THE ELECTROCONVULSIVE THERAPY WORKBOOK

CLINICAL APPLICATIONS

ALAN WEISS

ROUTLEDGE

The Electroconvulsive Therapy Workbook

Electroconvulsive Therapy (ECT) remains one of the most effective forms of neurostimulation for severe mental illness. Sound scientific research underpins contemporary practice challenging the complex history and stigma that surround this treatment.

The Electroconvulsive Therapy Workbook integrates the history of ECT with major advances in practice, including ultrabrief ECT, in a hands-on workbook format. Novel forms of neurostimulation are reviewed, highlighting the future directions of practice in this exciting area. The book is also richly illustrated with historical and technical images and includes 'clinical wisdom' sections that provide the reader with clinical insights into ECT practice. Online eResources are also available, featuring a wide range of questions and answers related to each chapter to help test and consolidate readers' understanding of ECT, as well as regionally specific legislation governing ECT practice in Australia and New Zealand.

This comprehensive introduction to ECT is a must-read for doctors in training, psychiatrists who require credentialing in this procedure, anaesthetists, nursing staff who work in ECT and other professionals who have an interest in ECT as well as consumer and carer networks.

Alan Weiss is conjoint senior lecturer at the University of Newcastle, Australia. He is also a fellow of the Royal Australian and New Zealand College of Psychiatrists (RANZCP) and chair of the Colleges Section for ECT and Neurostimulation (SEN); clinical director of the neurostimulation programme for the Hunter New England Local Health District; chair of the expert committee to revise 2010 NSW ECT Guidelines; and foundation director of neurostimulation at two private hospitals in Newcastle. Dr Weiss is a member of the International Society for ECT and Neurostimulation and the American Psychiatric Association.

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Clinical Applications

Alan Weiss

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Preface

Electroconvulsive Therapy (ECT) remains one of the most effective treatments for severe mental illness. It has a complex history that continues to stigmatise and distract from the large number of changes in technology and methods that have made it a modern treatment. Modern ECT practice is based upon sound scientific research generating a substantial evidence base that guides treatment. However, there continues to be a gap between the clinicians who administer ECT and its consumers and a failure of ECT practitioners to implement novel techniques.

Training provided to doctors administering ECT worldwide has been inadequate and highly variable. International audits have highlighted a lack of expertise and resources in this area. In 2003, the UK's National Institute for Health and Clinical Excellence (NICE) Guidance Document for ECT was very critical of ECT practice, stating that ECT should be a "treatment of the last resort", a criticism that may have merit owing to the vast difference between clinicians' and consumers' perspectives of ECT. Staff administering ECT often have superficial training before they are expected to administer the treatment in their hospital.

The Electroconvulsive Therapy Workbook is a book for clinicians and trainees of all disciplines who practise ECT. It is not a Royal College or Association clinical practice guideline or an academic work but a comprehensive approach to ECT that emphasises knowledge in an environment that challenges prejudice and stigma, incorporates new techniques to minimise unwanted side effects and maximise the benefits of ECT.

The Electroconvulsive Therapy Workbook has been the result of two major influences: 22 years of listening to patients undergoing ECT and using their experiences to change practice through the development of a competency-based ECT training programme for doctors, nurses and students working in the area of ECT. The competency-based learning model provides a structured approach to ensure that trainees who complete the ECT Entrustable Professional Activities (EPA) programme have a high level of technical skills and the ability to engage with patients undergoing ECT in an empathic manner, closely monitoring progress and making changes in treatment to minimise adverse reactions. There is an emphasis on training in a multidisciplinary setting that places the ECT team at the core of treatment. *The ECT Workbook* is an integral part of this programme, anchoring learning in sound clinical practice.

The ECT Workbook offers practical information, supported by recent evidence, concerning the clinical application of ECT in psychiatric practice throughout the world. Information is broken down into relevant sections using a workbook format: overview, definition, knowledge (ranging from past history to major advances), mechanism of action, clinical indications, efficacy, neurostimulation techniques, organisational

and administrative skills, clinical skills, technical skills, anaesthesia, maintenance ECT, the lived experience, the role of the ECT nurse and detailed scenario-based problems.

Relevant chapters are illustrated with historical, technical photos and figures to aid learning with a question and answer format following most chapters. Many sections include a "clinical wisdom" insert that offers advice where there is limited evidence to guide treatment drawing upon extensive practice-based experience in the administration of ECT.

After reading this volume it is anticipated that the reader will have a comprehensive understanding of current ECT practice and feel equipped to challenge stigma by implementing change into the way ECT is delivered in their service.

Dr Alan Weiss
Newcastle, NSW, Australia

Acknowledgements

The Electroconvulsive Therapy Workbook would not have been possible if it were not for the tireless and unyielding support from my wife, Ann, and my three daughters, Ella, Danika and Petra. Thank you Ella and Caitlin for your early inspiration and your support in helping me type and design the original manuscript that provided the framework for *The Electroconvulsive Therapy Workbook*.

I would like to thank all of the patients that I have treated with ECT over many years who have shared their lived experience, inspiring me to develop an ECT service and training programme with a strong focus on eliminating stigma, using modern techniques that minimise cognitive impairment while striving to achieve complete remission. In particular, I would like to thank Alirra for bravely agreeing to share her moving and personal account of ECT from the first moments through to maintenance treatment.

A big thank you goes to Shane and the ECT team at the Mater Hospital, Newcastle, Australia. This team forms the basis of the ECT training programme. Shane has provided endless support over many years to myself and countless trainees and has become a vast store of clinical wisdom concerning ECT practice. I am indebted to Shane who helped me write the chapter on the ECT nurse and his inspiration and encouragement to continue with this large and at times overwhelming project.

A special thank you goes to Doctor Michael, a vibrant and enthusiastic senior psychiatry fellow who is passionate about his patients, ECT and neurostimulation. Doctor Michael's enthusiasm and support has been inspirational in the writing of *The Electroconvulsive Therapy* Workbook, reinforcing my own passion to administer ECT in a manner that minimises stigma, is patient-focused and patient-responsive, and has a strong evidence base with the capacity to incorporate practice-based experience to ensure that patients benefit from this powerful treatment with the least possible side effects.

The Electroconvulsive Therapy Workbook would not have been as colourful and informative if it were not for Luke, who generously consented to model for all photographs in this volume. It is refreshing to incorporate the difference in his presentation between the two photo shoots that occurred many months apart echoing the enormous diagnostic, psychosocial and cultural difference in patients who are given ECT.

I am most grateful to Doctor John Fluit for opening up his fantastic medical history museum and providing all of the historical photos that grace this Workbook. I am indebted to him for assisting in writing Section 2.1 History: treatment of mental illness.

I would like to acknowledge and thank Amber for her inspiration and innovation in the drawings and figures that are used to simplify and clearly explain different concepts used in this *Workbook*.

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I would like to thank the staff and psychiatrists who work at Lakeside Clinic, Warner's Bay Private Hospital, Newcastle, Australia, who have provided encouragement and support, reinforcing that the techniques incorporated in *The Electroconvulsive Therapy Workbook* are effective in reducing stigma, minimising cognitive problems and achieving remission in a patient-focused supportive environment that is responsive to clinical change.

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Dr Alan Weiss

CHAPTER 1

Introduction

Section 1.1

Overview

PURPOSE

Electroconvulsive Therapy (ECT) is a treatment that has a complex history. It was first used in 1938. Since that time, many advances have been made in the practice of ECT and the science behind this very effective treatment for severe mental illness.

For many years, the training of doctors and other staff administering ECT was inadequate and highly variable. Medical staff administering this treatment often had very superficial training before they were expected to administer the treatment in their hospital.

Duffett and Lelliott (1998) commented that after a 20-year period only modest improvements in the local practice of ECT within England and Wales were demonstrated, after the Royal College of Psychiatrists (RCP) completed its third large-scale audit. These audits were very extensive and were followed by specific recommendations for change highlighting a lack of expertise and resources that were allocated to the provision of ECT.

Significant changes have been made since the release of National Institute for Health and Care Excellence (2003) guidance on ECT for depressive illness, schizophrenia, catatonia and mania. This document was based upon two systematic reviews sponsored by the Department of Health; UK ECT Review Group (2003) and Rose, Fleischmann, Wykes, Leese and Bindman (2003) highlighted the consumer's viewpoint. Following these reviews, the guidance for ECT was very critical, stating:

> ECT should be used only to achieve rapid and short-term improvement of severe symptoms after adequate trials of other treatments have failed when the condition is considered to be potentially life-threatening with, severe depressive illness, catatonia or a prolonged or severe manic episode. The current state of the evidence does not allow the general use of ECT on the management of schizophrenia to be

> recommended as the long-term benefits and risk of ECT have not been clearly established, it is not recommended as a maintenance therapy in depressive illness. ECT should be used as a treatment of last resort.
>
> (NICE, 2003)

This guidance was met with strong criticism from psychiatrists within the UK and around the world, as they were not consistent with the common clinical use of ECT in the everyday treatment of depression. The *ECT Handbook,* 2nd edition (Scott, 2005) was revised to address the criticisms raised by the NICE guidance document and released as *The ECT Handbook,* 3rd edition (Waite and Easton, 2013). More recently, the Royal College of Psychiatrists released the *ECT Accreditation Service (ECTAS): Standards for the Administration of ECT,* 12th edition (Royal College of Psychiatrists, 2015), which specifies minimum standards of practice. Australia and New Zealand have followed this lead, with many states making a considerable effort to review ECT practice by developing minimum standards guidelines (Chief Psychiatrist of Western Australia, 2015; NSW Health, 2010; SA Health, 2014; Victorian Government, 2014).

It was within this environment that *The Electroconvulsive Therapy Workbook* evolved over a 16-year period as part of a competency-based ECT training programme for staff working in this area.

CLINICAL WISDOM 1.1.1

One of the most distressing encounters that junior house staff and psychiatric registrars have to deal with when completing studies in psychiatry is their encounter with the relevant mental health legislation, which often involves dealing with an independent mental health review tribunal (MHRT) in the state/territory in which they practise. In many instances this creates significant ethical concerns within the individual about the pros and cons of administering psychiatric treatment to patients who are unable to provide informed consent.

The adversarial model is particularly paramount in some jurisdictions where the consumer/patient is entitled to legal representation whereas the medical arguments are often presented by a junior member of the medical team. The medical argument necessarily involves breaking the confidence of the patient by expanding the content of significant past events, psychotic delusions or self-harming behaviour. This process can create distress in the doctor who has limited academic knowledge, clinical and legal experience and a superficial understanding of complex clinical details.

The dilemma is magnified when the doctor is also required to ask for a determination to administer a course of ECT. It is not until some time later, when the doctor has followed a number of patients through a course of ECT, that they understand the marked and rapid clinical improvement that occurs with this treatment, providing meaning to what can often be a hostile and unpleasant experience.

The process becomes even more complex as the adversarial model challenges the fundamental core skill of psychiatry, namely establishing a good therapeutic alliance with the patient (Bellis, 2016; Martin, Garske and Davis, 2000). The registrar is obliged to reveal complex, detailed personal information in a semi-legal setting to enable the tribunal to make a determination. This fundamental breach of confidence usually results in the patient resenting the doctor, and often will be reluctant to speak to them for the remainder of the admission if the tribunal has determined that ECT is necessary.

The junior psychiatric registrar can be left feeling disillusioned, confused and angry as this process is at odds with their early impression of psychiatry as a profession that is altruistic, nurturing and caring. The ethical challenge is so intense that it often leads to early withdrawal from the training programme.

This phenomenon is well recognised and has led to the development of some innovative strategies to empathise with the new trainee, like *The Hitchhikers Guide to Psychiatry* (Varmos, 2008).

There are four guiding principles that can assist in navigating this difficult road. These principles are guided by the basic tenets of ethics (Bloch and Singh, 2001). They include:

- Beneficence: do good; maximise efficacy.
- Non-maleficence: do no harm; minimise side effects and reduce stigma.
- Autonomy: respect patient; ensure that individual wishes and differences are considered.
- Justice: equality; ensure that there is equal opportunity for treatment regardless of age, gender, colour, religion or wealth in the least restrictive environment (Bloch and Singh, 2001).

Application of these principles has formed the basis of clinical practice over many years, particularly in ECT, enabling difficult situations, ethical dilemmas and conflict situations to be overcome and resolved. Fink (2009) provides a more detailed and helpful discussion of these principles as they apply to ECT.

All medical practice seeks to optimise benefits and minimise risks by ensuring a high level of competency in staff administering the treatment. The ECT technique can have a substantial impact on clinical outcome, particularly cognitive impairment (Sackeim et al., 2007). The benefits of modern ECT are well defined and substantial, offering severely unwell patients a chance to recover in modern settings that provides autonomy, justice and beneficence.

> ECT worked for me, not that it will work for everyone. . . . We need to face up to ECT's risk and try to reduce them, but we need to acknowledge its potential benefits. . . . There are too many people in desperate need of a workable treatment to limit any viable options.
>
> (Dukakis and Tye, 2006)

AIMS

The aims of the Electroconvulsive Therapy training programme are set out in Table 1.1.1.

OBJECTIVES

The objectives of the Electroconvulsive Therapy training programme are set out in Table 1.1.2.

A COMPETENCY-BASED ECT PROGRAMME

A recent initiative in postgraduate medical education is competency-based learning with the use of modules incorporating entrustable professional activities (EPA) (Cate and Sheele, 2007). An EPA is defined as an activity or procedure that should only be carried out by a trained specialist who achieves a level of competency in a range of special skills that are fundamental to the procedure. ECT is a good example of an EPA. Such a programme was first described in the Netherlands to help supervisors determine the competency of their trainees (Scheele et al., 2008). Supervisors consider whether or not to delegate professional activities to trainees by determining whether they feel confident to trust a trainee to perform a specialised task with specific independence. At completion the trainee knows when to ask for additional help and can be trusted to seek assistance in a timely manner (Cohen and Port, 2012).

Competency-based training and assessment is the term used in the education literature that closely examines what actual tasks a person has to perform in the "workplace" in the role for which they are being trained and then ensuring that the required

Table 1.1.1 Aims

- Provide an overview of the historical context surrounding the practice of ECT
- Provide an understanding of how the community has been influenced by the media, resulting in shame, stigma and marginalisation of ECT practice
- Identify the changes that have occurred in ECT practice since its inception as the first neurostimulation technique
- Understand the science and research that underpin modern ECT practice
- Understand local protocols and procedures that determine ECT practice
- Understand the legal principals as they apply to the relevant Mental Health Act that governs the practice of ECT in the local region, with an emphasis on adequate informed consent
- Understand the clinical context in which modern ECT is utilised
- Understand the indications for ECT as well as the necessity for a comprehensive history, physical examination, appropriated investigations and mandatory cognitive and diagnostic measures
- Understand how to proceed with high-risk populations and special precautions that are required
- Be familiar with all aspects of anaesthesia
- Understand the rationale for monitor, role of the "time out procedure" and evaluation during and after the treatment
- Understand dosing protocols, procedures and rationale for different electrode placements
- Develop confidence in interaction with patients, careers and the ECT team
- Demonstrate an ability to obtain informed consent and the importance of involving family and careers when treatment is voluntary
- Ability to present a patient to the relevant mental health review tribunal to request an authorization to commence ECT

skills are taught and assessed in training (Cate and Sheele, 2007; Cohen and Port, 2012; Scheele et al., 2008). In particular, competency refers to the demonstrated ability of the person being trained to actually perform the important learned tasks, at the required level in the workplace (Cate and Sheele, 2007). It is known that knowledge alone does not ensure a competent practitioner. It also requires the right attitude and a number of practical skills for the task required.

In recent years this approach to medical education has been applied to ECT. The ECT competency-based training programme has been designed to provide "hands-on" learning for candidates over a six-week period. In addition to having hands-on experience treating many patients, there is also a self-discovery or experiential session with the aim of giving the trainee the experience of being the patient. This "getting your hands dirty" session is conducted once during the training period (often when the patient list is short). The aim is to give each trainee the experience of being the psychiatrist administering the treatment and then being the patient by simulating ECT treatment in theatre.

The ECT team has found that this experience provides the trainee with a personal experience of simulating ECT practice in situ as well as a snapshot of the patient's experience of the treatment. Feedback from trainees has consistently highlighted the value of this programme component, which is practical and a lot of fun.

At completion of the EPA the trainee will be proficient in the modern use of ECT, demonstrating proficiency in all of the expected tasks associated with the prescription, administration and monitoring of ECT and able to complete the medical competency form.

The ECT Workbook provides the framework for an ECT EPA where trainees have to complete a case-based discussion (CbD) critically examining

Table 1.1.2 Objectives

- Describe the history and recent innovations in ECT practice and treatment
- Describe brain neuromodulation with specific reference to neurostimulation
- Define ECT, highlighting its benefits and limitations in a concise way to challenge public perceptions of this very effective but misunderstood treatment
- Describe the indications and contraindications for ECT
- Demonstrate an awareness of and appropriate management of medical comorbidities
- Describe situations of increased risk associated with ECT and how to manage them
- Describe complications of ECT and their management
- Describe the principles of stimulus dose titration, the strengths and limitations of this technique and alternative dosing strategies
- Demonstrate a detailed knowledge of the techniques in administering different types of ECT
- Demonstrate an ability to identify and measure the correct anatomical sites for recording and treatment electrodes for different types of ECT
- Demonstrate an ability to adequately prepare all electrode and treatment sites for all forms of electrode placement
- Describe the difference between different electrode placements, highlighting strengths and weakness
- Describe the different types of ECT highlighting the benefits and limitations of each method
- Understand potential drug interactions with ECT
- Understand the basic science and research evidence that underpin ECT
- Administer different types of ECT in a competent and professional manner
- Demonstrate basic knowledge of EEG monitoring and the relevant parameters involved in clinical decision-making
- Demonstrate an ability to work with the ECT team, recognising the specific tasks and roles of each team member
- Identify the challenges that are encountered in setting up an ECT service
- Describe the principles involved with ECT anaesthesia and recovery
- Describe the rationale behind using different induction agents and their impact on the quality of ECT administered
- Demonstrate an ability to liaise with inpatient and community teams concerning relevant issues involved with the delivery of ECT

the use of ECT in either an acute or chronic patient. At completion of the module the ECT coordinator conducts a workplace assessment by completing a direct observation of procedural skills (DOPS) form. The candidate gives a PowerPoint presentation on a ECT topic that is clinically relevant and of interest to them. The final assessment is the completion of an open book exam followed by an interactive discussion of the results. All questions are taken out of *The Electroconvulsive Therapy Workbook*. Robust discussion is more important to complete the EPA than the final test score.

CLINICAL WISDOM 1.1.2

> It is not an exaggeration to say that ECT has opened a new reality for me. I used to deny when a depressive episode was coming on, to others and myself. I just could not face it. I thought if I ignored it, it might go away on its own. Now I know there is something that will work and work quickly. It takes away the anticipation and the fear. . . . It has given me a sense of control, of hope.
>
> (Dukakis and Tye, 2006)

Table 1.1.3 Medical Competency Checklist

Competency criterion	*Competent*	*(tick)*	*Comments*
Knowledge			
History			
Recent developments			
Legal aspects/legislation			
Drug interactions			
Clinical indications			
Risk situations			
The sequence of ECT			
Adverse events			
Anaesthesia			
Other			
Administrative skills			
Clinical governance			
Treatment schedule			
ECT facilities			
ECT documentation			
Clinical skills			
Patient interaction			
Staff interactions			
Informed consent			
Patient rapport			
Communication with staff			
Technical skills			
ECT clinical pathway			
ECT technique			
Equipment			
Basic steps			
Set dose/charge			
Skin preparation			
Cuff monitoring/ILT			
Monitoring lead placement			
Treatment lead placement			
Testing impedance			
Baseline determination			
Labelling the trace			
Role of anaesthetic agents			
Team consultation about current treatment			
Pre deep tendon knee reflex (DTKR)			
Observe fasciculations			
Post DTKR			
Recheck impedance			
Ensure mouth guard placement			
Team consent to treat			
Administer ECT			

Table 1.1.3 continued

Competency criterion	*Competent*	*(tick)*	*Comments*
Stimulus dosing			
Titration protocol	_____	____	_____
Determining dose/charge	_____	____	_____
Dosing strategies:			
Stimulus dose titration	_____	____	_____
Stimulus parameters:			
Pulse width	_____	____	_____
Seizure threshold	_____	____	_____
Subconvulsive stimulation	_____	____	_____
Electroencephalogram (EEG)			
EEG wave forms	_____	____	_____
Phases of EEG	_____	____	_____
Interpretation of EEG	_____	____	_____
When to change dose	_____	____	_____
Markers of seizure adequacy:			
• Postictal suppression index (PSI)	_____	____	_____
• Average seizure energy index (SEI)	_____	____	_____
• Maximum sustained power (MSP)	_____	____	_____
• Maximum sustained coherence (MSC)	_____	____	_____
Impedance – static/dynamic	_____	____	_____
EEPRS	_____	____	_____
EEG artefacts	_____	____	_____
Electrode placement (EP)			
Choice of EP	_____	____	_____
Right/left unilateral	_____	____	_____
Bifrontal	_____	____	_____
Bitemporal	_____	____	_____
Left anterior right temporal	_____	____	_____
Criteria for altering EP	_____	____	_____
New directions			
Magnetic seizure therapy	_____	____	_____
Transcranial magnetic stimulation	_____	____	_____

Trainee comments: _____

_____

Signature: _____

Director of ECT comments: _____

_____

Signature: _____

ECT coordinator's comments: _____

_____

Signature: _____

Date: _____

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Section 1.2

Definition

ECT is a treatment that has spaned nearly 80 years. During that time it has been given many different names, including Electroconvulsive Therapy (ECT), electroseizure therapy (EST), electoshock and convulsive therapy (CT) (Fink, 2009). Some of these names were not accurate and contributed significantly to the stigma associated with the treatment. Fink (2009) notes that electroshock is not an accurate term as there is no shock involved in ECT. It originated in 1933, when insulin was first used to treat schizophrenia and patients did show classic signs of "surgical shock", including sweating, pallor and lowered levels of consciousness, and it was called insulin shock treatment. Seizure therapy, known as convulsion therapy, followed a year later, with the electrical induction of seizures in 1938 being termed "Electroshock" (Fink, 2009). Electroconvulsive Therapy (ECT), now the preferred name, has been used more recently to describe the treatment.

Over the years, the term shock treatment has remained popular and used by the media to gain immediate attention and instant recognition following its use in the movie *One Flew Over the Cuckoo's Nest* (Kesey, 1962). The term continues to be used by the media to stigmatise and denigrate the treatment (Bucci, 2009; De Brito, 2004) or portray a more balanced report (Brockie, 2013; Morrison, 2009). The popularity of the term is reflected in the book *Shock: The Healing Power of Electroconvulsive Therapy* (Dukakis and Tye, 2006), which provides a balanced view of ECT, interweaving the history of ECT with a positive account of a consumers personal experience of the treatment that saved her life. Unfortunately the term "shock" carries with it the notion that the treatment is painful, an image that is widely used by the Citizens Commission on Human Rights, established in 1969, to "investigate and expose criminal and abusive practices of psychiatrists" (Church of Scientology, 2015).

Painful electric shocks were used as aversion therapy as part of the early developments of operant conditioning (Wilson and Davison, 1969). Operant conditioning was a technique that used positive stimuli to reward positive behaviours and negative stimuli to inhibit unwanted or negative behaviours like headbanging, unwanted screaming in intellectually disabled patients and self-injurious behaviours. The initial stimulus for aversion conditioning was chemical and its move into painful electric shocks was controversial (Wilson and Davison, 1969).

As the science of psychology progressed, aversion therapy was applied to a range of other "deviant" behaviours: homosexuality and other sexual deviations (Feldman, 1966), compulsive gambling (Barker and Miller, 1968) and changing the sexual object choice through controlling masturbation (Marquis, 1970). The stigma associated with these abandoned and now discredited treatments fuels the persistent stigma associated with ECT (Torpey, 2016).

Further confusion comes from "electroconvulsive shock" (ECS), a term used to describe the

CLINICAL WISDOM 1.2.1

One of the biggest challenges that ECT faces in modern times is the stigma that remains prevalent throughout the community. The multiple terms and definitions that have been applied to this treatment have actively contributed to this prejudice. The advent of neuromodulation and more specifically neurostimulation has placed ECT into a context that enhances understanding of how it works challenging misinformation enabling the development of new and more focal techniques like Focal Electrical Administered Seizure Therapy (FEAST).

Photo 1.2.1 *Aversion stimulator*

experimental induction of seizures in animals models that were designed to maximise the concordance of experimental animal studies with the clinical use of ECT (Nutt and Glue, 1993).

The journal *Convulsive Therapy* was established in April 1985 to provide a scientific platform for ECT research and discussion (McCall, Kellner and Fink, 2014). The foundation editor focused on convulsive therapy rather than other, more stylish areas of research because the practice was being actively challenged by both professionals and public attacks. Governments in many states and countries around the world condemned the practice enthused by the many new drugs and new forms of psychotherapy that were being developed to treat depression and psychosis (McCall et al., 2014).

The journal was called *Convulsive Therapy* as this was the most descriptive and least pejorative term when compared to other common terms used to describe ECT at that time, "shock therapy, electroshock and seizure therapy" (McCall et al., 2014). The goal of the journal was to provide a forum for ongoing debate and argument, systematic observation, comparison, deduction and verification of experiences with seizures and psychotic behaviour (Fink, 1985). Over the years, ECT has embraced modern anaesthetic practice, which has largely abolished the convulsion, the outward muscular manifestations of a seizure. Acknowledging this change in clinical practice and the increased trend to call the procedure ECT to overcome stigma, the journal changed its name to the *Journal of ECT* in 1998 (McCall et al., 2014).

Electroconvulsive Therapy has been defined as a medical procedure that involves the electrical induction of a series of generalised grand mal seizures, under general anaesthesia, with the specific aim of bringing about therapeutic remission in patients suffering from episodes of specific mental disorders such as major depression, mania and certain types of schizophrenia. Contrary to the views expressed by critics of the procedure, ECT is not subconvulsive electrical stimulation of the brain, or administration of aversive electrical stimuli for behaviour modification treatment. It is not invasive, no tissue is incised or removed, and therefore it is not a surgical procedure. It does not result in any

gross anatomical or histological lesions producing permanent brain damage.

It is believed that the brain's control of the seizure may be what makes ECT efficacious (Abrams, 2002). Seizure induction as a treatment for psychiatric illness was based upon early observations that symptoms of dementia praecox (schizophrenia) were diminished when patients developed epilepsy and that patients with epilepsy had a low incidence of psychosis (Mankad, Beyer, Weiner and Krystal, 2010).

Recent neuroscience reports have verified that repeated seizures create new neurons and enhance gliosis providing a further explanation as to why induced seizures are highly antimelancholic (Bolwig and Madsen, 2007).

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Section 1.3

Equipment

HISTORY: ECT DEVICES

Cerletti and Bini designed and built the first ECT device in Rome, Italy, in 1937 (Metastasio and Dodwell, 2013). In 1941, Dr H.M. Birch, with the assistance of C.R.Paul from the physics department at the University of Adelaide, built the first ECT device in Australia, which was used to treat patients with manic depression and schizophrenia at Glenside Hospital in South Australia (Website for the Virtual Museum, 2015).

C.R. Paul manufactured a second device in 1943 for Dr Dibden, who also worked at Glenside Hospital.

Dr H.M. Birch published an article in the *Medical Journal of Australia* on 20 June 1942 describing the physics involved in constructing the device, including a circuit diagram and a review of the first nine months of clinical use (Website for the Virtual Museum, 2015). The device used contemporary telecommunications technology incorporating a telephone dial that allowed the stimulus length to be varied. There were a number of different device manufacturers in Australia. Photo 1.3.1 illustrates an ECT device manufactured by Techtron Appliances in Melbourne, while Photo 1.3.2 illustrates an ECT device manufactured by "BOTH" and sold in Adelaide and Sydney.

Dr H.M. Birch recognised that the effective dose of the alternating current may differ between

Photo 1.3.1 *Dial-up ECT device*

Source: Rodman & Kelame electro medical instrument makers, Sydney

Photo 1.3.2 *Dial-up ECT device with history, Morisset Hospital Historical Society, "BOTH" electroconvulsive therapy machine (ECT)*

"There are several types of machines manufactured. An anaesthetic and muscle relaxant is given followed by artificial ventilation with oxygen. A soft mouth guard protects the teeth during the induced convulsion. Electrodes are covered with gauze wadding and soaked in saline to improve conduction then positioned across the skull. The telephone dial is dialed from the number '9' position to induce the current, which causes a controlled convulsion. ECT can be an effective treatment for severe depression, catatonia, some forms of mania and schizophrenia.

Why this treatment is so effective is still mysterious. The brain functions using electrochemical messages, and it is thought that ECT-induced seizures interrupt these messages and 'reset' the brain."

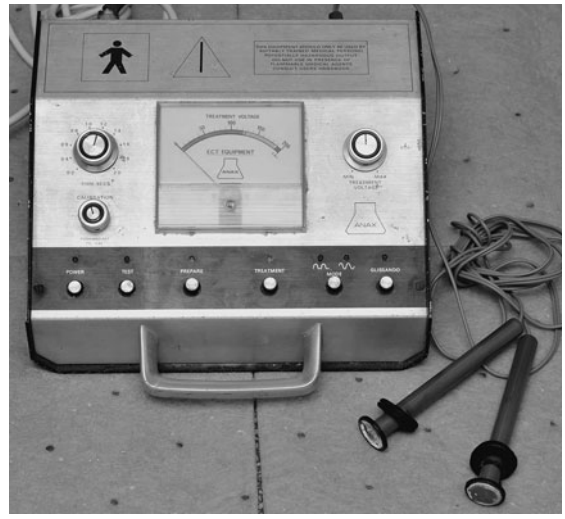

Photo 1.3.3 *Sine wave ECT device*

patients owing to the impact of the skin, tissue and bony structures, allowing the stimulus to be adjusted, an early acknowledgement of seizure threshold (Website for the Virtual Museum, 2015).

The telephone dial-up device from the 1950s illustrated in Photos 1.3.1and 1.3.2 was used at Morisset Hospital until the 1960s, when it was replaced by a sine wave ECT device shown in Photo 1.3.3.

Sine wave devices such as that illustrated in Photo 1.3.3 replaced the dial-up instrument in most

Photo 1.3.4 *MECTA Model C*

hospitals administering ECT at that time around the world.

Oregon Health Sciences University (OHSU), Portland, Oregon, developed the original MECTA, an acronym meaning Monitored Electro-Convulsive Therapy Apparatus, to counter the ECT stigma that had ramped up against ECT in the 1970s within the USA. Dr Paul Blachly was concerned that patients were getting inferior treatment and required a new device with built-in safety features: a self-test to assure adequate patient electrode connections before being allowed to treat to avoid skin burns, a bidirectional pulse width one tenth of the energy of competitive Medcraft and Reider sine wave devices, and two monitoring channels. MECTA (MECTA Corporation, 2015). Such innovation changed the practice of ECT. What is disturbing but common in the development of ECT is how slowly new technology gets incorporated into clinical practice. This is well illustrated in the community study of ECT, where some centres continued to use sine wave devices across the state of New York even after the year 2000 (Sackeim et al., 2007).

The original MECTA Model C device, illustrated in Photo 1.3.4, was developed in 1973 by Oregon Health Sciences University and sold by the MECTA Corporation from 1980. The instrument was innovative as it was the first device to incorporate monitored electroencephalogram (EEG) and electrocardiogram (EKG) brief pulse into an ECT device. MECTA Model D, shown in Photo 1.3.5, was developed by the MECTA Corporation and introduced in 1981 and was quickly followed by

Photo 1.3.5 *MECTA Model D*

Photo 1.3.6 *MECTA Model JR-1*

Models JR-1, shown in Photo 1.3.6, JR-2, SR-1, illustrated in Photo 1.3.7, and SR-2, which were developed by MECTA in collaboration with the Columbia University and released in 1985, a collaboration that lasted until 2006. These devices dominated the US market for 13 years and lead to substantial improvement in clinical practice. These devices were eventually replaced by new devices in 1998 (MECTA Corporation, 2015).

In the United Kingdom, the device market was dominated by ECTRON Limited, which was set up by a psychiatrist, Robert Russell, in 1950. Devices have evolved from the Ectnos and Ectonustim series to the current model Ectonustim Series 6+ ECT device (ECRON Limited, 2016). In more recent years, the UK, like many other ECT services worldwide, has incorporated Thymatron and MECTA devices into their practice.

Photo 1.3.7 *MECTA Model SR-1*

In Australia, the sine wave devices were replaced with a Kabtronics unit, which incorporated brief-pulse, square wave technology, an innovation that reduced the level of cognitive impairment in patients having ECT (Spanis and Squire, 1981). The Kabtronics device is illustrated in Photo 1.3.8.

It was manufactured locally using electrical fittings manufactured by Clipsal, a large Australian company. The device utilised a Y-shaped, fixed handheld unilateral electrode that incorporated both mental discs with a switch built into the top of the yoke, allowing the stimulus to be delivered by direct pressure from the thumb, illustrated in Photo 1.3.9. In many centres, these electrodes replaced the rubber band and metal disc system that was commonly used at that time and is illustrated in Photo 1.3.10.

Theoretically it was a useful innovation; however, the electrodes could not be adjusted to suit individual patient variability, with treatment often being administered using the wrong electrode site, Lancester rather than the d'Elia position (d'Elia, 1970; Lancester, Steinert and Frost, 1958). There were safety issues concerning the built-in switch, which could be easily pushed accidentally.

Photo 1.3.8 *Kabtronics ECT device*

Photo 1.3.9 *Kabtronics ECT electrodes*

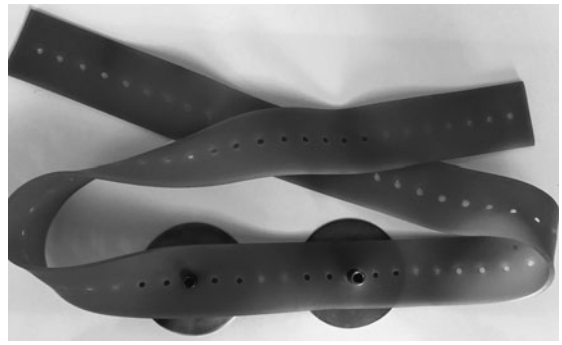

Photo 1.3.10 *Rubber band and metal electrodes*

Photo 1.3.11 *Thymatron DGx ECT device*

Incorporating an EEG into the ECT instrument increased the clinical power to deliver effective ECT rather than sole reliance on the length of motor end point, a feature that has failed to have clinical utility (Abrams, 2002; Mayer, 2006).

The EEG facilitates discrimination between electrode positions and different stimulus doses. It can predict treatment response and changes in the EEG that may indicate threshold changes highlighting the need to increase the stimulus dose or reduce the anaesthetic induction agent. Postictal suppression or electrical silence is an important feature of the EEG that has strong clinical relevance as it has been shown to correlate with treatment efficacy (Mayer, 2006), illustrated in EEG 5.5.9.

Photos 1.3.11 and 1.3.12 illustrate two models of the Thymatron DGx device, which incorporated a two-channel EEG that was stored on a dual graph

Photo 1.3.12 *More recent Thymatron DGx ECT device*

paper trace, developed in the late 1980s by Somatics, a US-based company (Somatics L.L.C., 2015). This was the first device widely used in Australia that incorporated an EEG with a stimulus that had a constant-current, square wave with a pulse width of 1.5 milliseconds (ms). A few years after it was released, Somatics released the Flexidial, which plugged into the back of the device, as shown in Photo 1.3.13. The Flexidial enabled the operator to change the frequency and pulse width and allowed the device to administer stimuli up to double the millicoulombs (mC) from 504 mC to 1008 mC (Somatics L.L.C., 2015).

Photo 1.3.13 *Flexidial for Thymatron DGx ECT device*

It incorporated one- or two-channel EEG recording and calculated objective markers of seizure adequacy that were printed out at the end of the seizure when the recording device was turned off. It was the first attempt to provide objective measures to aid the clinician in determining whether a seizure had been of good quality or not. In the mid-1990s the Thymatron System IV replaced the Thymatron DGx. This device is illustrated in Photo 1.3.14.

In 1998, the MECTA Corporation released a series of competitive devices, the spECTrum 4000 and 5000M and Q, which replaced the SR and JR models. Like the Thymatron, these devices incorporated EEG data analysis to aid the clinician. The spECTrum 4000 was fully featured except it did not have EEG capacity, whereas the 5000 models had the capacity for six-channel recording. An early spECTrum 5000M device is illustrated in Photo 1.3.15.

The MECTA spECTrum 4000M and 5000M devices were similar to the Thymatron System IV, changing all of the stimulus parameters with a single dial to determine the stimulus charge. The MECTA spECTrum 4000Q and 5000Q required the ECT practitioner to set each stimulus parameter –

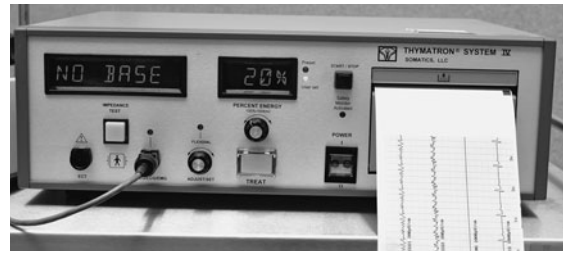

Photo 1.3.14 *Thymatron System IV ECT device*

Photo 1.3.15 *MECTA spECTrum 5000M ECT device*

Photo 1.3.16 *MECTA spECTrum 5000Q ECT device*

pulse width, duration, frequency and voltage – separately. The spECTrum 5000Q is illustrated in Photo 1.3.16. Photo 1.3.17 illustrates the MECTA spECTrum 5000 digital display options.

In Australia, the common use of MECTA devices in clinical practice has been a recent phenomenon with the release of the spECTrum 5000M and Q. MECTA SR and JR devices were used in a few centres but there were no ELCRON devices sold, with the market being dominated by a locally produced device made by Kabtronics.

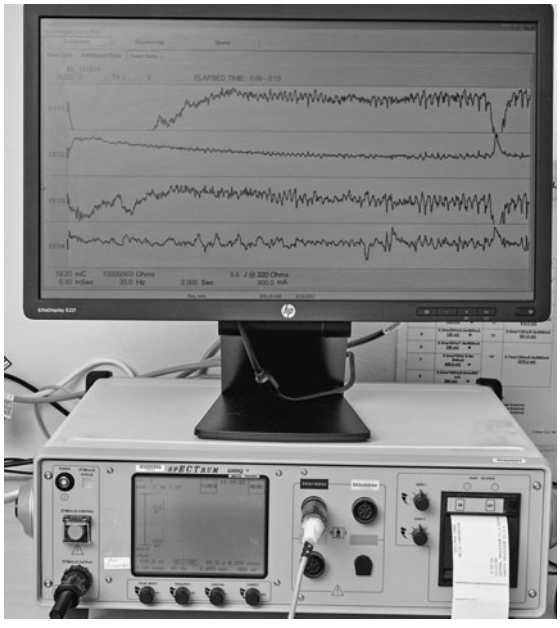

Photo 1.3.17 *MECTA spECTrum 5000Q ECT device with digital display*

The new Thymatron System IV device had other features that were clinically useful. "System IV" referred to the capacity to record information from four different channels, generating a more comprehensive trace: two EEG channels as well as channels for an electromyogram (EMG) and an electrocardiogram (ECG). The Thymatron System IV device generated a larger number of markers of seizure adequacy, which were designed to assist the clinician in assessing the adequacy of the seizure obtained. Tables 5.5.1 and 5.5.2 illustrate the markers of seizure adequacy for the Thymatron DGx and Table 5.5.3 for the MECTA spECTrum 5000 devices.

ECT DEVICE CHARACTERISTICS

The Thymatron System IV, MECTA spECTrum 5000 and Ectonustim Series 6 share similar specifications. They all deliver a constant current while the voltage varies according to the impedance (electrical resistance) offered by the head of the patient during the application of the electrical stimulus. The advantage of a constant-current delivery system is that the clinician is guaranteed a predetermined charge, independent of fluctuations and impedance. The delivered charge will be inversely proportional to the impedance in the circuit, following Ohm's law (American Psychiatric Association, 2001). Careful skin preparation of all sites is required to maximise electrode contact before the electrodes are attached to minimise the impedance and reduce voltage and the risk of burns. All devices offer handheld electrodes, with the ECRON and MECTA incorporating the treatment button within the handle of one treating electrode so that the stimulus can be applied without touching the device. Care must be taken not to accidentally hit the switch prematurely. The Thymatron System IV is the only device to offer disposable treatment electrodes, an innovation that reduces stigma, heralding ECT as a modern medical practice.

All devices have the potential for recording an EEG. The Ectonustim Series 6 device and the MECTA 4000 series do not have built-in EEG recording facilities. Both the MECTA 5000 series

and the Thymatron System IV device have built-in channels for recording. All MECTA 5000 devices print only two recorded channels but have the capacity to store six channels of information. By contrast, the Thymatron "System IV" refers to its capacity to record information from four different channels generating a more comprehensive trace: two EEG channels as well as channels for an electromyogram (EMG) and an electrocardiogram (ECG). The device also generated a larger number of markers of seizure adequacy, which were designed to assist the clinician in assessing the adequacy of the seizure obtained.

All devices offer simular stimulus ranges. The Ectonustim Series 6 offers a range from 50 to 1000 millicoulombs and claims to have a feature called Auto Crescendo, which delivers an advanced 0.25-second auto crescendo onset that gently eases the patients into ECT (ECRON Limited, 2016). This device also claims an advantage over the other devices with its split pulse technology, where each pulse group consists of a single 1-millisecond (ms) pulse followed by two pulses of 0.6 ms as well as offering a mode for non-convulsive stimulation, a low-voltage unidirectional sine wave stimulus that may be used to give a counter-stimulus after ECT. The Ectonustim Series 6+ delivers different ranges of ECT output: low range, 50 to 750 mC at 750 mA, and high range, 200 to 1000 mC at 900 mA (ECRON Limited, 2016).

The MECTA spECTrum 5000 has a stimulus range from 22.9 to 1152 millicoulombs, whereas the Thymatron System IV range is from 25 to 1008 millicoulombs.

All devices have the capacity to measure static and dynamic impedance to ensure effective treatment. Static impedance needs to be manually assessed through pushing a button on the Thymatron device, whereas it is automatically displayed on the other two devices.

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CHAPTER 2

Knowledge

Section 2.1

History: treatment of mental illness

From very early times, physicians, witch doctors, apothecaries and charlatans have searched for methods of understanding and improving people's general health and sense of well-being or treating mental illness specifically. The principal methods employed included: trepanning, phlebotomy/purging, pharmacology, phrenology and electricity.

TREPANNING: EARLY PSYCHOSURGERY?

Trepanning was a technique that involved cutting holes into the skull. Trepanning tools, a skull and a photograph of the outcome are illustrated in Photos 2.1.1. and 2.1.2. From ancient times, trepanning had an enthusiastic following for many years and we know it was carried out successfully as trepanned skulls of early man have been found with healed bone edges. Although still used for

Photo 2.1.1 *Trepanning with skull*

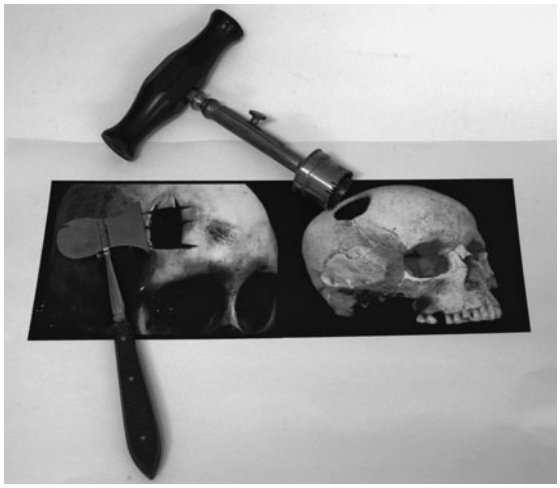

Photo 2.1.2 *Trepanning with tools and image*

legitimate reasons – for example, depressed fractures, removing blood clots and neurosurgery – it was particularly popular in the middle ages for treatment of vague headaches and to release evil spirits that were blamed for causing various derangements of the mind. It continued to be practised regularly, well into the eighteenth century.

The piece of bone removed was even pulverised and drunk as a therapeutic elixir when mixed with various liquids! There is no evidence that trepanation actually had any benefit for treatment of mental illness and in the early days of primitive instruments, no anaesthetic and poor hygiene the risks would have far outweighed any possible benefit.

BLOODLETTING

Bloodletting tools and a map that was used to guide treatment are illustrated in Photo 2.1.3. Bloodletting was one of medicine's earliest and most widely practised treatments. Even before the fifth century AD, surgeons and barbers practised bloodletting, which is reflected in the barber's red and white pole, red signifying blood and white the tourniquet.

"Cutting of a vein", or "airing a vein", was a logical treatment when based on a prevailing theory of four bodily "humours" – blood, phlegm, yellow

Photo 2.1.3 *Bloodletting*

bile and black bile. Excessive humours caused fever, inflammation and general debility so purging or bloodletting would rid the patient of this excess and restore the balance. Good health was just a lancet puncture away.

It was particularly popular in the eighteenth and nineteenth centuries and is still used in some cultures, where it is often combined with "cupping", where the application of a heated "cup" results in an engorged area on the skin due to the vacuum created as the air in the cup cooled.

Generally an artery or vein was punctured with a lancet for a good yield and an average quantity of 500–900 ml to get rid of bad humours continued to the point of faintness. It was often permanent; for example, King Charles II succumbed to bleeding by physicians in 1685. On 14 December 1799, George Washington went to his death with a throat infection after receiving a series of medical procedures including draining nearly 40% (9 pints) of his blood.

Various instruments were used, the oldest being just a lancet. The lancet was a simple blade,