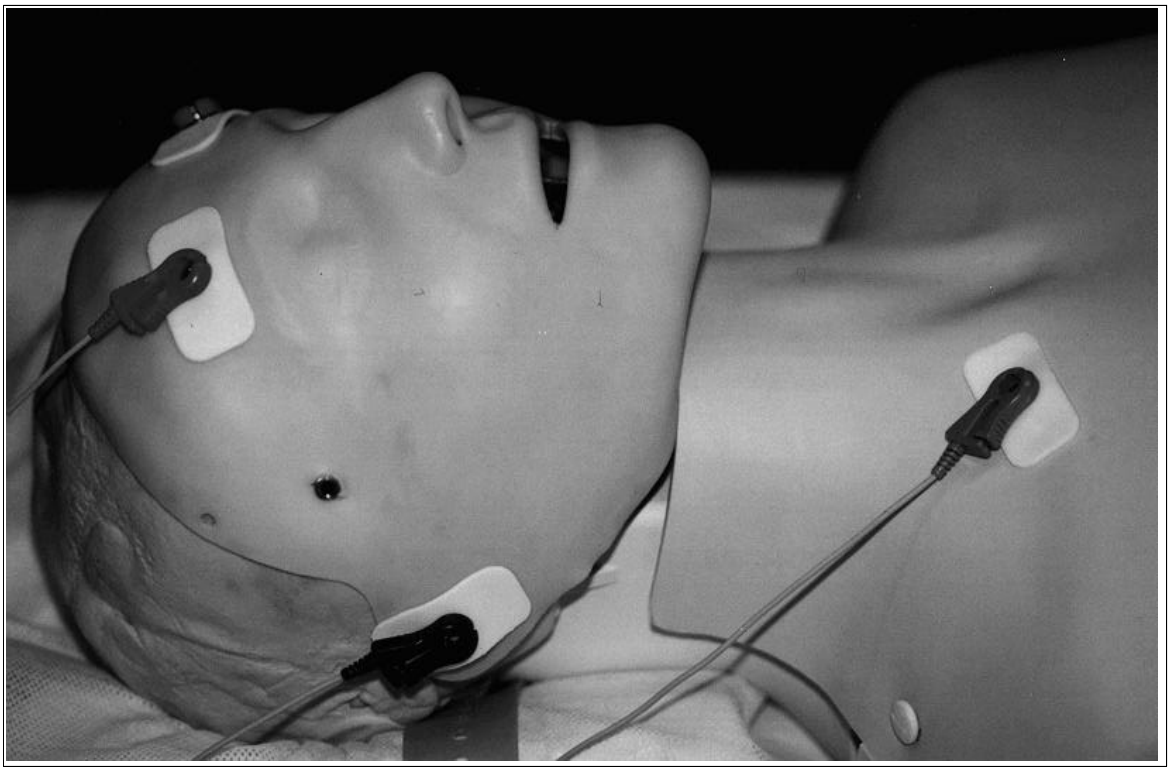
A.C.T.O.R

Apparatus for Convulsive Therapy
Operator Rehearsal



SYRINX Technology

A brief description of the Apparatus for Convulsive Therapy Operator Rehearsal (ACTOR).

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On the cover	Resting EEG being recorded from ACTOR
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1 Overview

SYRINX Technology is pleased to offer ACTOR the Electro Convulsive Therapy (ECT) simulator. SYRINX Technology's three principals are Stewart Montano (anaesthetist & biomedical engineer) Robert Montano (mechanical engineer) and Nicole Tsambasis (systems analyst and software designer). SYRINX technology has developed a number of unique solutions in the past including simulators for cardiopulmonary bypass, for placement of the "Swan-Ganz" catheter, a new airway management device for general anaesthesia and a real-time heat loss model of rail transport containers.

Bill Lyndon is a highly regarded academic psychiatrist specialising in psychopharmacology, the use of ECT for affective and neurological disorders, and teaching, especially the use of ECT.

The research and production of ACTOR has been the result of a collaboration between Bill and Stewart. Stewart is a biomedical engineer with experience in cardiovascular physiology and embedded microprocessor design, having a particular interest in the development of medical simulators.

2 Introduction : What is ECT?

ECT is the process of inducing a generalised seizure in a patient by the delivery of a trans-cranial electric stimulus. This is undertaken under general anaesthesia with muscle relaxation, which reduces the motor component of the seizure and the likelihood of patient injury. Seizure length has often been used to predict outcome, or duration of therapy. But as this is mostly measured by timing of the motor seizure, patient variations as well as drug doses may have a large effect on this measure. This makes measurement of motor seizure unreliable.

Recent changes in equipment used to deliver the electric stimulus, include the incorporation of facilities for electroencephalographic (EEG) monitoring during ECT. Continuous EEG recording during ECT has shown the unreliability of motor activity in predicting seizure duration, as well as a wide variety of EEG morphology, in response to otherwise standardised electrical stimuli. It is felt, by leading psychiatrists in the field, that study of the EEG morphology is as relevant to patient outcome as ECG is to patients with cardiac morbidity.

As with the introduction of any technological solution to a clinical problem, it brings with it drawbacks as well as advantages. In the case of Monitored ECT (MECT), the problems include the need to train the treating physicians to use the machine safely, as well as to recognise the significance of EEG morphological variation.

2.1 ECT training with a simulator

The current method of training physicians who have not used MECT before, as well as new psychiatry trainees, is like an apprenticeship. The trainee reads papers, listens to didactic instruction in MECT and may even watch some sessions of MECT. This exposes the trainee to some variations in EEG, few applications of the electrodes, and may only expose them to a single episode of dose titration.

Moreover, difficult to manage and catastrophic critical events occur rarely, so few psychiatrists have experience of these events. This means that few psychiatrists can learn from critical events.

ACTOR has been developed to aid in training & research, thus improving the efficacy & safety of patient care.

The design concept behind the development of ACTOR was to produce a simulation of convulsive physiology during the period of treatment for a patient undergoing MECT. Simply put, we set out to produce an "artificial patient" which would behave exactly as a real patient does when subjected to MECT. In addition, the design required that the ACTOR would be attached to all the equipment to which a normal patient was attached. This required that all the interfaces were made with the institutions equipment in the normal way. For example the patient EEG monitoring leads connect to ACTOR's EEG electrodes (situated using the fronto-mastoid positioning). The stimulating electrodes may be placed in any combination of unilateral or bilateral standard positions.

2.2 Modes of operation

The control electronics are able to change a number of aspects of the "patient" which cause 'events' or scenario's to which the trainee must respond. According to the trainee's response changes in the "patient" will be shown on the EEG tracing of the MECT machine. These changes are indistinguishable from those of a real patient and a high degree of realism is achieved. A non-exhaustive list of patient scenarios may be found in Appendix A. New scenarios may be added to ACTOR in the field by flash memory reprogram, or by a single IC swap. The latter is easily done by the end user

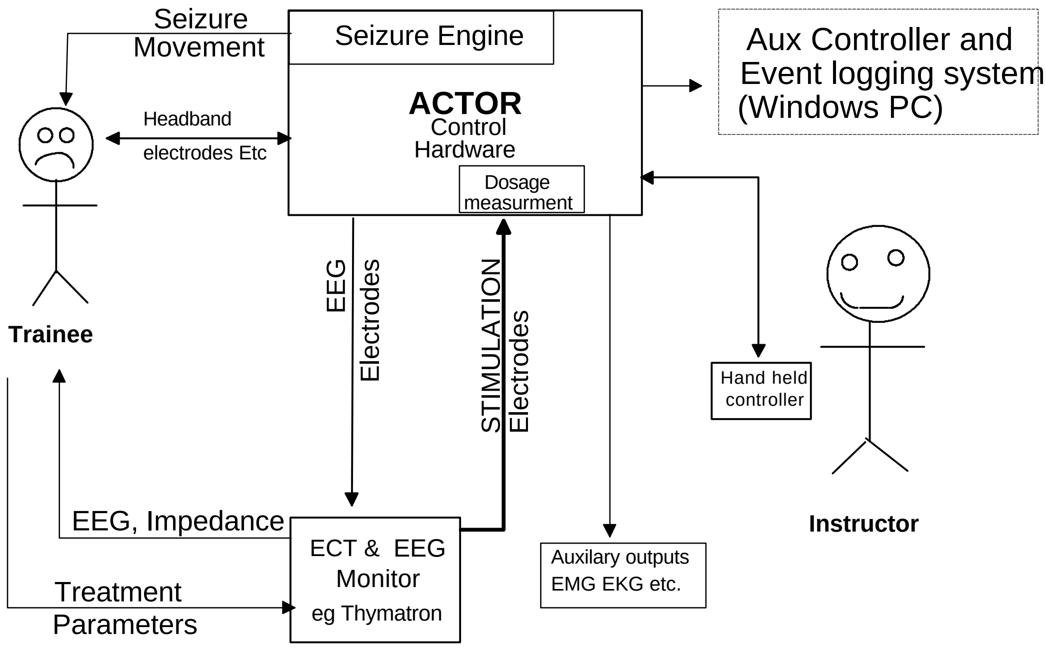


Figure 2 A schematic representation of the interaction and connections between ACTOR, the ECT machine, the trainee and the instructor.

2.3 Benefits

Benefits of a device such as ACTOR occur in a number of areas for example

A) Training novice Psychiatrists de novo (see section 2.4)

B) Use by equipment manufacturers to demonstrate new & existing features of their products

C) Continuing education and the maintenance of standards for experienced Psychiatrists

D) Training of psychiatric teams in Crisis resource management

E) Demonstrating ECT to medical and nursing students

F) Public demonstrations of ECT to dispel myths and dis-information that have unfortunately been associated with this effective and, at times, life saving procedure

2.4 The usefulness of ACTOR in the training of ECT practitioners

A recent project conducted by the authors was able demonstrate that a simulator was able to contribute significantly to the effectiveness of training in ECT. A group of trainee psychiatrists were randomised into 2 groups. The treatment group were able to gain hands on experience of using a MECT machine and the interpretation of real-time EEG tracings. They used the MECT machine connected to ACTOR as the "patient". The control group rehearsed the same steps and interpretations using each other as subjects. The MECT machine was not triggered!

An exit test was performed which demonstrated a large and significant difference between the groups. The simulator group were able to recognise more quickly and respond with fewer omitted critical steps than their tutorial taught peers.

This work has been presented at the ACT meeting in 1999 (Washington DC, May 1999) and also at the Annual Scientific Meeting of the Royal Australian and New Zealand College of Psychiatrists (Perth, Australia April 1999). An extract of the findings appears in appendix B.

In addition, ACTOR has now been used for a number of training and retraining workshops across Australia. As their session finishes most participants wipe the perspiration from their brow, and comment on both the reality and usefulness of ACTOR!!

3 Patient simulator description

3.1 Mechanics

The main interface between ACTOR and the MECT machine is the mannequin. This is a motorised head and thorax covered with a realistic face and skin, looking like a patient lying supine. It consists of a number of electrode attachment points, for EEG cables, stimulating electrodes and auxiliary physiological signals. The head allows use of all patient hardware, including mouth guards, anaesthetic masks and electrode retention straps.

To add further reality to the simulation ACTOR is able to move with the manifestations of the motor seizure. This not only adds to the simulation but also causes dental damage if appropriate precautions are not taken. (This movement is sufficiently realistic to have caused one unsuspecting trainee to drop the vertex electrode and jump back with surprise!)

3.2 Control hardware analog operating system

To provide a system which responds to changes in patient treatment, particularly stimulus dosing and electrode position, the system consists of an independent real-time RISC processor, in which the EEG, convulsive and physiological models run (see 3.4).

3.3 Operators console

A hand held, lightweight, console is used by the trainer to set the scenario, the patient type and to override the events if the trainee is doing particularly well (or poorly). It communicates with the control electronics by using the Convulsive Emulation Control Interface Language (CECIL). The activity of ACTOR may also be controlled from an attached IBM PC running the ACTOR hardware control software via a serial port.

3.4 EEG Physiological model

The EEG processor runs a heuristic model developed by the authors, generating not only convulsive EEG data, but also resting and post ictal wave forms. This enables those MECT machines equipped with morphological analysis algorithms to function with the data from ACTOR.

3.5 Data logging system

A optional computer keeps a continuous trend display of the events of the simulation. This permits easy reference for the instructor during the session, and a print out provides the basis for post simulation debriefing. This works independently of the brand of monitoring system in use.

In addition, seizures may be triggered from this console and patient variables set independently of the hand held controller. A technician can therefore control the simulator by serial link from another room.

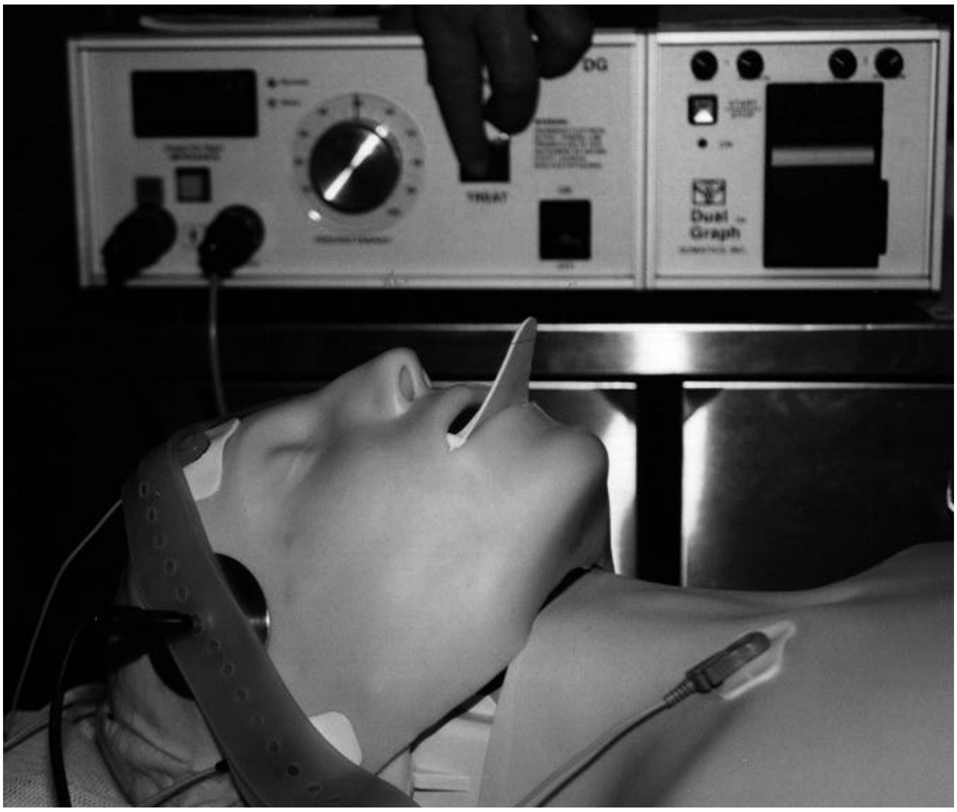
4 User equipment

The institution is required to provide a MECT machine. No modifications are required to the equipment and any brand or combinations of brands are suitable for connection to ACTOR. An institutions main treatment ECT machine can be used for patient care in the morning and simulations in the afternoon.

5 Advantages of hardware in medical simulation

Software models of various aspects of medicine exist today, especially since the advent of the buzz word "multimedia", however they are limited in both the breadth and depth of modeling. In addition, a computer based training (CBT) model has little realism when compared to the clinical experience. Literature already exists in anaesthesia demonstrating that residents exposed to hands on simulator training perform better than their tutorial taught peers. The research from section 2.4 and summarised in appendix B demonstrate that it is also true for ECT training with a simulator.

Furthermore, the interaction between a psychiatrist and the patient is almost EXCLUSIVELY machine based when administering ECT. That is, all inputs to the physician come from the EEG monitor and a few observed patient variables (chiefly movement). Therapeutic manoeuvres are achieved by manipulation of machine variables. ECT, therefore, lends itself to realistic hardware based simulation, like anaesthesia and aviation.



6 The role of Crew Resource Management in Psychiatry

Crew Resource Management (CRM) is a term used in aviation to refer to the ability to utilise the skills of the whole crew during a critical event. A parallel exists in medicine, where the senior physician is able to best use the skills of the whole team, when an unforeseen event occurs. The incorporation of ACTOR into an existing training program for ECT would form the basis for teaching the whole psychiatry team, i.e. CRM

With increasing complexity of aircraft and aviation systems, it has become apparent that during a crisis a single human is unlikely to be able to deal with the multitude of stimuli, make informed decisions and carry out remedial actions.

CRM aims to teach individuals who work as teams to work together as a team; in doing so bring the organised abilities of all team members to bear on the problem at hand.

The increasing complexity of patient care and medical interventions make this approach more & more necessary for optimal patient outcomes. Simulation provides the forum where the chief physician and the remaining team members can practice their respective roles. It also provides a safe, non threatening and patient independent method whereby new methods of treatment and crisis resolution may be practiced prior to becoming standard patient care

APPENDIX A
List of Simulated events

Routine ECT

Normal pre treatment EEG
Normal patient -- good seizure
Normal Post-ictal EEG suppression
Dose titration in a normal patient
Dose titration with unusually high threshold
Increasing threshold during the course of therapy

Patient Abnormalities

Dental Damage from seizure
Prolonged seizure
Poorly generalised seizure -- poor inter hemispheric coherence
Ultra brief seizure
Failed seizure
High patient impedance - preventing therapy

APPENDIX B

Does an ECT simulator enhance training of ECT Practitioners?

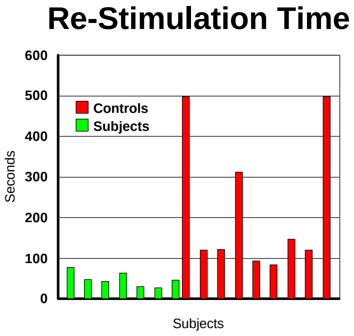
Oral presentation at the Royal Aust & NZ College Psychiatrists meeting Perth Australia April 1999 & Poster presentation, ACT meeting Washington DC May 1999
AUTHORS: Dr Bill Lyndon (northside clinic) & Dr Stewart Montano (St George Hosp. Sydney, Australia)

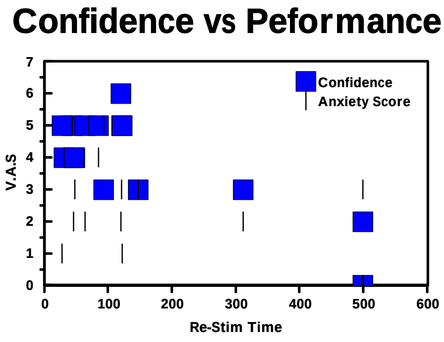
Introduction

The authors have developed an ECT simulation device which allows the trainee to deliver an actual ECT stimulus to a mannequin. The simulator has been programmed to produce a variety of EEG tracings which simulate real-life situations such as failed or prolonged seizures. An entire ECT treatment session can therefore be conducted on the mannequin instead of a real patient. The aim of this project was to evaluate the effectiveness of the ECT simulator as an aid to training psychiatrists.

Methods and Materials

Subjects were a group of 16 first year psychiatry trainees who had no previous involvement in ECT, other than witnessing one or two treatments as undergraduates. The group as a whole were given a one hour didactic session covering the theoretical background of the modern methods of ECT. They were then randomly divided into two groups, an experimental and a control group. The two groups were instructed in the operation of an ECT device with EEG monitoring (Thymatron) and a demonstration given of the operation of the device using the simulator. Each group was then given detailed "hands - on" instruction in ECT procedures and the use of an ECT device with EEG monitoring. The training of the experimental group was done with the aid of the ECT simulator and each trainee was able to give an actual treatment and have the EEG tracing to examine. A range of clinical situations was simulated for the experimental group as a whole, including a failed seizure. The control group used each other as models to practice the attachment of electrodes etc. rather than the simulator, and the ECT device was naturally not activated. Each group received specific instructions on how to deal with certain treatment events, such as missed or prolonged seizure, but only the experimental group were able to actually experience these events and take appropriate action in 'real time' using the simulator. Each trainee was then given a brief clinical vignette and asked to treat the 'patient' using the simulator. A pre-programmed event (a failed seizure) was produced by the simulator and the trainee asked to take the appropriate action. The time taken to restimulate was measured and the two groups compared. Also recorded were the number of correct action responses to the simulated scenario and a simple visual analogue scale measure of anxiety experienced by the trainee and the confidence with which the trainee made the treatment decision.





Results and Discussion

Graph 1 shows that those trained with ACTOR were able to recognise and treat a failed seizure in a very short space of time, when compared to tutorial taught controls. Graph two shows that few omitted important steps if they had hands on experience using the simulator. Surprisingly Graph three shows that performance is totally UNRELATED to perception of personal performance as shown by both anxiety and confidence scores. We have been able to show that hands-on-experience of ECT treatment sessions is able to help educate ECT practitioners.