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## Letter to the Editor: How is COVID-19 Going to Affect Education in Neurosurgery? A Step Toward a New Era of Educational Training



### LETTER:

Despite being underestimated during the isolation of the first cases in Wuhan, China, back in December 2019, severe acute respiratory syndrome coronavirus (i.e., SARS-CoV-2) has dramatically changed the world from that moment. Currently, approximately half of the world's population is or has been in some form of lockdown with almost all countries imposing travel restrictions in an attempt to retard the spread.<sup>1</sup>

The medical staff has always been at higher risk of contagious diseases compared to the general population. Knowing that coronavirus disease 19 (COVID-19) can be transmitted even from asymptomatic individuals, the risk is multiplied,<sup>2</sup> evaluated to be approximately 29% higher.<sup>3</sup> As a consequence, this pandemic has necessitated a dramatic paradigm shift in terms of interaction among health care professionals. Many medical offices have either made the transition to telemedicine or greatly reduced their patient volumes to accommodate the widely accepted "social distancing" recommendation by the World Health Organization and the U.S. Centers for Disease Control and Prevention.<sup>4,5</sup> Hospitals are developing screening and contingency plans for clinical medicine, but what about the education of our colleagues and our trainees during this time of uncertainty?

COVID-19 has forced us to rapidly adapt, integrate, and use technology to help us survive during these challenging times. To avoid an interruption of residency and fellowship training programs in neurosurgery, it has been imperative to find a strong integration among the different technologies and tools now available. Here we briefly discuss the emerging educational delivery methods and the utilization of technology platforms, some that already exist, and some that must be developed further in response to the COVID-pandemic.

### ONLINE MEETINGS

Because of the full schedules of residents in neurosurgery, it is very difficult for them to attend daily or weekly educational activities or even multiple conferences under normal circumstances. In fact, trainees have variable timetables, often making attendance of educational activities, such as grand rounds and journal clubs, difficult and stressful. Virtual attendance using web-based services may be helpful to overcome these issues.

Virtual meetings allow us to connect and educate the future class of neurosurgeons from the safety of their own homes. In such a difficult moment, it should be asked how we could improve the use of virtual meetings up to the point of allowing conferences at national and international scales. Another point of discussion should be the real possibility of these new types of meetings to become the new standards, somehow offering the same benefits of physical encounters, such as case-based panels with questions and answers, and the possibility of networking for the younger doctors.<sup>6</sup> Some of the possible flaws could include the risk of

losing the passion of live question and answer sessions, due to broadcasting delays, and the decision of some presenters to answer to selected questions, which may be found frustrating to the public. All virtual meetings will be considerably different from the traditional ones in which there are the chances to see live surgeries in which faculty members could allow a focus on the more important questions, guiding the younger public through the subtleties of the technique performed.

Attending congresses and educational sessions allow younger trainees and doctors to detach completely from the job's duties and focus in a rigorous way in the training session. Even if the assumptions of these technologies are great, there are still a lot of questions that are waiting for an answer, such as if the same feeling of involvement could be achieved, if the environment could be a strong source of distraction, if there will be any technological malfunction that will take away from the educational experience, and if the responsibility to report to work will take over.

As a profession, we must critically evaluate the value of face-to-face interaction and whether virtual meetings can serve as a substitute, particularly in a field that is dependent on human interaction and technical skills. Additionally, we must ask ourselves if these technology platforms afford the same networking opportunities as an in-person event.

### E-LEARNING

Because of the pandemic, all the universities in countries where lockdown has been established had to include distance learning as part of the curriculum. Many neurosurgical societies and associations have also already added educational materials on their websites.<sup>7</sup> E-learning is based on using technologies to educate a certain class of people outside the traditional spaces. One of the potential advantages of this form of learning is that the teachings can be live or can be prerecorded, allowing participants to both see the lectures at their own pace and even provide the opportunity to go back and review what they have already learned. Also, this modality can claim the advantage of having already several programs that are commonly used, such as Blackboard, Moodle, Vista, or Angle. These programs allow some forms of interaction because they present features such as chat and messaging.<sup>8</sup> E-learning opportunities are not limited to these procedures; in fact, webinars and podcasts can be added to this list of educational tools for participants. Obviously, the attendance of these sessions can be recorded, allowing also to provide continuing medical education (i.e., CME) credits. Also, in this case, this type of technology allows overcoming problems related to locations and scheduling constraints, also reducing in a significant way the associated costs. E-learning platforms could be also used to try to provide a more heterogeneous formation among the different programs, which could also rely on national and international experts.

Technology is a powerful tool that will likely emerge to enhance educational experiences but should not serve to be the sole replacement.

### SIMULATION-BASED TRAINING

The last decades have been characterized by a significant general evolution of neurosurgery. This allowed significant upgrades in

patient care and the spectrum of surgeries. All these implementations made it extremely difficult for residents to master all the operative techniques in a limited time.<sup>9</sup> Further, legal accountability for medical services and patient safety monitoring has placed increased pressure on operational performance and outcomes. The restrictions imposed with social distancing and the availability and cost of cadavers for training also pose significant difficulties in the neurosurgical formation. Disastrous situations, like the COVID-19 pandemic, could disrupt traditional teaching that occurs in the university hospitals, as well as affect the typical mentor-mentee relationship.

Simulation-based training programs are undergoing rapid evolution. Neurosurgical residents have the possibility to exercise on different common surgical procedures with no clinical risks.<sup>10</sup> This technology can boost the surgeon's confidence and reduce the steepness of her or his learning curve, especially with technically demanding procedures.<sup>10</sup> These simulations are not resident-dependent; in fact, they need to be supervised by experts who should be able to evaluate the performance of residents and suggest to them how to improve their skills. Residents' performance should be also recorded, not only for the supervisors' evaluation, but also to be able to track signs of progress over time. Despite being a very promising technology able to influence neurosurgical training, several barriers still need to be defeated, such as the high cost of the acquisition, the significant amount of space that many hospitals and programs do not have for its installation, and the fact that even the most modern simulators allow the performance of only a few specific procedures.

Even if it is a well-established area, there is still the need to study to better understand if the skills learned on the simulators could be transferred in the operating rooms.<sup>11,12</sup> Other concerns arise about the use of surgical simulators, such as the fear that they can compromise the learning of nontechnical skills essential to patient care and the need to find the right balance between the simulation-based, cadaveric skills training, and live surgical cases.

#### VIRTUAL AND AUGMENTED REALITY

Even if they started to be appreciated in medical fields only in the most recent years, virtual reality (VR) technologies have been widely used in other fields, such as entertainment industries, for some time already, with great results. VR aims to make the subject visualize a realistic 3-dimensional environment, able to provide feedback from the subject's actions.<sup>13</sup> In more recent times, VR technologies started to also be used in surgical fields, allowing an enhanced training of surgical skills.

The advantage of VR is that it can provide both augmented reality and/or mixed reality. Differently from the mixed reality, augmented reality provides an enhancement of the educational experience through the overlying of a real clinical environment. Despite being a futuristic technology, there are already different types commercially available, including Oculus Rift, HTC Vive, and Microsoft HoloLens.

Despite its important costs, VR can help in overcoming several problems of the present education of neurosurgical trainees, providing a safe environment where mistakes are allowed, improving the constructive learning experience.<sup>14</sup> It is important

to highlight the logistical advantage because VR can overcome some of the challenges of simulator-based training previously mentioned making it more easily accessible. However, we should not hurry and wait and see if future studies will state that VR can surpass simulator-based training methods.

It is possible to imagine that in a near future, virtual meeting platforms can be combined with VR technology to provide participants with a real-time feel compared to watching a screen, improving different aspects of the meetings, such as watching live surgeries, and being able to interact with the surgical team.

#### MOBILE DEVICES

Currently, it is widely accepted that mobile-based apps are to be considered an important source of learning for residents.<sup>8</sup> These software present several advantages, such as quick and generally cheaper access to educational materials, such as journals, e-books, and surgical videos. Several mobile apps are already available, helping surgeons in navigating conferences and tailoring the event to one's specific educational needs. These technologies have not only been used in clinical settings, as health care industries started to use them to allow surgeons to virtually tour their exhibit booth or to help surgeons familiarize themselves with surgical equipment and techniques.

Apps are not only used for educational purposes because they have also been used by surgeons to improve their experiences in the operating rooms. These apps can also help to improve team working as the surgeon can share the plan and instrument's details with the entire surgical team. Smartphones and social media networks are currently an integrated part of daily medical life. These social networks could help young trainees solve difficult clinical cases, as well as to create long-term meaningful contacts with experienced neurosurgeons. However, it is important to keep patient privacy as a priority.

#### GLIMPSE FROM THE HUMAN SIDE: ANNUAL MEETINGS

Annual meetings remain one of the fundamental pillars of medical organizations and associations. These meetings allow identifying yearly progress, recognizing leaders in scientific accomplishments, and to reconnect with each other. The mission of the main neurosurgical associations comprehends the duty to advance the art and science of neurosurgery through education, skills assessment, and advocacy. Can all this be done over a computer screen? This remains a difficult question to answer, particularly due to the current situation. The recommendations to maintain a safe meeting might range from taking participants' temperatures onsite, answering questionnaires, checking vaccination documents, social distancing and wearing masks and gloves, and possibly much more. When or if the immediate threat is gone, many will agree it might be time to assemble again, but with caution. One of the main reasons for which we attend meetings is the opportunity to interact and network. It would be difficult to think of neurosurgical meetings without the opportunity of stimulating debates between the old guard and the new one, and without discussing future technological developments with health care industry representatives.

Up until now, the commonly used technological solutions were not "appealing" enough. VR with the use of holograms could be

one way surgical demonstrations can move forward, as already stated. By simply placing a personal VR mask on our head, we can be virtually walking down the hall of the congress, seeing the exhibit area, and talking to vendors, which is no different from the way it used to be. This convenience can all be done from the comfort of your own home. The future might have the solutions for a contact-free annual meeting utilizing virtual 3-dimensional environments but it could come at a great cost.

## SUMMARY

The future of neurosurgical training is rapidly evolving. This evolution is partially due to the increasing integration with technologies and its strong innovation abilities. The modern society puts an increasing pressure on surgical staff to deliver high-quality patient care, and, to do so, it is important to find new ways to educate and train neurosurgeons nationwide. Because of the strong evolution of our specialty, neurosurgeons have to keep themselves updated on the newest findings. National and international neurosurgical societies and teaching institutions worldwide should consider utilizing the earlier mentioned methodologies and more to enhance education and training.

For the majority of us, we may remember 2019 as the last real meeting. The next year, 2021, could perhaps be a new era of hybrid meetings. However, 2020 is the year in which we could decide what we could include from the past and what we need to change.

## CRedit AUTHORSHIP CONTRIBUTION STATEMENT

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## REFERENCES

- World Health Organization. Coronavirus disease (COVID-19) outbreak situation. Available at: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>. Accessed June 1, 2020.
- Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): the epidemic and the challenges. *Int J Antimicrob Agents*. 2020;55:105924.
- Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020;323:1061-1069.
- Centers for Disease Control and Prevention. Public health guidance for potential COVID-19 exposure associated with international travel or cruise travel. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/php/risk-assessment.html>. Accessed April 2, 2020.
- World Health Organization. Coronavirus disease (COVID-19) advice for the public. Available at: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>. Accessed April 2, 2020.
- Plancher KD, Shanmugam JP, Petterson SC. The changing face of orthopedic education: searching for the new reality after COVID-19 [e-pub ahead of print]. *Arthrosc Sports Med Rehabil*. <https://doi.org/10.1016/j.asmr.2020.04.007>, accessed January 6, 2020.
- Tomlinson SB, Hendricks BK, Cohen-Gadol AA. Editorial. Innovations in neurosurgical education during the COVID-19 pandemic: is it time to reexamine our neurosurgical training models? *J Neurosurg*. 2020;133:1-271.
- Moran J, Briscoe G, Peglow S. Current technology in advancing medical education: perspectives for learning and providing care. *Acad Psychiatry*. 2018;42:796-799.
- Todnem N, Nguyen KD, Reddy V, Grogan D, Waitt T, Alleyne CH. A simple and cost-effective model for ventricular catheter placement training: technical note [e-pub ahead of print]. *J Neurosurg*. <https://doi.org/10.3171/2020.2.JNS19161>, accessed January 6, 2020.
- Grosch AS, Schröder T, Schröder T, Onken J, Picht T. Development and initial evaluation of a novel simulation model for comprehensive brain tumor surgery training [e-pub ahead of print]. *Acta Neurochir (Wien)*. <https://doi.org/10.1007/s00701-020-04359-w>, accessed January 6, 2020.
- Patel EA, Aydin A, Cearnas M, Dasgupta P, Ahmed K. A systematic review of simulation-based training in neurosurgery, part 1: cranial neurosurgery. *World Neurosurg*. 2020;133:e850-e873.
- Patel EA, Aydin A, Cearnas M, Dasgupta P, Ahmed K. A systematic review of simulation-based training in neurosurgery, part 2: spinal and pediatric surgery, neurointerventional radiology, and nontechnical skills. *World Neurosurg*. 2020;133:e874-e892.
- Aarseth E. Virtual worlds, real knowledge: towards a hermeneutics of virtuality. *Eur Rev*. 2001;9:227-232.
- Zaed I. COVID-19 consequences on medical students interested in neurosurgery: an Italian perspective [e-pub ahead of print]. *Br J Neurosurg*. <https://doi.org/10.1080/02688697.2020.1777260>, accessed January 6, 2020.