Tailored Online Neurosurgical Evaluation in the Outpatient Setting during COVID-19 Pandemic—The Maldives Experience

Technical Note

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ABSTRACT

Background: The recent COVID-19 pandemic has revealed important obstacles in our health care systems, including online specialist consultations, with relevance to the Maldives. Amidst mass lockdowns and social distancing, we observed the importance of developing a consistent method of performing effective neurological examinations that yield accurate results in a time-efficient manner.

Objectives: To describe our experience in the Maldives of performing an effective online neurological examination.

Methodology: We designed and implemented a platform for patients to register for online consultation, collected a comprehensive neurological history, including pictures/scroll-videos of past radiological reports, and guided the patient and their aide through neurological examination methods—both verbally through online video consultation and informative pictorials that depict exactly how to perform said examinations.

Conclusion: Neurological examinations are time-consuming, detailed, and require skill and expertise to be performed appropriately. Yet, it can be customized and adapted to be performed remotely. Proper guidance by examiner and assistance by family or friend with the use of pictorials can conclude a thorough online examination.

Keywords: Online, Neurosurgical evaluation, tailored, COVID-19

INTRODUCTION

According to Mehrotra et al., there has been almost a 60 percent decline in outpatient visits to hospitals during the COVID-19 pandemic. [1] Hence, virtual consultations are increasing rapidly and are being regarded as an acceptable new norm in many hospitals in different parts of the world. Thus, we must develop better ways to conduct online consultations for patients in need, especially neurosurgical patients where a delay in treatment may cause a permanent deficit or loss of life. The Neurosurgery Department of ADK Hospital, Male, Republic of Maldives serves the majority of patients with disorders related to the brain, spine, and peripheral nervous system throughout the Republic of Maldives. Hence, we intend to present an overview of our online consultation procedure, with details on how to conduct a full neurological examination. Please refer to Figure 1, which shows our hospital's general guide on how to prepare for an online consultation.

METHOD

Registration for online consultation is handled by a hospital remote call center for new and follow-up patients, while Clinical Support Service (CSS) unit additionally supports running the clinics smoothly. Allocated staff will acquire a brief history, collect pictures of necessary reports/documents (e.g. radiological, blood / biochemical investigations) and forward them to the patient.

Making videos and pictorials of the neurological examination

These are done via the consultation rooms. To fast-track medicine refills, pharmacies are informed to give drugs upon providing with soft copy of the online consultation prescription. For the patients who require a mandatory hospital visit, either for further neurological examination, scans, surgery, or dressings; CSS provides movement approval slips from Health Protection Agency (HPA) to physically visit the hospital. All documents including...
investigation requisitions, HPA permits, and prescriptions are relayed through secure online portals. Similarly, MRI films, CT scans, lab reports are sent to the patient via Google drive links with encryption (Figure 1).

Before the consultation, the preparation of the patient and family are asked according to the instructions given. The patient should have reliable internet capabilities, good headphones, and at least one assistant. As online consultation starts, visual identification and a short introduction (via video) of consultant, patient, and bystander is the first step. Any outpatient department (OPD) consultation, online or otherwise comprises three parts;

1. History taking
2. Clinical examination
3. Report review and decision.

Hence, thorough history taking proceeds the introduction. For the examination part, patients are first asked to upload the pictures and videos of already performed examinations according to instruction and guide pictorials. The remaining required neurological examinations will then commence live with demonstrations by clinicians followed by patients.

To conduct a neurological examination, we created an online Neuro-exam template, so that no maneuvers are
The neurological examination can be organized into seven categories:

1. Mental status
2. Cranial nerves
3. Motor system
4. Reflexes
5. Sensory system
6. Coordination
7. Station and gait.

Patients collect vital signs using thermometers and blood pressure monitors if available. For heart rate, bystander or patient is asked to feel the number of pulses in the wrist for 30 seconds.

**Table 1: Cranial Nerve Examination**

<table>
<thead>
<tr>
<th>CN</th>
<th>Method</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>I</td>
<td>Tested individually in each nostril by asking the patient to close their eyes and identify substances like soap, fruit</td>
<td>Family or friend required</td>
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<tr>
<td>II</td>
<td>Acuity: Snellen Chart displayed as a screen share and asked to tell the character they see with one eye shown by cursor. Mobile is held 1 foot from upright sitting patients and checked each eye independently, completely covering the other eye.</td>
<td>Fundoscopy: Not possible to perform. If history and related neurological examinations favours features of raised ICP, patient called to medical facility (Future direction: Specific lens and software for smartphones)</td>
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<tr>
<td></td>
<td>Field: Tailored Quadrangular screen split shared during consultation and asked to focus on center and identify numbers, pictures by both eyes independently from 0.5 feet distance for mobile and 1 feet for computer/laptops.</td>
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<tr>
<td></td>
<td>Color Vision: Identify the letter in Ishihara Chart</td>
<td></td>
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<tr>
<td>III, IV, VI</td>
<td>Six Cardinal Fields of gaze: Patient is asked to look in all direction while facing the camera in close proximity. Consultant may see the patient’s eye movement such as failure of movement and nystagmus (H pattern) (P and V). The consultant can look at pros.</td>
<td></td>
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<td></td>
<td>Pupillary Reflex: By flashlight or phone light.</td>
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<td></td>
<td>Convergence: Helper moves a small object in front of the camera towards the patient’s face in a way that’s not obstructing the patient’s eyes to the camera. (P and V)</td>
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<td>V</td>
<td>Motor: Motor features can be tested by asking patient to “open mouth and clench teeth” and asked to palpate temporal and masseter muscles. Sensation: Ask the patient to touch both sides of face simultaneously by finger and compare sensation over all areas of face and ask them to draw area of altered sensation with finger. (P and V)</td>
<td>Eliciting corneal reflex may inflict injury if attempted by non-professionals. Jaw jerk reflex not done—expertise to appreciate the reflex by the helper cannot be reliable.</td>
</tr>
<tr>
<td>VII</td>
<td>Motor: Asking the patient to smile, frown, blow the checks, shut eyes tightly, raise eye brows, wrinkle the forehead. Asking patient to “shut eyes tightly” can help to check symmetry as well. Facial expression muscles can be checked by asking patient to raise eyebrows and wrinkle forehead. (P) [11]</td>
<td></td>
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<tr>
<td></td>
<td>Special senses: Put some sugar, salt over the tongue and ask the patient to taste it.</td>
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<tr>
<td>VIII</td>
<td>If patient is following consultant’s conversation, it can be suggested that the patient has good hearing. Alternatively, finger rub near both ears simultaneously to elicit asymmetry in hearing. (P)</td>
<td>Testing with vibrating forks (Weber and Rinne) cannot be performed online</td>
</tr>
<tr>
<td>IX, X</td>
<td>Listening to patient’s voice can determine presence of hoarse or nasalisation. It could be possible to evaluate the patient’s soft palate and uvula (for deviation). Alternatively, high resolution photographs (while patient is saying “ash” to cause soft palate to rise upward) (P) [11,12]</td>
<td>It would not be appropriate to ask patients to assess their own gag reflex</td>
</tr>
<tr>
<td>XI</td>
<td>Ask the patient to do shoulder shrug and head rotation. (P)</td>
<td></td>
</tr>
<tr>
<td>XII</td>
<td>Patient asked to stick out their tongue and consultant can inspect to see any deviation, atrophy or fasciculations. (P) [11,12]</td>
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missed. For suspicion of stroke, a stroke card is used to list out the clinical findings present in inpatient.[3] The neurological examination can be organized into seven categories:
The motor examination includes appearance, tone, power, reflexes, and gait/coordination. Inspection through the video can accurately identify muscle atrophy, hypertrophy, foot drops, or wrist drop. Furthermore, motor examination such as standing on one leg, toe walking, heel walking, lifting one leg at the hip, Lasègue/Straight Leg Raise (SLR) test, foot eversion / inversion, dorsiflexion, plantar flexion, squatting, standing up from the chair with arms crossed over the chest can be used to assess lower limb focal motor deficits.

For upper limbs; interossei atrophy, biceps/ triceps atrophy can be noted by careful inspection. Range of movement of the neck can help rule out nuchal rigidity, Spurling's, and Lhermitte's sign. Fasciculation may be difficult to elicit remotely. The tone would be assessed during the cerebellar/gait examination and hence will be discussed elsewhere. During Online consults, muscle power from MRC grade 0 to 3 can be easily appreciated.[15] For grade 4-, 4, 4+, and 5 comparisons with the normal side and judgment of the doctors, patient, and helper is needed. In case of difficulty in concluding MRC grade by helper judging the resistance of muscle groups, we adopted a more easy to perform and minimal method (below), which is supported by Harrison's Principles of Internal Medicine 20th Edition.[11]

1. Asking patients to walk on toes, heel, and assessing with a webcam if they can properly lift their body or if any foot cannot hold.
2. Asking them to walk and watch if any leg is being dragged.
3. Asking them to stand up from a chair with crossed arms.
4. Giving the same type of squeezable balls to both hands and asking them press to access hand grip.
5. Asking them to use hand against resistance in a different direction and assessing the tension in the muscle group and their ability to lift the loads.

It is also valuable to test for pronator drift, where the doctor can easily see the results on camera. Assessing tendon reflexes is omitted due to the chances of errors and lack of reliability by non-medical helpers. Gait and coordination testing are explored in-depth with the cerebellar examination below. Pictorials for SLR with degree labeling, share with patients can give a relatively reliable Lasègue degree.

Please refer to Table 2 and Figure 3 for the cerebellar/gait examination method and guide pictorials.

After the neurological examination, it is important to explain the patient's condition, possibly via screen sharing and explanation with diagrams. Diagnosis and treatment options, which include technical terms, such as names of diseases, treatment modalities, surgical procedures can be discussed, but are better explained in written form via chat to minimize error. The final prescription is shared with the patient via secure cloud storage by CSS. Advice regarding physical therapy can be given by directing them to relevant pre-approved video recommendations, articles, and pictorials.

**DISCUSSION**

Regarding OPD consultations, our population of new patients and post-operative follow-up cases were being...
While in the Maldives there is no such law, in our opinion it comes down to a judgment call of using the most ideal service to reach as many patients as we can and attending to their medical needs - which ultimately takes precedent over any confidentiality risks.

In addition, the patient’s consent should always be confirmed for video evaluation, pictures, and so forth. Another interesting aspect of video consultations is ensuring correct patient and doctor; having a routine introduction a few minutes to confirm identity is essential in every session. Mistaken patient identity is more common than we would like to believe; in fact, the ECRI Institute notes that more than 7,000 patient identification events, many with serious consequences, were found in its database over a period of about 2.5 years. Another research shows that 11% of 1200 errors in the NICU were attended via Viber audio, video, and chat consultations. Our hospital had adopted the use of this social media app as our main means of communication due to its availability and frequency of use in the Maldives. This method worked decently and was especially useful for general consultations. However, the use of 3rd party applications such as Viber is always controversial due to privacy concerns, nonetheless, it is noteworthy that they contain end-to-end encryption. For a service to be used in the United States this way, HIPAA compliance is critical. Some web conferencing services such as Zoom is HIPAA compliant as they contain authentication and access control measures, as well as end-to-end encryption.

However, consumer-grade several apps lack the features and security controls essential for ensuring the confidentiality, integrity, and availability of electronically protected health information that is demanded by the HIPAA Security Rule. While in the Maldives there is no such law, in our opinion it comes down to a judgment call of using the most ideal service to reach as many patients as we can and attending to their medical needs - which ultimately takes precedent over any confidentiality risks.

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form of involving family members during a consultation if possible; exploring history taking via audio rather than a text while simultaneously receiving images or short videos (e.g. skin lesions, localization of pain); online prescription centers developed by private hospitals and state trading organizations with door-step delivery; older documents and records being scanned and sent to the hospital/doctor before the consultation, medical and radiological images were scanned or scroll videos were made for consultations and instruction tutorials were sent out to inform patients of what exactly was required of them, and explanation of disease condition was explained in short videos and treatment drawn on paper as an algorithm for easy understanding. Too lengthy sentences in this paragraph make them precise.

Regarding our neurosurgical OPD consultation, our department formulated a consistent method of doing it online and visually. As opposed to case-by-case basis communications every time, this new method became beneficial and rewarding, mainly improving the accuracy of testing and efficiency of time use. With the inclusion of a bank of informative and easy 

Figure 3: Cerebellar examination pictorials. (A) Examination of nystagmus and dysmetric saccades; (B) Gait examination; (C) Finger-to-nose test; (D) Heel-to-shin test; (E) Dysdiadochokinesis examination.

related to patient misidentification.[24] Of course, the number one priority is that the correct patient gets the medical attention they need but it can also help to avoid any legal repercussions.

Greenhalg et al. had conducted in-depth qualitative studies regarding the online consultation studies, which showed the possible advantages of cost-effectiveness and eliminating travel inconvenience but had the drawbacks that brought significant technical, logistical, and regulatory challenges along with disadvantage to the health professionals regarding the clinical examinations.[25] We also faced numerous challenges with online consultations; like issues with availability and use of technology in regards to the elderly, network and connectivity, prescription of medication and unavailability of old records such as sharing of imaging tests from other medical centers (as we do not have a nation-wide systemic database of patient medical records) and explanation of disease conditions and treatment formulation. The biggest issue we faced was uncertainty regarding how to perform effective neurosurgical examinations online. The majority of these challenges were overcome in the
to follow guides and pictorials, we prepared a document that patients have access to, that explained not only how to perform examinations and what to look for, but how to assess the results accurately and convey that information adequately. Patients were able to follow the procedures more accurately and often could prepare themselves for these examinations ahead of time by researching and even practicing. Hence, this, in combination with the video call from the doctor observing keenly for the patient’s response and guiding them with easy-to-understand instructions, was a huge improvement; and allowed for truly effective neurological examinations.

It took some time to develop and tailor a program for the effective visual neurological examination that applied to the public. One key challenge we faced was preparing a collection of diagrammatic pictorials that explained exactly how to perform certain examinations and what was expected of the patient without confusion.

**LIMITATIONS**

Neurological examinations can often be lengthy and time-consuming. However, these challenges were successfully overcome through the use of visual aids and video calls.

<table>
<thead>
<tr>
<th>Test</th>
<th>Method of consultation</th>
<th>Remarks</th>
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<tbody>
<tr>
<td><strong>Dysarthria</strong></td>
<td>Observing the speech of the patient with focus on articulation and phonation can help the doctor detect whether their speech is slurred, slow or difficult. It is also important to assess the muscle tone of the speech musculature. Different forms of dysarthria affect how certain consonants are said which include the letters ‘T’, ‘P’, and ‘K’. To detect these distortions, commonly used phrases include ‘baby hippopotamus’ or ‘British constitution’.</td>
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<tr>
<td><strong>Nystagmus and Dysmetria</strong></td>
<td>When checking for nystagmus, the patient should be asked to hold their head still and follow the helper’s finger as they move it through the various axes of vision. The patient should have the camera placed in front of them with a clear view into their eyes. When checking for dysmetric saccades, the patient should be asked to look back and forth between any two objects that are widely spaced. This movement of the eyes should be quick and accurate. If there is a lesion present, there will often be overshoot or undershoot seen in the eye movements.</td>
<td>Family member or friend is required to stand behind the camera and follow the instructions of the consultant.</td>
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<tr>
<td><strong>Tone</strong></td>
<td>Assessing the tone of muscle groups is dependent on comparison and can be a very subjective finding. The helper should ensure the patient is relaxed and then flex and extend the patient’s wrists, elbows, ankles, and knees looking for increased or decreased resistance as well as the smoothness of action. A simple gesture such as shaking hands can not only assess tone but also help to evaluate the flaccidity or rigidity of the movement. The “Pendular” knee jerk reflex test can be done to check for hypothenar. It is present, if the leg keeps swinging after the knee jerk more than three times.</td>
<td>An object similar to a reflex hammer is needed. This test should be done with caution as a non-professional may hit harder than necessary, potentially causing harm.</td>
</tr>
<tr>
<td><strong>Gait</strong></td>
<td>Gait of the patient can be examined as long as the doctor has clear vision of the patient’s entire body in order to observe all the different gait components. Simple tasks such as: walking to the end of the room, turning around, and walking heel to toe would be easy to understand and perform.</td>
<td>Helper required to ensure the safety of the patient especially whilst performing the Romberg’s test.</td>
</tr>
<tr>
<td><strong>Coordination</strong></td>
<td>Performing the finger-to-nose test requires for the camera to be placed in a way where the consulting doctor can see both the patient and the helper. In this test it is important that the doctor can clearly see the patients outstretched hand and finger to look for intention tremors and dysmetria. Tests for dyssynergia which include the patient having to perform rapid alternating movements requires it to be done with the correct technique so tutorial videos and pictures would be essential. The heel-to-shin test and heel-tapping test to check for dysmetria and dysdiadochokinesia should also be performed in this way. The rebound phenomenon can be performed but should be done with caution.</td>
<td>Heel-to-shin test and heel-tapping test should be performed in the supine position on a bed or soft to eliminate the effect of gravity and to ensure patient comfort. The helper should be advised to protect the patient from un-arrested movements during the rebound phenomenon test.</td>
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Table 2: Cerebellar Examination; (P) = Pictorial
detailed, requiring skill and expertise, so for the majority of these examinations, we have to keep in mind that the helper’s (family, friend) ability to perform these tests and potential bias toward a specific result can be an unfortunate but unavoidable factor. Misinterpretation of instructions and results could also occur. There is no replacement for certain examinations such as tactile sensation, fundoscopy examination, accurate motor grading (muscle power).

**RECOMMENDATIONS**

Ideally, this visual neurological examination program will be more effective if accompanied by a prepared form/questionnaire required by patients to fill in regards to their history and current symptoms before the online consultation. In comparison to direct verbal questioning via Viber, this is more time-effective and a step-wise order to the questions to ensure patients have more time to think of their answer so that no important detail is missed. However, this could require the expertise of trained front-office staff or an MBBS doctor that can advise patients in case of any queries; as consultant specialists should dedicate all of their time to the actual consultations themselves. Also, instructional tutorial videos could be more helpful than pictorials as patient and helper can see exactly how an examination is performed. Some specific equipment such as reflex hammer or lens for smartphone fundoscopy can also be recommended to already diagnosed patients that can afford it, so that progression of the disease can be assessed by consultants. Therefore, our recommendation is to fulfill these obligations for an even better experience in online consultations.

**REFERENCES**


**AUTHOR CRediT**

AN: Methodology, Resources, Writing – original draft, Supervision
KN: Conceptualization, Methodology, Resources, Visualization, Project administration, Writing – original draft, Writing – review & editing
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