Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Letter to the Editor

Nationwide online EEG education during coronavirus disease 2019 pandemic

The rapid spread of the novel coronavirus disease 2019 (COVID-19) has had a tremendous impact on worldwide medical care (Guan et al., 2020). The pandemic has also greatly reduced the chance for face-to-face education in medical settings. Thus, medical education and learning were major challenges during the pandemic, due to isolation (Papapanou et al., 2021). Various types of online lectures have been recently conducted, however, the efficacy and sustainability of online medical lectures are limited, particularly those that require "hands-on" programs (Guadix et al., 2020). In clinical and neurological examinations, electroencephalography (EEG) reading requires specialized knowledge and practical training (Benbadis, 2007). Additionally, an ideal EEG program provides face-to-face guidance from a professional clinician (Nascimento and Gavvala, 2021). Thus, this paper aimed to determine the efficacy and sustainability of a practical EEG learning system through online applications, along with a presentation of our challenges in the organization of the current EEG webinar. We believe that the present discussion may inspire a new standard of medical education by introducing the essentials of selecting tools and designing lessons for online education in EEG, in light of the changes in the learning environment caused by COVID-19.

We gave weekly online EEG lectures, "webinars," a total of 31 times using the online application Zoom Video Communications, from July 2020 to June 2021. We recruited EEG trainees (EEG technicians and clinicians) across multiple social networks, including Facebook (Facebook, Menlo Park, CA), Twitter (Twitter Inc., San Francisco, CA), and other social media platforms, including our original webpage. We assessed the background status of the trainees and their educational demands using an online questionnaire before the start of the webinars (Supplementary Table 1). Each webinar lasted for 60 minutes or more, with five to seven cases of EEG presented. Using a video capture device (Elgato game Capture HD60), the instructor shared anonymized EEG data. The instructor repeatedly explained the basic procedure of EEG reading in each EEG data set, and in every webinar so that the trainees could understand easily and better with each meeting. Interactive sessions were also included, that is, the instructor and representative trainees discussed the EEG waveforms presented. Other participants listened to the discussion, and if they had questions, they could ask using the comment function of the ZOOM application. During the process of switching the EEG data, the lecture was interrupted. Thus, while the person in charge was working on the switching process, the instructor used the whiteboard to outline and review the points that were related to the previous EEG. The whiteboard was captured using an external camera and shared via ZOOM.

After the trainees completed the webinars, we evaluated whether the webinars addressed the needs of EEG reading. Additionally, we evaluated the impact of the webinars on trainees' clinical practice behavior, that is, how their clinical practice changed after the webinars with respect to (1) the number of EEG examinations they conducted, (2) the total time spent reading EEGs, and (3) the total time spent interviewing patients with epilepsy. These parameter changes were classified into three categories: a <20% increase, a 20–50% increase, and a >50% increase from the baseline data (before the start of the webinar). These changes were analyzed following the trainees' background and the total count of attendance using the Cochran-Armitage test. We used an online self-report questionnaire to obtain the relevant data. The Ethics Committee approved the present study at Hiroshima University Hospital (No. E-2285). Informed consent for participation was obtained from all participants. All statistical analyses were conducted using JMP software (JMP Pro version 14; SAS Institute, Cary, NC, USA).

A total of 311 trainees were enrolled; 245 were males (78.8%). The number of clinicians and technicians were 296 (95.1%) and 15 (4.8%), respectively. There were only 14 (45.2) trainees who belonged to our department. The postgraduate year varied, and multiple areas of expertise were also present (Supplementary Table 1). In addition, the participants were from diverse regions nationwide. The number of trainees who had specialized in EEGs or epilepsy was negligible at baseline. The trainees' objectives and reasons for joining the webinar are listed in Supplementary Table 1. Each trainee participated as often as possible, and the mean number of participants per session was >90 at the end of the course period (based on the ZOOM plan, hosts up to 100 participants). After completing the webinar, the response rate of the questionnaire was 61.7% (192/311). The webinars satisfied most of the trainees (Supplementary Table 2). More than half of the participants reported that they could interpret essential EEG readings.

Significant clinical behavioral changes following webinar attendance were observed as the total individual attendance count increased (Fig. 1). Following the webinars, significant correlation between the number of webinars attended, and the behavioral changes in clinical practice after the webinars were visible. The more the number of times they participated in the webinars, the more EEG examinations they ordered (Fig. 1A); they spent more time reading EEGs (Fig. 1B) and interviewing patients who were diagnosed with or suspected to have epilepsy (Fig. 1C). In contrast, there was no significant correlation between the size of the hospital each trainee belonged to and the change in their behavioral changes in clinical practice (Supplementary Fig. 1). There was also no significant correlation between the postgraduate year of trainees and their behavioral changes in clinical practice following the webinars (Supplementary Fig. 2).

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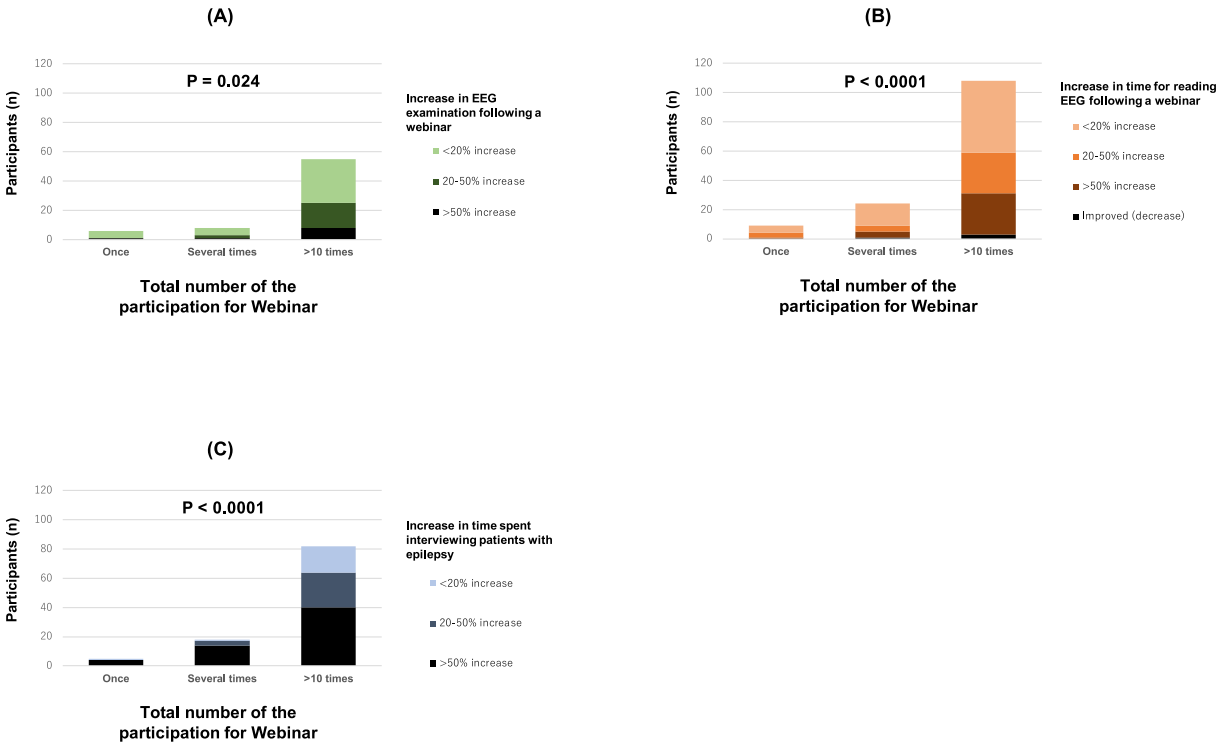

Fig. 1. Correlation between the number of webinar sessions attended and subsequent clinicians' behavioral changes in clinical practice. The more the number of times they participated, (A) the greater the number of EEG examinations, (B) the more the time spent reading EEGs, and (C) the more the time spent interviewing patients, following the webinar.

We conducted a weekly EEG webinar 31 times, where 311 participants joined from various institutes nationwide. Our findings suggest that social network services are invaluable in attracting trainees, and a weekly webinar is feasible and acceptable to EEG trainees. Additionally, after completing the webinar, the clinicians' behaviors in their clinical practices changed regarding ordering of EEGs, reading and interpreting EEGs, and interviewing patients with epilepsy. Although online lectures reportedly have limitations in practical education programs (Dickinson & Gronseth, 2020), our educational system was able to provide practical content in EEG readings that motivated trainees, likely due to the weekly serial seminar delivery. Additionally, the fact that the training was effective for participants irrespective of the size of their home institutions, and the postgraduate year supported the utilization of our webinars.

Meanwhile, the disadvantages of online lectures involve technical difficulties and learning isolation relative to face-to-face lectures (Junod Perron et al., 2020). A lack of human contact may also decrease trainees' motivation. Additionally, several network disturbances should be addressed in the new era education platform (Hassan and Mahmoud, 2021). However, this study confirmed that the more the number of times trainees participated, the more the positive clinical behavioral changes that were observed, regardless of the differences in the trainees' postgraduate years and hospital sizes. These clinical behavioral changes collectively suggest that conducting serial webinars might address maintenance and acceleration of trainees' motivations, and change clinicians' clinical behaviors regarding EEG reading. Trainees who were motivated following the seminars presumably made behavioral changes to apply what they learned from the seminars in their clinical practice; that is, they tended to utilize EEG more often and were probably better prepared to counsel patients with epilepsy in whom EEG is particularly invaluable. However, limitations such as a lack of a control group and self-reported measurements (re-call bias) were associated with the present study. The internal correlation between "increased number of EEG examinations" and "number of trainees' participations" might also be possible. As multiple recent studies have investigated the challenge in transition from in-person to online in medical education (Jin et al., 2021; Kaul et al., 2021), a comparison with a control group is an area for future research.

In conclusion, senior clinicians should keep in touch with trainees and pay more attention to their learning isolation during the ongoing pandemic. A new normal style of clinician collaboration through multiple networking systems warrants the sustainability and quality of medical education to deal with threats. Sustainable "interactive learning" and "motivation to learn" are crucial for education, and comparison with traditional learning is also an issue that is needed to be dealt with in the future.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Statement of ethics

The Ethics Committee approved the present study at Hiroshima University Hospital (No. E-3844).

Author contributions

SN; designed and conceptualized the study; analyzed the data; drafted the manuscript for intellectual content.

NM, TI, TW, HY, NM, YT, MK, MT, and **HM**; interpreted the data; revised the manuscript for intellectual content.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clinph.2021.08.010.

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