**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, Malé, 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.[2]

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

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.

### CRANIAL NERVE EXAMINATION

| CN | Method | Remarks |
|----|--------|---------|
| I  | Tested individually in each nostril by asking the patient to close their eyes and identify substances like soap, fruit.[4] (P) | Fundoscopy: Not possible to perform. If history and related neurological examinations favour features of raised ICP, patient called to medical facility (Future direction: Specific lens and software for smartphones)[10,11] |
| II | 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 feet from upright sitting patients and checked each eye independently, completely covering the other eye.[8] (P) Field: Tailored Quadrangular screen split shared during consultation and asked to focus on centre and identify numbers, pictures by both eyes independently from 0.5 feet distance for mobile and 1 feet for computer/laptops. (P) Color Vision: Identify the letter in Ishihara Chart[9] (P) | |
| III, IV, VI | Six Cardinal Fields of Gaze: Patient is asked to look in all direction while facing the camera 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 pupils. [10,11] Pupillary Reflex: By flashlight or phone light. 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)[10,11] | |
| V  | Motor: Motor features can be tested by asking patient to “open mouth and clench teeth” and asked to palpate temporal and masseter muscles. [12] Sensation: Ask the patient to touch both sides of faces 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)[12] | 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. |
| VII | Motor: Asking the patient to smile, frown, blow the cheeks, shut eyes tightly, raise eye brows, wrinkle the forehead. [13] Asking patient to “shut eyes tightly” can help to check symmetry as well[12]. Facial expression muscles can be checked by asking patient to raise eyebrows and wrinkle forehead. (P)[11] Special senses: Put some sugar, salt over the tongue and ask the patient to taste it. | |
| VIII | 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) | Testing with vibrating forks (Weber and Rinne) cannot be performed online |
| IX, X | 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] It would not be appropriate to ask patients to assess their own gag reflex | |
| XI | Ask the patient to do shoulder shrug and head rotation. (P) | |
| XII | Patient asked to stick out their tongue and consultant can inspect to see any deviation, atrophy or fasciculations. (P)[11,12] | |

Table 1: Cranial Nerve Examination; CN= Cranial Nerve; (P) = Pictorial ; (V) = Video sent during registration
Higher Mental Function is evaluated using the Mini-Mental State Examination (MMSE) MMSE5 and/or Montreal Cognitive Assessment (MoCA) parentage is used to calculate and assess higher mental functions. [6] Glasgow Coma Scale (GCS) is evaluated as well. If the patient is alert, oriented, giving one's history oneself, we will regard GCS as 15/15. All Eye and Verbal components of GCS can be assessed during an online consultation.

Please refer to Table 1 for the cranial nerve examination method and Figure 2 for guide pictorials. A sensory examination can be divided into three parts – cortical, superficial, and deep. For cortical sensation: graphesthesia can be tested by asking them to close their eyes identify letters or numbers that are being traced onto their palm or the tip of their finger; stereognosis can be tested by asking patients to close their eyes and identify various objects by touch, using one hand at a time; and tactile extinction can be tested by asking the patient to close their eyes and touch either the same or different locations on the patient's body on both left and right side simultaneously.[11,12] Superficial sensation (pain, temperature, light touch) can be tested by breaking a cotton bud in half (such that you create a sharp, pointy end) or using the sharp and blunt ends of a safety pin.[14] Dermatomal distribution can be known by asking the patient to draw the area where they do not feel or feel less.

As for deep sensation (joint movement, position, vibration): Test for proprioception by asking the patient to close their eyes and watching the helper grasp different locations of the patient (e.g. flex and extend toe), then ask the patient what they feel.[10,11] Vibration testing can be done crudely with the use of phone vibration features and placing them vertically on the standard desired bone prominences.

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, dorsi-flexion, planter 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
demanded by the HIPAA Security Rule.[22] 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 precedence 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.[23] 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.[19] 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.[20,21]

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

Figure 2: Cranial Nerve examination pictorial. CN= Cranial Nerve. (A) CN 1 examination; (B) CN II and III examinations; (C) CN V sensory examination; (D) CN V Corneal Reflex and motor examination; (E) CN VII examination; (F) CN IX and X examination; (G) CN IX examination. (H) CN XII examination.
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.
Following 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...
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

1. Mehrrota A, Chernew M, Linetsky D, Hatch H, Cutler D. What impact has COVID-19 had on outpatient visits. To the Point. 2020;23. Available from: doi: 10.25099/ds9e-jm36.
2. Lloyd H, Craig S. A guide to taking a patient’s history. Nurses Stand. 2007;22(13):42. Available from: doi: 10.7748/ns2007.12.22.13.42.c6300
3. Clinical epidemiology team. Stroke-Card; 2020 [cited 2020 Aug 6]. Available from: https://clinicalepi.i-med.ac.at/research/strokecard/
4. Glass A, Zazulia A. Clinical Skills: Neurological Examination; 2011 Feb 5 [cited 2020 Aug 6]. Available from: https://neuro.wustl.edu/Portals/Neurology/Educators/PDFS/Neurological-Exam-Lecture-Notes.pdf.
5. Gellman MD, Turner JR, editors. Encyclopedia of behavioral medicine. Springer New York; 2013.
6. Nasreddine Z, Phillips N, Bedirian V et al. The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool For Mild Cognitive Impairment. J Am Geriatr Soc. 2005;53(4):695-699. Available from: doi: 10.1111/j.1532-5415.2005.53221.x
7. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. The Lancet. 1974;2(7872):818-823. Available from: doi: 10.1016/s0140-6736(74)91639-0
8. Walsh F, Hoyt W, Miller N. Walsh And Hoyt's Clinical Neuro-Ophthalmology. 6th ed. Williams & Wilkins; 2005:934-935
9. Marey H, Semary N, Mandour S, Ishihara Electronic Color Blindness Test: An Evaluation Study. Ophthalmic Res. 2015;3(3):67-75. Available from: doi:10.9734/or/2015/13618
10. Mattle H, Mumenthaler M, Taub E. Fundamentals of Neurology, An Illustrated Guide. 2nd ed. Thieme; 2017:19-52.
11. Jameson J, Kasper D, Longo D, Fauci A. Harrison’s Principles Of Internal Medicine. 20th ed. McGraw-Hill; 2018:3025-3030.
12. Blumenfeld H. Neuroanatomy Through Clinical Cases. 2nd ed.; 2010:49-79.
13. Biller J, Gruener G, Brazis P, Demyer’s The Neurologic Examination. 7th ed. McGraw-Hill; 2017:4, 262
14. Clinical epidemiology team. Stroke-Card; 2020 [cited 2020 Aug 6]. Available from: https://clinicalepi.i-med.ac.at/research/strokecard/
15. Goldberg C, UC San Diego’s Practical Guide to Clinical Medicine; 2018 [cited 2020 Aug 6]. Available from: https://meded.ucsd.edu/clinicalmed/neuro2.html
16. Campbell W, Barohn R. Dejong’s The Neurologic Examination. 7th ed. Lippincott Williams & Wilkins; 2012:413
17. Mioni J, Piran P. Functional And Clinical Neuroanatomy: A Guide for Health Care Professionals. Academic Press; 2020:511-513
18. Wilkinson I, Raine T, Wiles K, Goodhart A, Hall C, O’Neill H. Oxford Handbook Of Clinical Medicine. 10th ed. Oxford University Press; 2017:86.
19. Russell S, Triola M. The Precise Neurological Exam, informatics; 2006 [cited 2020 Aug 6] Available from: https://informatics.med.nyu.edu/modules/pub/neurosurgery/coordination.html
20. Nass S, Gostin L, Levit L. Reforming the HIPAA Privacy Rule. JAMA. 2009;301(13):1373. Available from: doi:10.1001/jama.2009.424
21. McCormack M. Is Zoom HIPAA Compliant for Video Conference?., Compliance Group. 2020 [cited 2020 Aug 6]. Available from: https://compliancy-group.com/is-zoom-hipaa-compliant/.
22. Zoom; 2020 [cited 2020 Aug 6]. Available from: https://zoom.us/docs/doc/Zoom-hipaa.pdf.
23. HIPAA Compliant Instant Messaging. HIPAA Journal. 2020 [cited 2020 Aug 6]. Available from: https://www.hipaajournal.com/hipaa-compliant-instant-messaging/.
24. Hughes P, Latino R, Kelly T. Preventing Patient Identification Errors. PSQH. 2017. https://www.psqh.com/analysis/preventing-patient-identification-errors/
25. Martin R, Fanaroff A, Walsh M, Fanaroff And Martin’s Neonatal-Perinatal Medicine. Elsevier Health Sciences; 2010:86.
26. Greenhalgh T, Vijayaraghavan S, Wherton J, et al. Virtual Online Consultations: Advantages and Limitations (VOCAL) study. BMJ Open 2016;6

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