals and health centers.[13] Perhaps even more impactful is that telemedicine may increase access to quality spine care for patients in rural areas without local neurosurgical services.[6,14] Olldashi et al[14] showed that nearly 590 neurotrauma patients benefited from remote evaluation in facilities lacking neurosurgery services. More importantly, approximately 70% of the patients were successfully treated locally by nonneurosurgeons as a result.[14] Although the possibilities are seemingly endless, future high-quality studies are still required to assess the impact and utility of telemedicine in spine surgery, as literature on this topic remains scarce.[15]

DISADVANTAGES AND CONSIDERATIONS

Establishing an effective telemedicine practice requires significant resources. It involves the appropriate selection of equipment, network design, training of the health personnel, maintenance of technical services, and support to address any infrastructural issues.[3,16] In addition, patients must be familiar and proficient with the necessary technology. Patient confidentiality is also a concern and providers must ensure the security of data transmission and storage. To this end, providers should always obtain informed consent specific to each telemedicine encounter. Furthermore, some physicians may find it challenging to establish rapport with their patients over this platform.

With respect to the physical examination, there are many technical maneuvers that cannot be reliably performed remotely, potentially limiting the completeness of an assessment. In this case, an in-person follow-up visit may be required. With regard to telemedicine reimbursements, much uncertainty currently exists, and reimbursements for Medicaid beneficiaries and privately insured patients are widely variable.[6] Historically resistant, but currently mobilized by the COVID-19 pandemic, some the largest health insurance providers have announced telemedicine reimbursements to parallel the current reimbursement structure, at least for the time being.[17]

FUTURE DIRECTIONS

As spine surgeons become more comfortable and understanding of what telemedicine provides, its role in patient care will expand. For example, use of telemedicine for routine follow-up visits or to "prescreen" patients for an in-person encounter may increase surgeon productivity and efficiency. Moreover, saving patients' travel and wait times will likely directly

increase interest in pursuing telemedicine services and may also have a positive impact on a patient's review of their clinical experience. In a health care system that is increasingly focusing on a value-based care model for reimbursements, this could have significant implications. In fact, a Press Ganey "Telemedicine for Medical Practice" survey was published in 2018, in some ways foretelling the future importance of telemedicine in clinical practice.[18]

It remains to be seen whether the surge in telemedicine services offered as a result of the COVID-19 pandemic will find a permanent place in our health care system; however, the future is bright. Some of the potential benefits to telemedicine have been seen before, including telemedicine for trauma services, increasing access to care in countries without readily available neurosurgical services.[14] An integrated approach with the involvement of current residents and medical students provides an opportunity to participate in an advancing field.[19] Future studies focusing on the impact of telemedicine on patient outcomes will dictate how this technology is incorporated into spine surgery moving forward.

CONCLUSION

Telemedicine continues to have an incremental role in various specialties, including spine surgery. The lack of literature regarding telehealth in the context of treating patients with spine pathology presents opportunities for future research that will directly influence the incorporation of this modality into our practices.

REFERENCES

1. World Health Organization. *Telemedicine: Opportunities and Developments in Member States. Report on the Second Global Survey on eHealth.* Geneva, Switzerland: World Health Organization; 2010.
2. Health IT. What is telehealth? How is telehealth different from telemedicine? https://www.healthit.gov/faq/what-telehealth-how-telehealth-different-telemedicine. Accessed May 19, 2020.
3. Basil GW, Eichberg DG, Perez-Dickens M, et al. Letter: implementation of a neurosurgery telehealth program amid the COVID-19 crisis—challenges, lessons learned, and a way forward. *Neurosurgery*. 2020;87(2):E260-E262.
4. Demaerschalk BM, Bobrow BJ, Raman R, et al. Stroke team remote evaluation using a digital observation camera in Arizona: the initial mayo clinic experience trial. *Stroke*. 2010;41(6):1251-1258.
5. Debono B, Bousquet P, Sabatier P, et al. Postoperative monitoring with a mobile application after ambulatory lumbar discectomy: an effective tool for spine surgeons. *Eur Spine J*. 2016;25(11):3536-3542.
6. Kahn EN, La Marca F, Mazzola CA. Neurosurgery and Telemedicine in the United States: assessment of the risks and opportunities. *World Neurosurg*. 2016;89:133-138.
7. Roy B, Nowak RJ, Roda R, et al. Teleneurology during the COVID-19 pandemic: a step forward in modernizing medical care. *J Neurol Sci*. 2020;414:116930.
8. Weinstein RS, Krupinski EA, Doarn CR. Clinical examination component of telemedicine, telehealth, mHealth, and connected health medical practices. *Med Clin North Am.* 2018;102(3):533-544.
9. Awadallah M, Janssen F, Korber B, et al. Telemedicine in general neurology: interrater reliability of clinical neurological examination via audio-visual telemedicine. *Eur Neurol*. 2018;80(5-6):289-294.
10. Goz V, Spiker WR, Brodke D. Mobile messaging and smartphone apps for patient communication and engagement in spine surgery. *Ann Transl Med*. 2019;7(suppl 5):S163.
11. Martinez-Ramos C, Cerdan MT, Lopez RS. Mobile phone-based telemedicine system for the home follow-up of patients undergoing ambulatory surgery. *Telemed J E Health*. 2009;15(6):531-537.
12. Davis LE, Coleman J, Harnar J, et al. Teleneurology: successful delivery of chronic neurologic care to 354 patients living remotely in a rural state. *Telemed J E Health*. 2014;20(5):473-477.
13. Farabi H, Rezapour A, Jahangiri R, et al. Economic evaluation of the utilization of telemedicine for patients with cardiovascular disease: a systematic review [published online ahead of print November 23, 2019]. *Heart Fail Rev*. doi:10.1007/s10741-019-09864-4.
14. Olldashi F, Latifi R, Parsikia A, et al. Telemedicine for neurotrauma prevents unnecessary transfers: an update from a nationwide program in Albania and analysis of 590 patients. *World Neurosurg*. 2019;128:e340-e346.
15. Dario AB, Moreti Cabral A, Almeida L, et al. Effectiveness of telehealth-based interventions in the management of non-specific low back pain: a systematic review with meta-analysis. *Spine J*. 2017;17(9):1342-1351.
16. Chen S, Cheng A, Mehta K. A review of telemedicine business models. *Telemed J E Health*. 2013;19(4):287-297.
17. Daggubati LC, Eichberg DG, Ivan ME, et al. Telemedicine for outpatient neurosurgical oncology care: lessons learned for the future during the COVID-19 pandemic. *World Neurosurg*. 2020;139:e859-e863.
18. Press Ganey. Telemedicine for Medical Practice Surveys Frequently Asked Questions. https://www.pressganey.com/docs/default-source/default-document-library/telemedicine-for-medical-practice_faqs_040918.pdf.
19. Kondziolka D, Couldwell WT, Rutka JT. Introduction. On pandemics: the impact of COVID-19 on the practice of neurosurgery [published online ahead of print April 10, 2020]. *J Neurosurg.* doi:10.3171/2020.3.JNS201007.

CME Quiz

To earn CME credit, you must read the CME article and complete the quiz and evaluation assessment survey on the enclosed form, answering at least 70% of the quiz questions correctly. **Select the best answer and use a blue or black pen to completely fill in the corresponding box on the enclosed answer form.** Please indicate any name and address changes directly on the answer form. If your name and address do not appear on the answer form, please print that information in the blank space at the top left of the page. Make a photocopy of the completed answer form for your own files and mail the original answer form to Wolters Kluwer Health, Continuing Education Department, P.O. Box 1543, Hagerstown, MD 21741-9914 by **December 31, 2022.** Only two entries will be considered for credit. For more information, call (800) 638-3030.

Online quiz instructions: To take the quiz online, **log on to your account at www.cssnewsletter.com**, and click on the "CME" tab at the top of the page. Then click on "Access the CME activity for this newsletter," which will take you to the log-in page for **http://cme.lww.com**. Enter your ***username*** and ***password.*** Follow the instructions on the site. You may print your official certificate ***immediately***. Please note: Lippincott CME Institute, Inc., ***will not*** mail certificates to online participants. **Online quizzes expire on the due date.**

The American Association of Neurological Surgeons (AANS) manually tracks *AMA PRA Category 1 Credits*™ earned from neurosurgery activities not sponsored or joint-sponsored by the AANS. As a service to AANS members, Lippincott CME Institute will continue to provide the AANS a monthly listing of their participants and the CME credits they earned so that AANS members do not have to send their individual certificates to the AANS for tracking.

Credits related to activities on orthopaedics may be applied to American Board of Orthopaedic Surgery Maintenance of Certification. Please confirm credit for specific activity with the Board at www.abos.org.

1. All the following are basic components of a successful telemedicine routine, *except*
- A. patient screening
- B. technology and equipment survey
- C. preappointment communication
- D. postencounter briefing
- E. family history identification

2. Which one of the following patients would be *most* suitable for a spine telemedicine evaluation?
- A. 48-year-old man with a 1-day history of foot drop
- B. 35-year-old woman with 12 hours of urinary incontinence
- C. 62-year-old woman with acute paraplegia after a fall at home
- D. 21-year-old man with mechanical back pain without any imaging
- E. 65-year-old man 2 weeks after C5-C6 ACDF without any symptoms and requires a wound check

3. Which one of the following medical specialties has evidence to support the use of remote video basic evaluation with excellent interobserver reliability?
- A. Chiropractic
- B. Ophthalmology
- C. Neurology
- D. Pathology

4. It is recommended to use 2-factor identification at the start of a telemedicine visit. Which one of the following is a suggested method of 2-factor identification?
- A. Name and date of birth
- B. Sex and age
- C. Age and home address
- D. Medical history and name

5. A basic neurologic examination cannot be done via telemedicine.
- A. True
- B. False

6. Remote wound monitoring can decrease unnecessary visits to the hospital.
- A. True
- B. False

7. Which one of the following is a potential advantage of a telemedicine encounter?
- A. Detailed neurologic examination can be performed.
- B. No technology is required.
- C. Telemedicine is an easy method to establish patient rapport.
- D. Telemedicine may result in considerable savings in overall costs.

8. All of the following are disadvantages associated with telemedicine, *except*
- A. requirement for appropriate equipment
- B. requirement for proper network design
- C. training of health personnel
- D. continued maintenance of technical services
- E. possible evaluation of patients in areas with a lack of certain subspecialties

9. Patients who need a detailed neurologic examination should be evaluated in a clinic setting.
- A. True
- B. False

10. Scientific literature demonstrating use of telemedicine in spine surgery is scarce.
- A. True
- B. False