SPECIAL ISSUE

Neurology and Telemedicine: The Way Forward

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Abstract

***Objective*:** During the coronavirus-2019 (COVID-19) times, we have all learned to appreciate the advantages of communicating with each other on the digital or virtual format. This included both social, commercial and professional settings. This was necessitated through the restrictions on direct physical contact mandated by the pandemic. Through innovations and adaptations, the practice of medicine has also changed with telemedicine, triggered by 'necessity is the mother of invention' concept being embraced by both patients and physicians. Neurology, traditionally seen as a complex speciality and the preserve of a couple of thousand practising neurologists in the country, has opened itself up to the telemedicine or tele-neurology format very easily in the anecdotal and a few pilot studies conducted globally and in India.

***Design*:** Despite the initial misgivings and anticipation of patient reluctance to adopt this technology, the real-world experience has been, to the contrary, where both young and old patients have readily embraced the new medium and cooperated with the neurologists to improve their care, which would otherwise have been severely restricted in the COVID-19 times. The neurologists have also adapted to the new way of working to deliver optimum diagnosis and care plans.

***Outcome measures*:** There have been technical glitches (in form of internet connectivity, smartphone hardware and software problems and lighting and camera angle and image stabilization issues to name a few), which have been reduced with practice and innovation. Feedback from neurologists, patients, and their carers via regular audits and questionnaires are being circulated, and practice parameters are being improved (IFNR survey- Ref 5). The contribution of national regulatory agencies, such as the Ministry of Health and Family Welfare (MoHFW), and stakeholders, such as the Telemedicine Society of India (TSI), has been phenomenal to facilitate the tele-neurology practice and make it safe for all stakeholders.

***Results*:** In a country of 1.37 billion population and only 2,500 accredited neurologists, there is a need for tele-neurology to be able to serve patients living in remote areas in mountains and coastal areas, and also in poorly connected areas on the plains. This becomes paramount for patients requiring specialised acute neurological care and to improve access, which now becomes a practical feasibility on the digital format to bring neurology to the doorsteps of the people.

Follow-up care of patients, epidemiological studies of various neurological chronic illnesses and their audit will become realities cutting down on costs and time to access quality neurological care using the digital format for 21st-century India.

***Conclusions*:** Tele-neurology is no longer a vision, but a reality precipitated by the pandemic, the needs and aspirations of the Indian population, and the technological infrastructure India has achieved in the last 20 years.

Keywords: *COVID-19*; *India*; *internet*; *neurologist*; *tele-neurology*

Tele-neurology was conceived as an idea nearly two decades ago (1). However, its practice never took off through a combination of physician inertia and a lack of acceptance of new ways of working (2, 3). Overreliance on neurodiagnostics led to perpetuation of the face-to-face consultation mode. Coronavirus-2019 (COVID-19) has changed the entire healthcare delivery model as both physicians and patients were compelled to

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accept the 'new norm' (4). Initial hopes that the crisis would soon blow over were replaced by acceptance of alternative modes of patient interactions, which would be the new way of working. This has led to neurologists and our colleagues – allied healthcare professionals, nursing staff, administrators and support staff – beginning to value the benefits of the 'the new norm'. These data are emerging from audits conducted recently under the auspices of the Indian Federation of Neurological Rehabilitation (5). Patients also have welcomed the new doctor–patient interaction format, as they increasingly value the convenience of the virtual platforms of receiving equivalent levels of service from medical personnel without travel and waiting time hassles.

New standards of care and benchmarking have been established for specialities, including neurology, to ensure that the standards of care evolve to reflect the new working practices (6). Issues of medicolegal boundaries, clinical care standards, patient privacy and trust, and modified examination techniques to blend in with the virtual format are challenges that have arisen, and these have been majorly overcome within a short space of time through flexibility exhibited by both patients and physicians. Anxieties of adopting new ways of working seem to be the major barrier in the smooth transition. New legislation endorsing and legalising telemedicine practice and laying down guidelines has majorly helped in this transition (7).

The major issue of ensuring safety for both the medical service providers and staff in the hospitals, as well as for the patients, has necessitated strict hygiene and social distancing to avoid disease spread in those patients who have to come to hospitals or need in-patient care. We observe a gradual acceptance of these novel working standards among healthcare staff, our patients and their carers (8).

Methods

The neurology consultation

Traditionally, the neurology assessment is predominantly based on history elicitation. In the face-to-face contact, in addition to the verbal history, the non-verbal communications, including body language and facial expression, helped to establish a meaningful doctor–patient relationship built on trust and responsibility (9). This has been a limitation on the virtual format. In addition, issues of consent and identity verification, which were implied in the face-to-face interaction, have to be rigorously spelt out in the virtual interactions.

Protocols have been developed from the American Academy of Neurology telemedicine workgroup recommendations way back in 2017, with suggestions for a model curriculum (10, 11). This suggested evaluation equivalency to various modules so that we are able to work efficiently in a technologically rich environment. These models test knowledge of technology and its basic implementation and limitations, licensures, medical issues and ethics, 'website manners', patient privacy and disclosures, and the assistance of tele-presenter (healthcare professional co-located with the patient) – these have been structured before the COVID-19 pandemic.

The neurological examination

It is recommended that both the neurologist and the patient appreciate the limitations of tele-neurology (3). Laws have been enacted by the government of India (7), and guidelines allow either side to terminate the virtual consult and convert it to a face-to-face interaction if either side feel that the service provision would be suboptimal otherwise. This matter of trust facilitates the smooth virtual interaction unless it becomes necessary to convert to the in-person interaction.

The Canadian Association of Physical Medicine and Rehabilitation (CAMP&R) has undertaken significant pilot studies for virtual neurological examination, as well as for musculoskeletal and orthopaedic disciplines (12). In this study, in addition to video consultations, E-consultations, telephone consultations, secure messaging and email interactions come within the rubric of the virtual care platform, thereby protecting patients and healthcare personnel from infection hazards.

Research studies published by Hassouna et al. (13), Ansary et al. (14), and Tanaka et al. (15) lay down the recommendations for the virtual neurological examination and musculoskeletal examination in some detail. In the virtual neurological assessment, examination of the mental status, cranial nerves, cerebellar signs, gait, Romberg, asterixis and tremors has a high level of feasibility and concordance, while examination of the muscle power and tone, the tendon jerks or reflexes, the fundoscopy or retinal examination, examination of the vestibular system and a detailed sensory examination are potential challenges.

The challenges arise from technical barriers (lack of expensive fundal photography equipment, which can give good fundal visualisation from remote), subjective Medical Research Council methods of motor power evaluation (this may open up standardisation of power estimation through force resistance measurements, which would be an advancement from traditional neurological examinations), the examination of muscle tone, the art of elicitation of tendon reflexes for which we would need 'tele presenters' who could be trained by the neurologists and would come from specialist nurse or physiotherapy backgrounds as professionals to facilitate clinical consultations or tests for vestibular function. In addition, cortical sensory examinations, joint position sensation examination and perianal sensations are only possible when in-person evaluations are carried out by trained neurologists and so not possible in the. All these are not commonly undertaken in day-to-day practice unless patients report specific symptoms in that domain when the above are specifically examined. The examinations most neurologists undertake are driven and directed by the history

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obtained from the patient. Thus, the benefits of a tele-neuro examination far outweigh the occasional practical difficulties as enumerated above, and apart from the limitation of not being able to examine reflexes and potentially the fundus the rest can well be successfully managed (however, in any acute neurological presentation, the patient should be evaluated through an in-person examination wherever possible and feasible to avoid missing cardinal signs).

Virtual neurological examination

Mental status

The orientation (state date), language and recent memory (question about the recent event), assessing the fluency of speech and any obvious receptive or expressive aphasia and attention (serial seven subtraction from 100), and administering the Montréal Cognitive Assessment by telephone are easily feasible.

Cranial nerves

Facial strength (lifting eyebrows, squeeze eyes shut, showing teeth and pursing lips and observing for asymmetry), speech with comments on dysarthria or dysphonia, neck flexion (turning head to the right and left, and then shrugging the shoulders), tongue (observing the tongue at rest for bulk and fasciculations, and then sticking the tongue out and moving from side to side), people examination for symmetry and light reaction by having the patient cover and uncover each eye independently, eye movement examination by looking at the nine cardinal positions of gaze and examination of saccades by alternately gazing between the upper right and left corner of the screen of smart phone, and then just above and below the screen.

Motor examination

Assessing the muscle bulk in upper and lower limbs and observing for abnormal movements, assessing for pronator drift and forearm rolling, undertaking bodyweight squats and unilateral heel raises are entirely feasible and possible. To assess motor power, patients at home in Canada have used milk bottles (plastic) to assess deltoid and biceps power or other common household articles like a backpack filled with books with modified forms of muscle power scoring when one scores 5/5 for a full raise, 4/5 for a partial raise and 3/5 for antigravity movement without any object being held. Likewise, for triceps and wrist flexion pushing against a wall or arising from a chair with similar muscle raiding for a full, partial or antigravity without object whenever it gives reasonable assessment of muscle strength. For finger flexion and grip strength being able to crumple a paper into a ball with a tight ball being five, a loose ball being for and being able to close the faced without paper being crumpled being three would be reasonable strength measurement tools. Table (to demonstrate assesment of power in upper and lower limbs using elastic band for MRC comparisons and objective documentation).

Grade	Explanation of Dorsal interossei examination
5	finger abduction using an elastic band with the task fully performed
4	partial maneuver with the elastic band
3	antigravity without elastic band

Grade	Explanation of Quadriceps examination
5	Full maneuver and the knee extension being assessed through a single-leg squat with the full maneuver of five.
4	standing on one leg but no squat
3	seating with knee extension

Grade	Explanation of Tibialis examination
5	being able to walk on the heel with full maneuver
4	standing on heels
3	antigravity maneuver while seated

Grade	Explanation of Gastrocnemius Soleus examination
5	ankle plantar flexion with calf dependent on full maneuver while being seated
4	ankle plantar flexion with calf dependent on partial maneuver while being seated
3	antigravity maneuver while being seated

Coordination/gait

This includes rapid alternating finger to nose or heel to shin and bradykinesia testing with finger tapping and opening or closing the fist. The gait is assessed by observing the stance and ability to stand with feet together, and by observing gait and the ability to walk in tandem.

Sensory examination

A specific region to test depends on the history obtained from the patient and examination guided towards a peripheral nerve, a nerve root, a plexus or spinal cord tract. The patient may use a cotton ball or his or her own fingertips to check the sensation in the toes.

Results

Components relative appropriateness for tele-neurology

A) **Appropriate for tele-neurology:**

1. functional strength testing and sensory examination (spinothalamic test and vibration test using a tele-presenter)

2. cerebellar and gait testing (movement disorder neurologists through decades of reviewing videos are most proficient adopters of telemedicine)
3. mental state examination, including montreal cognitive assessment or other cognitive measures
4. cranial nerve examination (except the fundus examination requires special cameras that are expensive and not available everywhere presently)
5. various measurement scales, including the Unified Parkinson's Disease Rating Scale and National Institutes of Health *Stroke Scale*.

B) **Difficult but possible via tele-neurology (variable and dependent on tele-presenter):**

1. detailed motor testing (reliant on the tele-presenter to determine tone and specific rates of the medical research council grading scale)
2. muscle stretch reflexes testing
3. proprioception
4. functional testing for positive psychogenic examination components.

C) **Likely not appropriate via tele-neurology:**

1. comprehensive vestibular testing (given current peripheral devices in existence)
2. comprehensive neuroophthalmology (without requisite peripherals)
3. comprehensive neuromuscular examination
4. brain death examination
5. if the patient or the neurologist feel that there are hardware issues with regard to Internet connection speeds or quality of the camera or if the patient is not proficient in being able to conduct an interaction over the digital format and unable to seek help from an efficient relative or the services of a tele-facilitator
6. if the environment or lighting conditions or privacy issues are potentially at risk
7. the neurologist feels challenged by the digital platform or has concerns about clinical negligence issues in any particular case, which might limit the quality of care otherwise available from that individual on a face-to-face platform of interaction.
8. Dependent on the laws in existence with regard to the practice of tele-neurology in a particular state or country, the services may be possible to deliver or otherwise depended on the evolution of the evolving healthcare delivery format.
9. Option to terminate a digital interaction and convert to a face-to-face interaction at the next available opportunity without compromising the health safety or confidence of the patient in the medical system.
10. Patient unable to follow instructions or unable to test the equipment ahead of the visit to have minimum standards of engagement.

Tele-prescription

Guidelines and laws have been established, which facilitate tele-prescription with categorisation of classes of medicines that are prescribed through the digital interaction and others (scheduled drugs) that require a face-to-face doctor–patient interaction, unless it is a repeat prescription (3).

Tele-investigations

The physician is able to request investigations as normal when the patient attends the diagnostic facility following which the results are sent electronically on a confidential platform to the requesting physician and to the patient as well through a secure platform or connection.

Tele-referrals

Cross-consultation and second opinions from another colleague, including neurosurgery, neuroradiology, neuropathology and neurophysiology with viewing of the appropriate scans, EEG's and pathology slides are entirely possible and shareable with the patient, leading to better patient satisfaction.

Telestroke

Where time is of the essence in thrombolysis and mechanical thrombectomy, colleagues from India have been pushing the time boundaries to start treatments early by utilisation of various pilot projects by teleneurology in remote and academic centres. Although undergoing these treatments has been tardy so far and it is hoped post-COVID the tele-stroke practice will get a boost to reduce stroke morbidity (16–19).

Discussion

We have been drowned in the digital technology for over two decades now, although the penetration of the same in the healthcare sector has been limited for varying reasons (2, 3). Smart phone penetration in low- and middle-income countries has been phenomenal in the last 5–10 years where the provision of health care has been limited by travelling expenses and modes of transport. Tele-health or tele-neurology will be able to change all of that. The health of the physician providers or neurologists is paramount as lives have been lost through inadequate prevention and infection control measures. With being a scarce specialty the health of neurologists (and that of all other doctors and allied health professionals and nurses and healthcare industry support staff and workers) all need to be treasured and preserved as it takes decades to train all the above providers for the benefit of society (20).

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With less travelling to see the doctor, the carbon footprint is reduced, resulting in a greener planet and preservation of the ozone layer for the benefit of humanity. A restructuring of the healthcare economic system has become mandated by the wake-up call generated by the 125 μm RNA virus – severe acute respiratory syndrome (SARS) – Cov-2.

From a neurologist perspective, however, a complete assessment and evaluation are nearly always possible through the virtual patient interaction and the virtual neurological examination (21). In the least, it provides a triaging opportunity with a specialist who would otherwise be inaccessible in a face-to-face format of interaction in the 'old norm' (22). The default option of converting to the traditional physical consultation remains either through a clinical need or as a consequence of failure of the virtual endeavour. Either way it is worth the try, as a huge impact on the reduction of waiting times benefits patients in geographically remote areas, decreased travel-related costs and overall reduced expenses through curtailed travelling expenses and more convenient care to people most in need of specialised input, which has remained otherwise the preserve of the privileged few globally.

Conflict of interest and funding

The authors declare no potential conflicts of interest.

Authors' contributions

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Multimedia

Neurology Quality and Innovation Lab – Virtual Neuro Examination. https://www.nqil.ca/initiatives/virtual-neuro-exam

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