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Safety and Fidelity in Electroconvulsive Therapy (SAFE ECT)

A Novel Virtual Reality–Based Training Program in Electroconvulsive Therapy (Phase 1)

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Authoritative guidelines and textbooks provide practitioners and trainees a wealth of written information about all aspects of electroconvulsive therapy (ECT) practice.[1–6] However, currently, there are no recommendations for using simulation training, virtual or augmented reality in the training of clinicians who will learn to administer ECT. Electroconvulsive therapy technique varies between and within countries.[7–9] This is not necessarily a problem; research has shown that many treatment techniques are effective, and there is no single strategy that is superior to the other. However, treating a patient with ECT requires, as most standardized medical procedures, skills to administer the treatment. This includes an understanding of the necessary sequential steps to provide the patient with a safe and effective treatment each time during an index course or a maintenance series. For the clinician who administers ECT, this requires an understanding of the device's technical facilities and electrophysiological parameters, such as current, charge, pulse width, seizure threshold and electrode placement, and their impact on the course of the depression and adverse effects.

Although training in ECT is mandatory, it receives limited attention in most textbooks. According to Sivasanker and Ninatu in The ECT Handbook,[5] some centers have used simulation for the training of psychiatrists, using a physical mannequin, and this has been well received. The Royal College of Psychiatrists have published the "Good practice guide to ECT" and provides a detailed list over required knowledge and skills.[10]

Although ECT training includes theoretical education, to understand indications, risks, benefits, and opportunities in the device's facilities to adjust and modify treatment strategies, the treatment modality also requires an understanding of the logical order of steps to provide the treatment. This is where virtual reality (VR)-based training may be helpful.

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Virtual reality training has been used extensively in medicine to obtain improved procedural skills within surgery and general medicine and recent studies show that VR-based training can teach health care workers the BLS (Basic Life Support) algorithm faster.[11] Although VR has been used in treatment of certain psychiatric disorders, experiences in using VR in mental health training is limited. Studies in ECT are, to our knowledge, lacking.

Using VR to improve skills within a certain discipline is regarded as "simulation-based mastery learning" (SMBL), according to Griswold-Theodorson et al.[12] The goal of SMBL is to "ensure that all learners accomplish all educational objectives or reach competency standards beyond proficiency levels with little or no variation in outcome."[12] Although evidence is limited, findings indicate that SMBL in surgery procedures can improve patient care processes and outcomes.[12]

Checklist-based VR training in ECT will standardize training and provide a possibility for the trainee's endless repetitions until procedure is internalized and, thus, may enhance the trainee's confidence in the technique and improve patient care during ECT.

CHECKLIST IN MEDICINE AND PSYCHIATRY

The use of checklists was introduced in aviation 1935 after a fatal air crash and has since then been considered as permanent and mandatory tool to reduce accidents caused by human errors. After decades, the use of checklists has expanded beyond aviation and is now mandatory tools used by many other industries[13] including medicine and mental health. In 1999, the Institute of Medicine proposed the use of checklists to both avoid reliance on memory by standardizing and simplifying key processes, as well as maintain vigilance.[14] Surgical checklists have been demonstrated to reduce adverse events and improve patient care.[15] The "WHO surgical safety checklist" was published in 2007.[16] Subsequently, Woodcock et al.[17] modified this checklist addressing practice in the ECT suite. The number of patients was too small to draw any conclusions regarding significant reduction in patient morbidity. However, the authors experienced that the use of checklist revealed potential somatic risk situations, such as misprescriptions, the discovery of deep vein thrombosis, and abdominal aortic aneurysms, and ensured that the correct ECT dose was given to the correct patient.

CULTURAL SETTING

In our hospital, we train and certify approximately 10 to 15 clinicians in ECT annually. A relatively large group of clinicians participate in the regular ECT services at 2 sites in the hospital trust. Ten years ago, in a retrospective quality assessment comparing two different initial dosing principles within the hospital trust (not published), we discovered that from 69 age-based ECT courses, we had to exclude a substantial number of initial treatment sessions because of uncertainty regarding the dosing technique. Based on this experience, an expert group consisting of consultants in psychiatry and psychiatric and anesthetist nurses developed a quality improvement program for ECT practice, consisting of a certification program, an e-learning course, and a web-based clinical pathway for ECT.

AIM

The aim of this project was to develop an ECT checklist–based training program based on VR technology. This first phase includes a model for a stepwise training, preparing the candidate for the required sequences that precede the actual treatment.

MATERIAL AND METHODS

Based on a checklist developed to ensure a standardized preparation for ECT treatment, we established a working group consisting of clinicians involved in ECT treatment (anesthesia and psychiatry), specialists in clinical simulation training, leaders responsible for quality improvement in the hospital trust, and engineers with skills in developing VR programs.

The Thymatron System IV (Somatics, LLC) is the preferred ECT device in almost all of Norwegian ECT suites. Thus, we based the programming on the functions available in this particular model. The program should include the following steps in sequential order:

- Welcoming the patient and check that the patient has been fasting before treatment
- Turning the device on and off
- Know how to print out the paper and finish printing
- Check that the right program has been chosen, pushing the "Percent energy" button
- Indicate correct position of treatment electrodes according to right unilateral d'Elia electrode placement and prepare (rub) skin
- Place recording electrodes correctly, using bilateral 2-channel electroencephalography (EEG) recording (frontal – mastoid process) and electromyography (EMG) recording (over left brachioradial muscle)
- Measuring "Baseline"
- Adjust "percent energy" (charge, millicoulomb) from initial position (5% energy, 25.2 mC) to the correct dose (here defined as 50% energy, 252 mC)
- Apply the Thymapad on the right temporal region
- Apply conductive gel on hand-held electrode and place this electrode over the vertex
- Measure impedance, pushing the "impedance test" button

We did not include application of the electrocardiogram electrodes in the description because this monitoring usually is taken care of by devices other than the Thymatron.

Technological Challenges and Solutions

SAFE-ECT professionalizes parts of the technology used in computer games. We developed the training program using C Sharp (C#) programming language, based on the graphic motor Unity3D with the Virtual Reality Goggles Oculus Rift. By using cloud servers, we are able to let users communicate via the Internet in a common virtual room where they can see and hear each other, regardless of geographical location via the Internet. In this virtual room, we programmed all the tasks the users are supposed to do, and we track all the users' actions to measure if they are doing all the tasks they are supposed to. All the users' actions are synchronized across the Internet, so that other users in other locations can see everything everyone else is doing.

The program is designed to lead the trainee through the sequences determined by the checklist. Before each action, large virtual posters on the "wall" tell the trainee what is going to happen. If necessary, the trainee may explore the poster, to find illustrations that show correct electrode placement and so on. In the virtual room (the patient and the ECT device), each action is highlighted by yellow arrows, which indicate what the trainee should do. If the action is performed correctly, the trainee is rewarded, receiving a large, green tick. If performed incorrectly, nothing happens, and the trainee must repeat the action until rewarded.

RESULTS

We developed a prototype that guides the trainees through the initial steps to prepare them for real-life ECT treatment. We have tested the program to ensure that the sequential steps are correctly presented. We have demonstrated the program at the Nordic Association of Convulsive Therapy 14th Experience Meeting, at Gjøvik, Norway, in May 2019, receiving enthusiastic feedback from ECT colleagues.

DISCUSSION

Strength and Limitations

In phase 1, we have developed a novel training program based on VR technology to standardize the initial sequential steps that prepare the trainee for ECT. To our knowledge, this is the first attempt to use VR technology to provide training in ECT. The strength of this project is the possibility to give clinicians in the process of learning the art of ECT an unlimited access to train on the logical steps before administering ECT in "real life." This will increase the trainee's confidence in the method and improve patient safety. Another strength is that guidance provided by an expert in the field may be offered regardless of geographical distance. A third strength is that this program may be available globally for clinicians who use this particular device. A limitation is that the prototype, so far, has not been tested systematically in training. Another limitation is that the program must be installed and connected to external devices (VR glasses and external sensors), which presupposes a basic understanding of running the program and solving certain problems that the trainee may encounter during training.

Future Development and Possibilities

Phase 1 represents developing the prototype. We have yet to demonstrate its feasibility and applicability in clinical practice.

The following steps in developing a full-scale training program for clinicians will be as follows:

1. To test the prototype. record and solve technical problems, and adjust development according to feedback from trainees.
2. To develop a program that goes through the standard treatment of a virtual patient, select dosing procedure (age based, stimulus titration), and assess the quality of the treatment by observing the seizure and interpreting the EEG – phase 2.
3. To develop scenarios that clinicians will or may encounter, such as problems with high impedance, interpreting low-quality EEG, lack of clinical response, prolonged seizure, anesthesiological problems, and postictal confusion, and develop simulation scenarios addressing legal and ethical problems such as lack of consent to the treatment, cognitive decline, and compulsory ECT – phase 3.
4. To translate and make the program internationally available.

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