

Practical Considerations When Performing Neurodiagnostic Studies on Patients with COVID-19 and Other Highly Contagious Diseases*

Seline Haines, BS, R. EEG/EP T.; CNIM; Amy Caccamo, R. EEG/EP T., CLTM; Fonda Chan, M.D.; Puneet Gupta, M.D., M.S.E.

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The coronavirus disease 2019, SARS-COV-2 (the cause of COVID-19), first detected in December 2019, has spread into a pandemic, leading to an overflow of patients requiring hospitalization ([Root A; Kamal et al.](#)) and a shortage of personal protective equipment (PPE) in the United States and worldwide ([Baker & Sullivan; CDC March 12, 2020](#)). Although COVID-19 mainly affects the respiratory system, there are reports of neurological effects as well ([Zhou et al.; Mao et al.; Rabin RC; Chen et al.; Li, Bai & Hashikawa; Talan March 27, 2020; Talan April 1, 2020](#)), prompting the need for neurodiagnostic testing. In this article, we share our experience on how an EEG study was performed on a COVID-19 positive patient, what we learned from it and how we have adapted our workflow. Our goal, as always, is to provide high quality patient care but it has become increasingly more important to limit exposure and protect the health of our EEG/neurodiagnostic technologists at this time.

In our facility, the ACNS Guidelines have always been followed as the minimum technical requirements for performing neurodiagnostic studies, such as for performing EEGs ([ACNS Guidelines 1, 3 and 5](#)). Although such guidelines acknowledge that there is “no single best method” for performing a neurodiagnostic procedure for every circumstance, they do offer “standards considered minimum for the usual clinical recording.” (Guideline 1). Furthermore, it is department policy to adhere to standard infection prevention measures when performing neurodiagnostic procedures on both normal and infected patient populations ([Bonner & Davidson](#)). However, the highly contagious nature of the new coronavirus ([CDC April 2, 2020](#)) led our facility to adhere to strict airborne isolation protocols, which require the use of the limited supplies of PPE, including face masks, gloves and gowns.

Case:

A 73-year-old male presented to our hospital with 10 days of progressive influenza-like symptoms including a non-productive cough, shaking chills and fever. Influenza and streptococcus tests were negative. He was then considered a person under investigation (PUI) for COVID-19 and was placed in an airborne isolation unit which was recently converted into a “COVID ICU”. The patient had an acute decline requiring intubation, sedation and a paralytic. While still febrile, he was witnessed to have a convulsive-like spell and an EEG was ordered. When this case occurred, there were no clear guidelines or recommendations available on how to adapt the workflow in performing EEG procedures as there is available today by [ACNS](#) and [ASET](#). Like most providers, our hospital was also rationing PPE at the time of this event. Despite the highly contagious nature of the predominantly airborne transmitted illness ([CDC April 2,](#)

[2020](#)), the neurology team believed that the critical nature of the patient's condition warranted an EEG therefore the test was ordered. All EEGs performed by our laboratory follow the ACNS guidelines on EEG testing per standard protocol.

Many of the EEG technologists on duty at the time were in the high-risk category for COVID-19 (e.g. advanced age, pulmonary disease, immunocompromised) ([CDC March 31, 2020](#)). Given the rationing of PPE, more than one EEG technologist was discouraged from being in the room. Therefore, the decision was made that an experienced technologist, capable of troubleshooting any issues in a timely manner, would perform the EEG. Thus, the EEG laboratory manager performed the routine EEG study. She shares her experience below:

"As I walked through the doors to the new COVID-19 ICU unit, the nurses were not wearing any unusual PPE outside the patient rooms. It was busy like in any ICU setting. The main difference was that all the doors were completely closed. After putting on the PPE (gown, head cover, foot covers, gloves, mask and goggles), I slid open the room door, walked in with the EEG system and shut the door behind me.

I performed each step of the EEG hookup as I was taught so many years ago. I measured, marked, cleaned, applied, glued and wrapped the patient's head. During this process I noticed that this ICU experience was different. The room had a noticeable 'lack of activity.' The nurses only entered for brief periods of time - just long enough to complete a medically necessary task (2-5 minutes). By the time I finished the hookup, I realized I had been in the room with this very sick patient for well over an hour."

The routine EEG study was done according to our department policies which are based on the ACNS Guidelines ([ACNS Guidelines 1, 3 and 5](#)). The EEG machine was placed as far away from the patient as possible. Due to the nature of a diffuse encephalopathic pattern, the routine EEG was converted into a bedside, continuous video-EEG (cvEEG) recording to assess for electrographic epileptiform abnormalities. The cvEEG recording lasted a total of 43 hours and 39 minutes. No electrode maintenance was necessary due to preserved recording quality.

Upon completion of the study, the EEG equipment was cleaned according to the most current CDC policy for COVID-19 infection prevention and the equipment was then covered with a clean plastic drape. Because the current understanding of the incubation period for COVID-19 could extend for up to 14 days, the equipment was stored in a separate room for 2 weeks ([Lauer et al.; CDC March 20, 2020](#)). A decision was made to reserve the use of that EEG machine if another EEG was ordered for another patient in the COVID-19 ICU.

Discussion:

As numerous protocol changes to infection prevention measures and patient management occurred due to the COVID-19 pandemic, it was vital to adapt processes for neurodiagnostic testing to fit this unique situation. Therefore, after our first experience with performing an EEG on a COVID-19 patient, we felt the need to share our experience and the changes we made to our testing protocols in order to help others, as this will likely become be an iterative process.

At our facility, we have adopted two new protocols. The first is a protocol titled “Guidance on Neurodiagnostic (EEG) Service Delivery during COVID-19 Outbreak”, which describes triage recommendations for suspected or confirmed COVID-19 patients based on the medical necessity of an EEG ([CDC March 7, 2020](#)). With aggressive social distancing and quarantine strategies, the objective of this protocol is to protect our patients and staff, preserve PPE, minimize disease transmission and maintain patient throughput.

Guidance on Neurodiagnostic (EEG) Service Delivery during COVID-19 Outbreak: Describes recommendations to triage for the medical necessity of an EEG for a presumed positive (i.e., PUI) or positive COVID-19 patient. Key considerations when making decisions about medical procedures should include (full description to be published in *TNJ*, Volume 60, Issue 2):

1. Urgency of procedure (medical necessity)
2. Health and age of the patient
3. Duration and proximity of staff exposure
4. Current and projected COVID-19 cases in the facility and region causing demand for PPE
5. Immediate supply of PPE available within a facility
6. Staffing availability

At our facility, non-urgent studies are deferred, when possible, to a future date. EEG may be deemed necessary for cases of assessment and management of subclinical status epilepticus and cases of unexplained mental status, where EEG testing results could alter the medical management of the patient.

Modified EEG Recording Process: COVID-19 Protocol: The modified EEG Recording Process limits the technologist’s exposure time with the patient. These steps delineate a clear approach to performing neurodiagnostic tests on these patients. For any patient in the COVID-19 ICU at our facility, we use the revised EEG protocol, which includes the following (full detailed protocol to be published in *TNJ*, Volume 60, Issue 2):

- For a neurodiagnostic test to be performed, a Medical Justification Form is required to be completed by the ordering patient care team, approved by the interpreting neurologist and placed in the patient chart.
- The Manager of Neurodiagnostics and Epilepsy determines which technologist will perform the procedure based on risk assessment to determine the appropriate person to perform the procedure ([CDC March 7, 2020](#)). Experienced EEG Technologists are preferred as a high level of judgement and critical thinking skills and experience in recording and assessing the waveforms. Also, the real-time troubleshooting skills in this critical situation are necessary in providing the optimal balance between quality and efficiency while minimizing collective staff exposure. If an appropriately qualified or experienced EEG Technologist is not immediately available, then performing the procedure may be delayed until an appropriate EEG Technologist is available.
- If possible, a portable video-EEG system will be assigned to be used with PUI or positive patients. This system may be stored on the unit designated for such patients.

- All appropriate PPE, following the current hospital policy and CDC guidelines, will be used by the EEG Technologist to complete the procedure.
- If possible (e.g. not on a ventilator), ensure that the patient is also wearing a N95 mask.
- If the patient has received a nebulizer treatment, the study will be delayed by at least four hours, if possible, to reduce the chance of potential airborne transmission created during the nebulizer treatment ([April 1, 2020](#)).
- The portable video-EEG system will be kept outside of the patient room, if facility and workflow allow for it.
- The process of performing the 10/20 measurement for electrode placement may not be followed. Electrode placement will be documented in the EEG per ACNS guideline 1.
- A reduced array of disposable electrodes ([ACNS March 25, 2020](#)) will be applied with paste and tape instead of collodion; in addition, applying a head wrap will be considered to help secure the electrodes.
- A minimum of 8 electrodes will be used, with the following electrodes preferred due to their ease of application and relative high utility in screening for clinically relevant EEG abnormalities as shown by other authors ([Westover et al. 2020](#); [McKay et al. 2019](#); [Gururangan, Razavi & Parvizi 2018](#); [Tanner et al. 2014](#); [Rubin et al. 2014](#)).
 - Left: Fp1, F7, T7, P7, O1, C3
 - Right: Fp2, F8, T8, P8, O2, C4
 - Midline: Cz
 - EKG, Ground, and Reference
- Verbal and tactile stimulation activation procedures may be performed if clinically appropriate.
- Hyperventilation and photic stimulation activation procedures will not be routinely performed.
- After electrode application and brief recording with verbal and/or tactile stimulation (if appropriate), the EEG technologist will exit the patient room.
- The EEG monitoring technologist will immediately start monitoring the live study remotely and annotate the EEG, marking any clinically or electrographically relevant areas. If no EEG monitoring technologist is available, then the EEG technologist will proceed with the next step.
- The interpreting physician will be immediately notified that the study is up and running, and the interpreting physician will immediately review the live study remotely.
- The EEG recording will be acquired for a minimum of 20 minutes.
- If the patient must be recorded for a longer time period (i.e. converted to a cvEEG), the EEG technologist may leave the unit unless any additional electrodes are needed per interpreting physician's request or to better secure the leads. If further setup needs are required, the technologist will need to re-enter the patient's room to address such issues.
- The cvEEG will be monitored remotely by the EEG monitoring technologist and will be reviewed remotely by the interpreting physician as clinically required.
- Electrode maintenance will be minimized daily on an as-needed basis after quality is assessed remotely.
- The cvEEG recording should be discontinued as soon as medically possible.

- EEG equipment will be cleaned following CDC guidelines ([CDC April 1, 2020](#)).

EEG equipment should be cleaned using the most current recommended infection control procedure per facility policy and CDC recommendations ([CDC April 1, 2020](#)) and ACNS and ASET recommendations ([ACNS](#); [ASET](#); [Bonner & Davidson](#)). Even with appropriate cleaning, the authors recommend that neurodiagnostic departments make specific equipment decisions to limit exposure, such as utilizing the same piece(s) of EEG equipment for COVID-19 patients and isolating/quarantining the equipment temporarily from other clean equipment between patient use ([CDC April 2, 2020](#)).

These are trying times with unprecedented circumstances which require us to alter our processes. Our goal is to continue to deliver high quality patient care while decreasing technologist exposure times and optimizing resource utilization. This will allow us to not only take care of patients but each other and the community at large. Stay safe.