TURUN YLIOPISTO
UNIVERSITY OF TURKU

Anaesthesia for Electroconvulsive Therapy in Finland

– Variation in Clinical Practices and The Management of Adverse Effects

Saara Huoponen

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University of Turku

Faculty of Medicine
Anaesthesiology and Intensive Care
Doctoral programme in Clinical Research
Turku University Hospital, Turku, Finland

Supervised by

Docent Markku Taittonen, MD, PhD
Department of Anaesthesiology
Intensive Care and Pain Medicine
University of Turku and
Turku University Hospital
Turku, Finland

Ulla Ahlmén-Laiho, MD, PhD
Department of Anaesthesiology
Intensive Care and Pain Medicine
University of Turku and
Turku University Hospital
Turku, Finland

Reviewed by

Docent Timo Kaakinen, MD, PhD
Research Group of Translational Medicine
Medical Research Center Oulu
Oulu University Hospital and
University of Oulu
OYS Sydän
Oulu University Hospital
Oulu, Finland

Docent Sari Sjövall, MD, PhD
Department of Anaesthesiology and
Intensive Care
Satasairaala
Pori, Finland

Opponent

Docent Merja Vakkala, MD, PhD
Surgery and Anaesthesia Center Oulu
Oulu University Hospital and University of Oulu
Oulu, Finland

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Kyllä kouluissa on oltava uskonnonopetusta. Muuten lapset uskovat ensimmäistä kadunkulmalla seisovaa kynttilänheiluttajaa.

-Veli-Matti Karjalainen

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ABSTRACT

Electroconvulsive therapy (ECT) is a well-established treatment for severe depression and remains the most effective option when rapid symptom relief is required, such as in acutely suicidal patients. This thesis aims to examine variations in ECT anaesthesia practices across Finnish neuromodulation units and to explore their potential consequences for the treatment of severely depressed patients.

The thesis comprises three substudies. The first two are based on a survey conducted in Finnish neuromodulation units, which included 72 questions covering staff qualifications, the selection of anaesthetic agents and adjuvants, patient monitoring methods, and reported adverse effects (AEs). The first substudy focused on differences in anaesthesia practices, while the second explored the reported AEs, their perceived frequency, and the medications used to manage them.

The first substudy revealed considerable variation, particularly in the anaesthetists' educational backgrounds, the choice of general anaesthetics, and the management of AEs. Propofol and methohexital were the most commonly used anaesthetic agents. The second substudy found headache to be the most frequently reported AE, followed by confusion, hypertension, muscle pain, and nausea. Notably, the recognition and pharmacological treatment of AEs differed between units, raising concerns that some may go unnoticed or untreated.

The third substudy, a systematic literature review and meta-analysis, was informed by the survey findings and the traditional view of methohexital as the gold standard in ECT anaesthesia. The review found that propofol and methohexital appear to be equally effective in terms of treatment response; however, the included studies were dated and generally of low quality, highlighting the need for further research on the topic.

KEYWORDS: electroconvulsive therapy, ECT, anaesthesia practices, adverse effects

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TIIVISTELMÄ

Aivojen sähköhoito eli electroconvulsive therapy (ECT) on tehokas hoitomuoto vaikeaan masennukseen. Se on edelleen tehokkain vaihtoehto tilanteissa, kun tarvitaan nopeaa hoitovastetta, esimerkiksi akuutisti itsetuhoisilla potilailla. Tämä väitöskirja tarkastelee ECT-hoitoihin liittyvän anestesian hoitokäytäntöjen vaihtelua ja vaihtelun aiheuttamia mahdollisia seurauksia vakavasti masentuneiden potilaiden saamassa hoidossa Suomessa.

Väitöskirja koostuu kolmesta osatutkimuksesta. Kaksi ensimmäistä perustuvat suomalaisissa ECT-yksiköissä toteutettuun kyselytutkimukseen. Kysely sisälsi 72 kysymystä koskien mm. henkilökunnan koulutustaustaa, hoidossa käytettyjen nukutusaineiden ja muiden lääkkeiden valintaa, potilaiden monitorointimenetelmiä sekä sähköhoidon yhteydessä raportoituja haittavaikutuksia.

Ensimmäisessä osatutkimuksessa keskityttiin anestesiakäytäntöjen eroihin eri yksiköiden välillä. Merkittävää vaihtelua havaittiin etenkin anestesiasta vastaavien lääkäreiden koulutustaustassa, nukutusaineiden valinnassa ja haittavaikutusten raportoinnissa. Propofoli ja metoheksitaali olivat yleisimmin käytetyt nukutusaineet. Toisessa osatyössä selvitettiin raportoituja haittavaikutuksia, niiden yleisyyttä ja haittavaikutusten estoon ja hoitoon käytettyjä lääkevalintoja. Yleisimmin raportoitu haittavaikutus oli päänsärky. Lisäksi esiintyi sekavuutta, verenpaineen nousua, lihaskipua ja pahoinvointia. Haittavaikutusten raportoinnissa ja lääkehoidossa ilmeni merkittäviä eroja yksiköiden välillä. Tämä herättää huolta, sillä osa haittavaikutuksista saattaa jäädä havaitsematta ja hoitamatta.

Kolmas osatutkimus oli systemaattinen kirjallisuuskatsaus ja meta-analyysi. Katsauksen perusteella propofoli ja metoheksitaali vaikuttavat olevan yhtä tehokkaita nukutusaineita potilaan saaman hoitovasteen kannalta aivojen sähköhoidon yhteydessä. Katsaukseen valikoituneet tutkimukset olivat kuitenkin vanhoja ja pääosin heikkolaatuisia, mikä korostaa lisätutkimuksen tarvetta aiheesta.

AVAINSANAT: sähköhoito, ECT, anestesiakäytännöt, haittavaikutukset

Table of Contents

Abbreviations

AE	adverse effect
APA	American Psychiatric Association
BL	bilateral (electrode positioning)
BVM	bag-valve-mask
CGI	clinical global impression
CI	confidence interval
CO2	carbon dioxide
DS	depression score
ECG	electrocardiogram
ECT	electroconvulsive therapy
EEG	electroencephalogram
EMG	electromyogram
GA	general anaesthesia
GABA	gamma-aminobutyric acid
GRADE	grading of recommendations, assessment, development, and evaluations
HDRS	Hamilton depression rating scale
LMA	laryngeal mask airway
MADRS	Montgomery–Åsberg depression rating scale
MAO	monoamine oxidase
MMAT	mixed methods appraisal tool
NA	not available
NMBA	neuromuscular blocking agent
NR	not reported
NSAID	nonsteroidal anti-inflammatory drug
PENV	post-ECT nausea and vomiting
PIC	postictal confusion
PRISMA	preferred reporting items for systematic reviews and meta-analyses
PROSPERO	international prospective register of systematic reviews
RCT	randomized controlled trial
RUL	right unilateral (electrode positioning)

SD	standard deviation
SE	standard error
SSC	Surgical Safety Checklist
SSRI	selective serotonine reuptake inhibitor
TCA	tricyclic antidepressant
WHO	World Health Organization

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Huoponen S. H, Sisa K, Taittonen M, Saari T, Ahlmén-Laiho U. A Survey of ECT Anaesthesia Practice Variation in Finland. *Journal of ECT*, 2025;41(2):84-88.

II Huoponen S. H, Sisa K, Saari T, Taittonen M, Ahlmén-Laiho U. Recognition and Treatment of the Adverse Effects in Electroconvulsive Therapy as Reported by Neuromodulation Units in Finland. *Brain and Behavior*, 2025; 15(1): e70227.

III Huoponen S. H, Sisa K, Saari T, Taittonen M, Ahlmén-Laiho U. Propofol Versus Methohexital in Electroconvulsive Therapy: Impact on Treatment Efficacy and Adverse Effects. A Systematic Literature Review and Meta-Analysis. *Acta Anaesthesiologica Scandinavica* 2025;69(7):e70083.

1 Introduction

In Finland, the most common reason for the administration of electroconvulsive therapy is severe depression when other treatment modalities have been tried and found to be inadequately effective. Moderately severe depression that does not respond to medication is also considered to be an indication for ECT in the country. When ECT is used in a more acute context, the indication is depression with psychotic features and/or suicidality. Schizophrenic patients form a relatively small subgroup of patients. In 2013, just over 9% of Finnish ECT patients received the treatment with a schizophrenia-based indication (Sumia et al., 2021). In contrast, globally (especially in Asia), the typical indication for ECT is schizophrenia (Leiknes et al., 2012).

Despite decades of research, the exact mechanism of action of ECT is still not fully understood, but seizure-like activity induced by electricity is considered an essential part of the treatment. Theories regarding favourable changes in neurotransmitters (especially serotonin and dopamine levels) have been proposed (Baldinger et al., 2014). There has also been speculation about an inflammation-associated theory, suggesting that depression causes a state of inflammation in the brain that can be extinguished by ECT (Guloksuz et al., 2014). Other theories, some more recent, include ECT-induced changes in brain plasticity and stimulation of neurogenesis (Bouckaert et al., 2014).

In Western countries, ECT is administered under general anaesthesia (GA), but there are still regions in Asia, South America, and Africa, where the treatment is given to patients without anaesthesia. This is most likely due to economic and resource constraints: medications are not available or they are so expensive that patients cannot afford them. (Leiknes et al., 2012; Tripathi et al., 2014.)

All general anaesthetics raise the seizure threshold and thus weaken the seizure that is being induced by ECT. Therefore, the dose of anaesthetic as well as the timing of its administration can modulate the effects of ECT. If the anaesthetic shortens the duration of seizures, the amount of electricity must be increased to produce a seizure considered sufficient in length and other qualifying features. Higher electrical currents, however, expose the patient to more severe cognitive side effects, the most common being confusion and memory impairment. (Stripp et al., 2018.)

As of the end of 2022, there were 26 healthcare units of various sizes in Finland where ECT was administered. The anaesthesia practices in Finnish neuromodulation units has not been studied before, but the experiences of professionals, including the author of this thesis, have suggested that there are significant differences in these practices.

The first part of this dissertation reviews prior scientific literature on the topic of ECT anaesthesia and the adverse effects (AE) related to ECT treatment. The second part presents the findings of a survey of Finnish ECT anaesthesia practice and the perceived AEs of ECT in the country, as well as the findings of a systematic literature review and meta-analysis examining the effects of the anaesthetics propofol and methohexital on the response to ECT treatment and the profile of ECT related AEs.

2 Review of the Literature

2.1 Background

2.1.1 Historical perspective of ECT and its evolution

Electroconvulsive therapy, also known as ECT, is an invention that has been around for over 80 years. Its foundation was established by Hungarian neuropathologist and neuropsychiatrist Ladislas Joseph Meduna (1896–1964). In the late 1920s, Meduna observed a high concentration of glial cells in the brains of epileptic patients. Later, his colleagues at the same hospital discovered that, unlike Meduna's observations regarding epileptic patients, schizophrenic patients appeared to have a lower concentration of glial cells in their brains. They also established that the prevalence of schizophrenia among epileptic patients was lower than in the general population.

Meduna became interested in these differences and inferred that the seizures experienced by epileptic patients were likely responsible for these discrepancies. Encouraged by this, Meduna decided to conduct experiments with chemically induced seizures for patients with schizophrenia. On January 2, 1934, he administered the first injection of camphor into a patient's muscle to induce a seizure. Over the next two years, Meduna treated more than a hundred schizophrenic patients with chemically induced seizures. Approximately half of these patients experienced significant benefits from this therapy. Meduna's theory was that epilepsy acted as an antagonist to schizophrenia. (Gazdag & Ungvari, 2019)

In addition to camphor, other medications such as insulin and cardiazol were also used to induce seizures. However, chemically induced seizures had significant downsides: the interval between medication administration and the onset of seizure varied, and it was usually very uncomfortable for the patient. Seizures were also typically prolonged. These challenges prompted Italian neurologist Ugo Cerletti (1877-1963) and his colleagues to seek an alternative method to induce seizures. Cerletti first tested electroconvulsive therapy on animals, including dogs and pigs. He believed that the immediate unconsciousness induced by electroshock would be beneficial for patients and that it could be administered relatively safely compared with insulin and cardiazol, which were very unpleasant and even life-threatening for

patients. An additional advantage of electroconvulsive therapy was that it was relatively inexpensive. (Kotsaki et al., 2021.)

The first electroconvulsive therapy for a human patient was administered in April 1938 when police brought a man with paranoid schizophrenia to the University Neuropsychiatric Clinic in Rome. Cerletti and his colleagues performed electroconvulsive therapy using electrodes on this bald man. After 14 treatment sessions, signs of recovery were observed: functional abilities improved, auditory hallucinations disappeared, and the patient expressed a desire to return to work. The patient was discharged at the end of May 1938. (Kotsaki et al., 2021.)

2.1.2 Overview of conditions treated by ECT and patient selection

ECT is primarily used for severe psychiatric conditions, particularly when other interventions have failed or when a rapid therapeutic response is required. Although the application of ECT varies across regions, its clinical value is supported by a substantial body of evidence across a range of indications.

In many Western countries, the most common indication for ECT is severe depression, particularly when associated with psychotic features or acute suicidality. In such cases, the urgency of symptom resolution often leads to the decision to initiate ECT, especially when pharmacological or psychotherapeutic approaches have proven inadequate (Kellner et al., 2020). ECT is effective in both unipolar and bipolar depressive episodes, particularly in treatment-resistant depression and in situations where a rapid response is clinically necessary (Meyer et al., 2020).

Internationally, the pattern of use varies. For instance, in many Asian countries, the most common indication for ECT is schizophrenia (Leiknes et al., 2012). ECT is recommended for individuals with schizophrenia who are unresponsive to antipsychotic medications, present with catatonia, display severe agitation or aggression, exhibit suicidal behaviour, or require rapid symptom relief in acute exacerbations (Pompili et al., 2013). Importantly, catatonia, whether associated with schizophrenia or occurring in the context of mood disorders or medical conditions, is a well-established indication for ECT. The treatment is often highly effective regardless of the underlying etiology (Kellner et al., 2020).

Although less common, manic episodes may also be treated with ECT, particularly in cases of treatment-resistant mania or delirious mania, where immediate clinical intervention is needed. While pharmacotherapy remains the first-line treatment for mania, ECT has demonstrated efficacy when conventional treatments fail (Jacobowski et al., 2013; Kellner et al., 2020).

Beyond the primary indications of mood disorders and schizophrenia, ECT has been explored for a variety of other psychiatric and neurological conditions. These

include Parkinson's disease (for both motor and psychiatric symptoms), status epilepticus, delirium (due to diverse causes), postpartum depression, and obsessive-compulsive disorder. However, the use of ECT in these cases remains relatively rare, and research is currently limited, making clinical guidelines less definitive (Kellner et al., 2020).

The decision to administer ECT is made by a psychiatrist, based on a comprehensive evaluation of the patient's psychiatric history, treatment response, medical status, and symptom severity. There is emerging evidence that older adults may experience particularly favourable outcomes with ECT, and high age alone should never be a contraindication for its use (Haq et al., 2015).

2.1.3 The role of anaesthesia in ECT

During the first decades of ECT treatment, patients received ECT without any anaesthesia. The motor convulsions induced by electricity were extremely intense, leading to bone fractures, dental injuries, and/or dislocations in up to half of the patients treated. Moreover, cardiovascular complications were prevalent. (Lava-Parmele et al., 2021.)

In the 1960s, relief for patients came with the introduction of GA and neuromuscular blocking agents (NMBAs). This became known as "modified ECT." An integral aspect of this pharmacological modification was the use of drugs that block conduction at the neuromuscular junction to prevent dental injuries, bone fractures, and other tissue damage. The short-acting depolarizing succinylcholine was then, and still is, the most commonly used NMBA in ECT anaesthesia. Other NMBAs were also tested, but the rapid reversal of succinylcholine's effects made it superior to slow-acting non-depolarizing NMBAs in the context of a typical ECT session's duration. It was not until the introduction of the rocuronium antagonist sugammadex in the 2010s that a viable alternative to succinylcholine became available.

The administration of an NMBA required the addition of GA, as solely experiencing the paralyzing effects of the neuromuscular blocking drug was psychologically distressing for patients. Consequently, inducing GA before the neuromuscular blockade and the ECT treatment itself became a standard part of modified ECT.

In the 1960s, barbiturates were commonly used in ECT anaesthesia. However, a drawback of GA was that the anaesthetics inhibited or shortened the seizure. The goal was to find the smallest possible amount of anaesthetic that would be sufficient to sedate the patient. (Lava-Parmele et al., 2021.)

In Western countries, ECT is now only administered under GA, but there are regions in Asia, South America, and Africa where treatment continues to be given

without it. This often results from a lack of funding and resources: medications may be unavailable, unaffordable for patients, or beyond the financial capacity of the healthcare system. (Leiknes et al., 2012; Tripathi et al., 2014.)

The use of ECT is currently on the rise, and modern anaesthesia practice plays a crucial role in ensuring its safety and effectiveness as well as guaranteeing that the treatment is tolerable for the patient. As a result, more anaesthesiologists need to become aware of the specific aspects of this procedure. (Joung et al., 2022.)

2.1.4 Mechanism of action

The mechanism of action of ECT has been studied, and various theories have been proposed over the years; however, the exact mechanism of action remains unclear.

It is believed that the antidepressant response to ECT requires generalized convulsions. An electric stimulus that does not induce convulsions typically causes side effects such as memory impairments but does not alleviate the patient's depressive symptoms. It has been speculated that these epileptic-like seizures in the brain could trigger neurotrophic effects, such as neurogenesis and neuronal sprouting. Additionally, convulsions spreading to a wider area of the brain may be a more effective means of alleviating depression than localized seizures, supported by findings such as bilateral ECT providing faster relief from depression compared to unilateral treatment. Furthermore, unlike ECT, placebo treatment does not alleviate depression. (Bolwig, 2011.)

2.1.5 The implementation of ECT treatment

The ECT treatment aims to reduce psychiatric symptoms or, ideally, achieve remission of the disorder. This is typically accomplished through 6 to 12 ECT sessions over a period of 2 to 4 weeks, with patients closely monitored for improvements in their psychiatric symptoms. (Ninke & Groene, 2023.)

To prevent relapse, more intensive serial ECT administration can be gradually tapered off once remission from the psychiatric disorder is achieved. After remission, treatment with pharmacotherapy, maintenance ECT, or a combination of both should continue. Maintenance ECT refers to administering ECT treatments at infrequent intervals, for example, every 1 to 4 weeks. The goal is to determine a treatment interval that sustains remission and supports the patient’s well-being. The specifics of the treatment strategy following a series of more frequent ECT treatments are based on the frequency and severity of the patient's previous depressive episodes, as well as the number of prior medication trials. (Espinoza & Kellner, 2022.)

2.1.6 ECT in Finland

ECT treatment has been available in Finland since 1944. In the 1960s, its popularity significantly declined with the introduction of new medications and improved treatment methods for depression. However, in recent decades, ECT has experienced a resurgence, and its usage has increased in Finland. This rise is attributed to advancements in anaesthesia methods and research demonstrating the safety of the treatment even for elderly patients, who typically have many chronic long-term illnesses. (Sumia et al., 2021.)

The annual prevalence of major depressive disorder in Finland is 7,4 % (Markkula et al., 2015). According to a 2013 study, 23 out of 100,000 Finns received ECT treatment, with the average treatment series lasting 9.7 sessions. Of Finnish ECT patients, 38 % were selected for treatment due to major depression, 31 % for psychotic depression, 14 % for bipolar depression, and 9.3 % for schizophrenia (Sumia et al., 2021).

2.2 Physiological effects of ECT

2.2.1 Impact of ECT on the cardiovascular system

During and immediately after the administration of the ECT current, there is typically a phase lasting a few seconds caused by parasympathetic nervous system activation, during which the patient's pulse decreases and bradycardia is observed. Occasionally, a brief asystole may also be observed. Following this short parasympathetic phase, a more dominant phase of sympathetic nervous system activation occurs. This phase is characterized by tachycardia, hypertension, and, in some cases, the occurrence of other arrhythmias. This sympathetic phase lasts a few minutes, after which the hemodynamic changes begin to resolve and return to the patient's baseline.

Although the hemodynamic changes described are transient, monitoring these changes during treatment is essential. This is especially true for patients in whom sudden hemodynamic changes could be particularly detrimental, such as those with diagnosed heart disease. Careful monitoring during and after the procedure is crucial for planning effective hemodynamic management. (Hartnett et al., 2023; Saito, 2005.)

2.2.2 Impact of ECT on the respiratory system

ECT primarily affects the respiratory system through the effects of its anaesthesia. The combination of anaesthetic agents and a NMBA leads to an episode of apnoea,

during which the anaesthesiologist must manually ventilate the patient. If the patient is difficult to ventilate, potential causes may include severe obesity, other anatomical factors, or a predisposing lung condition, which can lead to hypoxia during ECT treatment. Additionally, a very long seizure may deplete the patient's oxygen reserves.

In many ECT treatment units, hyperventilation of patients is common. Its purpose is to induce hypocapnia, which has been shown to prolong the duration of seizures sought during ECT. This seizure prolongation has been demonstrated using both electroencephalogram (EEG) and electromyogram (EMG) measurements. (Gómez-Arnau et al., 2018; Saito, 2005.)

To prevent hypoxia, a preoperative airway assessment, appropriate monitoring, and sufficient pre-oxygenation are essential. In cases of a difficult airway or failed ventilation, neuromodulation units providing ECT must be equipped with the appropriate tools to ensure adequate oxygenation. These include Guedel airways, a suction kit for removing secretions, an intubation kit, and supraglottic airway devices.

2.2.3 Seizure induction and its physiological implications

According to research, the antidepressant and mood-regulating effects of ECT are based on the generalized tonic-clonic seizure induced by the electrical stimulus. This stimulus consists of a series of brief electrical pulses delivered alternately between two electrodes, creating a bidirectional current flow. The brief electrical pulses gradually disrupt neuronal cell membranes, leading to an increase in intracellular sodium and calcium concentrations, as well as an increase in the electrical charge inside the cells. Once the charge reaches a critical level, it triggers waves of neuronal firing, resulting in a seizure. The goal of ECT is to trigger a seizure lasting at least 20 seconds (typically 20–60 seconds). (Swartz, 2014.)

The ECT causes seizures that affect gamma-aminobutyric acid (GABA) and glutamate systems, increasing the release of neurotransmitters like serotonin, dopamine, and norepinephrine. These neurotransmitters are crucial for mood, emotions, and motivation, and they also influence neural plasticity. (Subramanian et al., 2022.)

2.2.3.1 Electrode placement

Unilateral electrode placement over the non-dominant hemisphere is associated with fewer and less severe cognitive side effects than bilateral placement. However, the relative efficacy of right unilateral (RUL) versus bilateral (BL) ECT remains debated. In a randomized controlled trial from 2000, high-dose RUL and BL ECT

showed comparable response rates for depression and were roughly twice as effective as low- or moderate-dose unilateral ECT. Nonetheless, BL ECT was linked to greater impairments in both anterograde and retrograde memory across several measures. (Sackeim et al., 2000.)

A systematic review further supports that high-dose brief-pulse RUL ECT is as effective as bilateral ECT and may offer cognitive advantages, positioning it as a strong first-line option for many patients. (Kolshus et al., 2017.)

The common approach is to begin with RUL ECT. However, if there is no clinical response after 4 to 6 sessions, switching to bilateral stimulation is considered. It is essential to administer at least 8 to 10 treatments—including some using bilateral ECT—before determining that the patient is unresponsive to the therapy. (Murugesan, 1994.)

The electrode placements are illustrated in Figure 1.

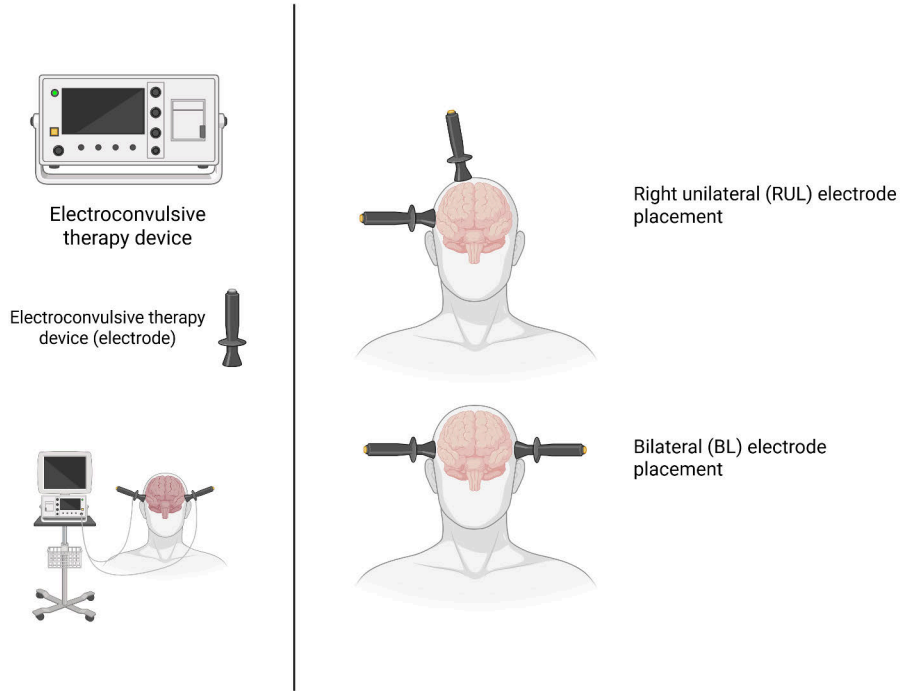


Figure 1. Electrode placements for electroconvulsive therapy, author's own illustration. Created with Biorender.com

2.3 Anaesthetic agents

2.3.1 Commonly used agents

Several different anaesthetics can be used in ECT treatment, with methohexital, thiopental, etomidate, propofol, and ketamine being the most common worldwide. Sevoflurane and benzodiazepines are also viable options but are rarely employed. (Joung et al., 2022.)

The ideal anaesthetic for ECT has a rapid onset, minimizes physiological changes induced by ECT, has minimal anticonvulsant effects, and allows for a quick recovery. While many anaesthetic agents can be used for ECT, factors such as seizure duration, hemodynamic stability, recovery time, antidepressant effects, and cognitive side effects must be considered when choosing the drug. Since most anaesthetics have a dose-dependent anticonvulsant effect, it is important to use the lowest effective dose during ECT for each patient. (MacPherson, 2015.)

2.3.2 Adjuvants

So-called adjuvants can supplement the effects of the GA agent and the NMBA. Opioids such as remifentanil or alfentanil have been added to GA to reduce the need for the primary anaesthetic, thereby extending the duration of seizures induced by ECT. While this approach has prolonged seizures, research on its impact on patient recovery from mental illness is limited, and there is currently insufficient evidence to support the routine use of opioid adjuvants in ECT anaesthesia. (MacPherson, 2015.)

Dexmedetomidine has also been explored as an adjuvant. It has been shown to have beneficial effects, including reducing ECT-related AEs such as postictal confusion (PIC), nausea, and injection pain. However, its primary drawback seems to be the prolongation of recovery time. ECT is a fast-paced procedure, and patients typically need to be moved out of the recovery room promptly. (Soehle & Bochem, 2018.)

2.3.3 Comparison of anaesthesia agents

The following table compares various ECT anaesthesia agents regarding their efficacy, recovery time, and side effects. (Table 1)

Table 1. Effects of commonly used anaesthetics pre- and post-electrical stimulation (PRE/POST).

Anaesthetic	Blood pressure	Heart rate	Seizure duration	Dosage (mg/kg)	Other aspects
Methohexital	-/+ +	N/+	N	1-1.5	Availability problems
Propofol	-/+	-/N(+)	-	1.5-2	Injection pain
Etomidate	N/+ +	N/+	+	0.15-0.3	Slow recovery, injection pain
S-Ketamine	-/+ +	+/+	N	1-2	Psychotic action, hallucinations
Thiopental	-/+ +	+/+	-	1.5-2.5	Histamine release
Diazepam	-/+	N/+	- -	0.15-0.2	Long acting, slow recovery
Sevoflurane	-/+	+/+	- -	Not applicaple	Slow induction

N= neutral, - =moderately lower/shorter, - - =much lower/shorter, + = moderately higher/longer, + + = much higher/longer
Modified from Joung et al. (2022)

2.4 Neuromuscular blocking agents

The requirements for neuromuscular blocking during ECT can be summarized as follows (Mirzakhani et al., 2012):

- The reduction of motor activity is necessary to prevent any potential injury to the patient during the procedure.
- The quality of the seizure must not be significantly affected.
- A rapid recovery of spontaneous breathing following the procedure, without any residual paralysis, is essential. This ensures that the patient can quickly and safely regain normal respiratory function and be moved out of the recovery room without delay.

Suxamethonium remains a commonly used NMBA during ECT due to its rapid onset and short duration of action, both ideal for the brief nature of the treatment. Some patients may experience muscle soreness afterward. However, it is important to be aware of the contraindications of suxamethonium. It can cause hyperkalaemia, leading to cardiovascular instability, and should be avoided in patients with prolonged immobilization as well as those with genetic muscular diseases. Additionally, it can cause bradycardia, malignant neuroleptic syndrome, and malignant hyperthermia. (Ninke & Groene, 2023.)

Non-depolarizing NMBAs, such as mivacurium, atracurium, rapacuronium, and rocuronium, have been utilized in ECT, but they have not achieved widespread

popularity. However, with the introduction of sugammadex, a rapid and predictable reversal of the effects of non-depolarizing NMBAs can be accomplished. The combination of rocuronium and sugammadex may replace the use of suxamethonium in ECT, helping to reduce some of the risks and side effects associated with the latter. (Arora et al., 2025; Mirzakhani et al., 2012.)

It is recommended to monitor the depth of neuromuscular blockade and recovery from it when NMBAs are administered to patients (Fuchs-Buder et al., 2023). However, it is noteworthy that the commonly used train-of-four monitoring method is unsuitable for assessing neuromuscular blockage caused by suxamethonium.

Although adequate neuromuscular blockade is necessary during ECT, intense jaw clenching is inevitable due to the electrical stimulation of the masticatory muscles, particularly the temporalis and masseter muscles. As a precaution, a bite block should be properly positioned before delivering the electrical current to protect the patient's teeth and reduce the risk of tongue lacerations. (Joung et al., 2022.)

2.5 Preoperative assessment and patient preparation

2.5.1 Pre-anaesthesia evaluation

A thorough examination of the patient's medical history may uncover important anaesthetic factors to consider (Mayo et al., 2010). Assessing psychiatric patients can be challenging, as they may be non-communicative, delusional, or paranoid. A thorough evaluation may take longer than for a typical surgical patient and may require contacting various healthcare providers or family members to verify the patient’s medical history. (Bryson et al., 2017.)

It is important to carefully consider the interactions between the prescribed psychiatric medications and the selected anaesthetic regimen (Ninke & Groene, 2023). Significant interactions are presented in Table 2.

Special attention should also be given to patients with pre-existing cardiovascular diseases. During ECT, patients typically experience an increased cardiac workload, which can be particularly risky for those with acute or chronic heart conditions. Several studies suggest that cardiac complications are more common in individuals with underlying cardiovascular disease. (Hermida et al., 2022.) Therefore, it is important that the patient's cardiovascular diseases are properly managed and well-controlled before starting the ECT treatment series.

Anaesthetising patients with severe pulmonary conditions for ECT may carry higher risks, just as it would for any procedure requiring GA in this patient group (Meyer et al., 2020). If possible, all pulmonary conditions should be stabilised before starting ECT treatment.

Table 2. Interactions between antidepressants and anaesthetics.

Antidepressant	Interaction
Tricyclic antidepressant (TCA)	• Increases effects of opioids, hypnotics and inhalational anaesthetics • The QT interval may prolong if propofol or sevoflurane are used
Selective serotonine reuptake inhibitors (SSRI)	• The use of drugs that also inhibit serotonin reuptake, such as pethidine, tramadol, and MAO inhibitors, may result in serotonin syndrome. • The QT interval may prolong during the use of propofol or sevoflurane
MAO-Inhibitors	• Indirect sympathomimetics (e.g. ephedrine) may lead to treatment-resistant arterial hypertension • Pethidin and Tramadol may lead to excitatory reactions/serotonergic activity
Lithium	• No known interactions with anaesthetics

Modified from Ninke and Groene (2023) and Terveysportti (2025)

2.5.2 Screening tests

Generally, preoperative assessment derives limited benefit from screening tests unless there is a clear indication based on the patient's history and physical examination (Lafferty et al., 2001). A good example is a routine thoracic X-ray: it is not beneficial, and the need for such an imaging study should thus be based on the patient's comorbid conditions. Also abnormal haemoglobin and white blood cell counts do not influence the decision to proceed with ECT nor do they predict complications. Exceptions to the lack of benefit from screening tests include an electrocardiogram (ECG) and measurement of sodium and potassium levels, especially in elderly patients and those with somatic conditions before starting a course of ECT treatments. These tests can help identify correctable, unexpected conditions that may impact the risk associated with the procedure. (Lafferty et al., 2001.)

2.5.3 Contraindications

The 2001 consensus statement from the American Psychiatric Association (APA) indicates that there are no absolute contraindications for ECT (Rasmussen, 2002.) However, certain conditions, including uncontrolled hypertension, coronary artery disease, congestive heart failure, aortic stenosis, implanted cardiac devices, poorly controlled obstructive lung disease or asthma, and increased intracranial pressure (with or without mass lesions), carry a relatively high risk and may result in fatal outcomes during ECT. (Sundsted et al., 2014; Tess & Smetana, 2009.)

2.5.4 Pre-ECT fasting and medication adjustments

Before ECT, patients should refrain from eating solid food for at least 6–8 hours. However, they may consume clear liquids during this time to allow for the intake of oral medications up to 2 hours prior to the procedure. (Joung et al., 2022.) In most cases, patients may continue taking their regular medications until the morning of the procedure (Tess & Smetana, 2009).

Some medications a patient is taking may influence the seizure threshold. Since a sufficiently long and high-quality seizure is crucial for the effectiveness of ECT, the continuation of drugs such as benzodiazepines during the treatment course should be carefully evaluated on an individual basis. (Janjua et al., 2020.)

2.6 Intraoperative considerations

2.6.1 Equipment and monitoring during ECT

The treatment and recovery rooms for ECT should be equipped with essential monitoring devices. At a minimum, this includes non-invasive blood pressure monitoring, an ECG monitor, and a pulse oximeter. A nerve stimulator for assessing neuromuscular blockade should also be readily available. Suction equipment, an oxygen delivery system, and a bag-mask ventilation system must be on hand. Supplies for anaesthetic induction, emergency medications, and equipment for intubation or the use of a laryngeal mask airway (LMA) in case of a difficult airway, along with resuscitation equipment, must be easily accessible. After the procedure, supplemental oxygen via nasal cannula or face mask may be required in the recovery room. Standard non-invasive hemodynamic parameters and oxygen saturation should be monitored for 15–30 minutes following ECT. (Joung et al., 2022; Salik & Marwaha, 2025.)

2.6.2 Management of hemodynamic fluctuations

During a seizure, systolic blood pressure may rise to 200 mm Hg or higher due to the sympathetic surge, but this effect typically subsides immediately afterward, seldom leading to complications. Treatment or prophylaxis is generally unnecessary unless the patient has underlying conditions, such as ischemic heart disease or an aneurysm. In such cases, intravenous beta-blockers administered during or prior to ECT can help reduce risks. (Andrade et al., 2016; Roche et al., 2016.)

ECT can lead to temporary ECG changes, such as arrhythmias or T-wave abnormalities. These changes are typically benign and present no significant risk to

healthy individuals. However, they may be more concerning for patients with pre-existing heart conditions. (Ottaway, 2002.)

If myocardial ischemia is suspected, troponin levels should be measured, noting that creatine phosphokinase levels may be falsely elevated due to the seizure. Atropine can be used to treat bradyarrhythmias, while beta-blockers are effective for managing tachyarrhythmias that may occur during the procedure. (Andrade et al., 2016.)

Transient asystole may occur after electrical stimulation, particularly in younger patients or during subconvulsive stimulation due to unopposed parasympathetic activity. Succinylcholine and lithium can increase its risk. However, it is generally not associated with severe complications, and resuscitative measures are typically unnecessary as normal cardiac rhythm usually returns spontaneously. Anticholinergic premedication is recommended if asystole has occurred during the patient's prior ECT sessions. (Andrade et al., 2016.)

2.6.3 Airway management and oxygenation

Hyperventilation-induced hypocapnia is commonly used in electroencephalography to trigger epileptic activity and has been employed to enhance seizure quality with ECT. This method is particularly beneficial for patients with a higher seizure threshold or a history of inadequate seizure duration. However, this technique may result in prolonged seizures and should be avoided in younger patients who have a history of extended seizure duration during ECT. (Bryson et al., 2017; Pande et al., 1990.)

The primary goal of ventilatory management during ECT is to sufficiently reduce carbon dioxide (CO_2) levels to promote seizure activity without focusing on a specific end-tidal CO_2 value. ECT patients are typically ventilated using a bag-valve-mask (BVM) device. Capnometry and/or capnography are not universally applied during ECT and may not be very accurate during BVM ventilation.

Pre-oxygenation of the ECT patient before general anaesthesia induction should be performed using either a nasal cannula or a facemask. High-flow nasal oxygenation is also a good alternative, particularly for obese patients or those with underlying pulmonary issues. This process enhances the safety of the procedure by increasing the patient's oxygen reserves, thereby extending the period of tolerable apnoea. Following pre-oxygenation through the patient's spontaneous breathing, active hyperventilation with 100% oxygen via the BVM device is performed, further raising blood oxygen levels. The benefits of hyperoxia include improved seizure quality and a reduction in the amount of electrical charge needed for the stimulus. (Aksay et al., 2014.)

LMA is a suitable option for managing the airway during ECT anaesthesia, especially when ventilation with a conventional face mask is difficult. However, using LMA increases the risk of dental trauma, so extra care must be taken to protect the teeth. For instance, two rolled cotton gauze bite blocks can be placed between the molars on both sides when using an LMA. (Nishihara et al., 2003.)

2.7 Post-anaesthetic care

2.7.1 Recovery from anaesthesia and immediate postoperative care

ECT patients should undergo short monitoring in the recovery room after the procedure. Once stable respiratory function has been achieved, they may be transferred to the post-anaesthesia care unit. Monitoring of heart rate, ECG, pulse oximetry, and blood pressure should continue until discharge criteria are met. If the patient shows stable hemodynamic and respiratory status and awakens appropriately, they can then be returned to inpatient care. (Chawla, 2020.)

2.7.2 Adverse effects of ECT and their management

Transient memory impairment is a typical AE of ECT. Postictal confusion or agitation can occur following ECT, but it typically responds to small doses of benzodiazepines or propofol (Tzabazis et al., 2013). A prophylactic antiemetic is advised for patients with high risk for nausea and vomiting, or when anaesthetic agents like sevoflurane or etomidate, which are known to increase the risk of nausea and vomiting, are administered. (Joung et al., 2022.)

Headaches and myalgia are common side effects that patients often experience after ECT. Preventive treatment may be especially necessary for individuals with a history of severe headaches or those who have previously suffered significant post-ECT headaches. (Dinwiddie et al., 2010.)

Sumatriptan and nonsteroidal anti-inflammatory drugs (NSAIDs) have been shown to effectively reduce the incidence of headaches following the procedure (Karaaslan et al., 2019 ; Markowitz et al., 2001). Additionally, musculoskeletal pain, commonly observed after the initial ECT treatments, typically responds well to NSAIDs. (Joung et al., 2022.)

Serious, though rare, AEs associated with ECT include cardiac arrhythmias (with or without hemodynamic changes), respiratory distress, prolonged apnoea, aspiration, extended paralysis, and prolonged seizures. (Espinoza & Kellner, 2022.)

Summary of AEs that can be managed wit medication is available in Table 3.

Table 3. ECT related adverse effects and their treatment options.

Adverse effect	Incidence (%)*	Treatment options
Headache	22-77	Patients with a history of migraine or severe headaches may benefit from preventive headache treatment. Sumatriptan appears to be an effective and well-tolerated alternative to NSAIDs and paracetamol.
Myalgia	9-88	NSAIDs are more effective than paracetamol or placebo in the treatment of myalgia. Additionally, using rocuronium instead of succinylcholine may reduce the incidence of myalgia.
Postictal agitation	2-40	A propofol bolus can be used to prevent or alleviate postictal agitation and may be preferable due to its shorter duration of action compared to benzodiazepines.
Post-ECT nausea	1-23	Traditional antiemetics are recommended; propofol may reduce post-ECT nausea**

*The reported incidences vary across different studies. **Research specifically addressing this topic remains limited.
Modified from Haghighi et al. (2016), Dinwiddie et al. (2010), Saricicek et al. (2014), Karaaslan et al. (2019), Markowitz et al. (2001), Tzabazis et al. (2013), Ertman et al. (2025), Andrade et al. (2016) and Kramer et al. (2003)

2.8 ECT in special populations

2.8.1 Paediatric patients

ECT treatment has been found to be effective and safe for children and adolescents, but it is infrequently administered and likely underutilized in these patient groups (Benson & Seiner, 2019). Children referred for ECT often have severe psychiatric conditions, compounded by dehydration, malnutrition, and reduced functional capacity due to delayed treatment. Referrals typically occur after other options fail. These children may also have coexisting conditions such as developmental delay or Down syndrome, be on the autism spectrum, and some present with a distinct combination of catatonia, autism, and psychosis/self-injurious behaviour. (Stein et al., 2020.)

Recent studies support the effectiveness of ECT in treating paediatric patients, showing particularly high response rates for depression. In urgent situations, such as with suicidal or catatonic patients, ECT is an appropriate treatment option and should be considered. (Døssing & Pagsberg, 2021; Pal et al., 2024.)

The AEs of ECT in paediatric populations are generally similar to those observed in adults, including headaches, nausea, muscle pain, confusion, and temporary memory loss (Døssing & Pagsberg, 2021). Benign cardiac arrhythmias, symptomatic bradycardia, and prolonged seizure duration are possible but rare (Stein et al., 2020).

The facility's capabilities and the expertise of the available staff must be considered, especially when selecting younger or higher-risk children for ECT. The same anaesthetic agents used for adults can also be used for paediatric patients, taking dosage into account. Specific concerns for children undergoing ambulatory anaesthesia include upper respiratory infections and the risk of apnoea. (August & Everett, 2014.)

Endotracheal intubation should be considered for children at risk of aspiration or upper airway obstruction during sedation, such as those with Down syndrome, airway-related syndromes, or severe obesity. (Stein et al., 2020.)

2.8.2 Geriatric patients

Elderly individuals often have significant medical comorbidities for which they are on medications, making this patient group more susceptible to side effects and drug interactions from depression pharmacotherapy. Therefore, ECT can be a particularly favourable option, and it has been established as a safe and effective treatment for the elderly; they have a higher remission rate following a course of ECT compared to younger patients. Additionally, elderly patients who remit after ECT experience a lower relapse rate than their younger counterparts. (Riva-Posse et al., 2013.)

There are no absolute contraindications to ECT in the elderly; however, preoperative medical assessment and anaesthesia should be standardized, given the high rate of medical comorbidities. The most important organ systems to assess before starting ECT are the cardiac, pulmonary, and neurological. (Riva-Posse et al., 2013.)

In elderly patients, it is often necessary to reduce the dosage of anaesthetic and analgesic drugs. The dosage of NMBAs should also be decreased in geriatric patients. (Aurini & White, 2014.)

Some AEs are less common in elderly patients. For example, in the context of brief procedures requiring anaesthesia, they are ten times less likely to report pain and four times less likely to experience postoperative nausea and vomiting compared to younger patients. (Aurini & White, 2014.)

2.8.3 ECT during perinatal period

Studies indicate that the prevalence of depression during pregnancy is 15%, while postpartum depression affects 17% of women. Postpartum psychosis occurs in 1 to 2 per 1,000 women after childbirth and requires urgent care, often necessitating hospitalization. ECT during the perinatal period is generally recommended for psychotic or severe non-psychotic depression, catatonia, and prolonged severe

mania, especially when the condition is life-threatening, resistant to other treatments, and requires a rapid response. (Cantwell, 2021.)

The risks, AEs, duration of treatment, and response to ECT during the perinatal period are similar to those in the general population. The AEs are typically mild and most commonly include nausea, vomiting, myalgia, and headache. Other potential AEs of ECT may include confusion and memory loss. The most common risk to the foetus is cardiac arrhythmia, which can manifest as an irregular heart rate after the seizure, foetal bradycardia during the tonic phase, or decreased heart rate variability. No associations have been found between ECT and congenital anomalies (neither morphological nor behavioural). (Ward et al., 2018.)

The administration of ECT anaesthesia during pregnancy adheres to standard anaesthetic guidelines, which include foetal monitoring, measures to minimize the risk of aspiration, prevention of aorto-caval compression, and management of venous thrombosis risk. (Cantwell, 2021.)

2.9 Safety and risk management

2.9.1 Overall risk in ECT

The complication rate of ECT has significantly decreased from as high as 50% in the 1960s to less than 1%, comparable to the morbidity and mortality associated with minor surgeries (Mayo et al., 2010). The estimated mortality rate associated with ECT is about 2.1 deaths per 100,000 treatments. The most common complications are acute cardiopulmonary events, which are estimated to occur in less than 1% of treatments. (Kaster et al., 2021; Watts et al., 2021.)

2.9.2 The prevention and anaesthetic management of ECT complications

Most psychiatric patients undergoing ECT will receive anaesthesia outside of an operating room. When providing care at an off-site location, it is crucial to adhere to established anaesthetic safety standards. The standards for monitoring vital functions and for delivering medications and oxygen are the same as those required for general anaesthesia in surgery. An experienced anaesthesia team should be in charge of these patients, as supervision and emergency support may be challenging in off-site settings. (Ninke & Groene, 2023.)

Sometimes, patients' apnoea periods may be prolonged. This can result not only from excessive dosages of NMBAs or anaesthetics but also from underlying conditions, such as sleep apnoea. Therefore, ventilation should be continued until spontaneous breathing has fully recovered. In some cases, measures such as using a

Guedel airway or a nasopharyngeal tube, positioning the patient on their side, or lifting the jaw may be necessary to secure the airway during the recovery phase. (Chawla, 2020.)

Prolonged seizures lasting more than 180 seconds can occur in 1% to 2% of patients receiving ECT and are associated with an increased risk of post-ECT confusion and memory issues. Seizures lasting longer than 120 seconds should be stopped using intravenous benzodiazepines such as diazepam, midazolam, or lorazepam. For subsequent treatments, propofol is considered the preferred anaesthetic. (Andrade et al., 2016.)

ECT can cause significant fluctuations in heart rate and blood pressure. Following the electrical stimulus, a parasympathetic surge often results in bradycardia and brief sinus pauses. This effect may be more pronounced in patients taking β-blockers. Asystole occurs occasionally, but it is rarely prolonged enough to necessitate cardiopulmonary resuscitation. (Chawla, 2020.)

Patients with a history of bradycardia during ECT are often pre-medicated with anticholinergic agents such as glycopyrrolate. A subsequent sympathetic surge can increase heart rate, blood pressure, and myocardial oxygen demand, posing risks for individuals with pre-existing heart conditions. Timely treatment is crucial to prevent major cardiac events, and in some cases, patients may require premedication or postictal treatment with intravenous esmolol, labetalol, or nicardipine to manage potential risks. (Chawla, 2020; Hermida et al., 2022.)

2.9.3 The use of safety checklists and protocols

The World Health Organization (WHO) surgical checklist model has been widely implemented in surgical settings through locally modified versions, demonstrating its effectiveness in enhancing patient safety and reducing complications. These checklists have also shown improvements in communication among healthcare staff. Research findings support the WHO's recommendation to use the Surgical Safety Checklist (SSC) for all operative procedures. (Fudickar et al., 2012.)

Structured checklists, similar to those used in surgical procedures, have been developed for managing psychiatric patients (Mattinson & Cheeseman, 2018). However, an internationally standardized checklist for ECT treatment, like the WHO's SSC, has not yet been created. Although national guidelines and recommendations may exist in other countries, such tools for ECT patients have not yet been established or widely adopted in Finland.

2.10 Current research trends in ECT anaesthesia

Recent research has explored various aspects of anaesthesia management during ECT. A 2024 study investigated the effects of reducing anaesthetic dosage during ECT, finding that lower dosages maintained tolerability without compromising clinical outcomes. (Espinola et al., 2025.)

Of particular interest in recent ECT anaesthesia research are potential adjuvants. Among the recently explored options is dexmedetomidine, which serves as an adjunct to ECT or even as a potential anaesthetic alternative (Liu et al., 2024; Modir et al., 2023). Additionally, both ketamine and S-ketamine have attracted attention among researchers and have been utilized in ECT as a primary anaesthetics and in sub-anaesthetic adjunct doses (Ren et al., 2024; Zou et al., 2021). Alfentanil, when used as an adjunct to anaesthetics for ECT, has been shown to reduce the blood pressure increase associated with the procedure (McCutchen et al., 2023).

Most studies comparing different ECT anaesthetics are old, but the topic remains relevant, with some recent studies available. For example, the effects of S-ketamine and propofol on ECT treatment outcomes have been studied; however, the sample sizes were small, and the research found no differences between the anaesthetics concerning treatment efficacy. (Zeng et al., 2025.) One interesting recent research perspective is the identification of anaesthesia depth and the optimal timing for electrical stimulus delivery, as measured by EEG, and their impact on ECT treatment outcomes (Pustilnik et al., 2025).

3 Aims

The primary aim of this thesis was to document and analyse potential variations in anaesthesia practices within Finnish neuromodulation units and to explore the consequences of such variations for patients receiving treatment for severe depression with ECT.

This thesis consists of three studies, with the specific aims being:

1. To investigate the degree of diversity in anaesthesia practices among Finnish neuromodulation units that provide ECT. Additionally, the study explores whether any recent changes have been made to the ECT practices in each unit.
2. To investigate the occurrence of adverse effects associated with ECT in Finnish neuromodulation units and to examine the medical interventions these units utilize to prevent and address them.
3. To investigate whether research has shown a difference in clinical outcomes and the occurrence of adverse effects between patients receiving either methohexital or propofol as anaesthetics for ECT.

4 Materials and methods

4.1 Survey (Studies I and II)

The first two sub-studies of this dissertation are based on a nationwide survey conducted among Finnish neuromodulation units that administer electroconvulsive therapy. The survey aimed to assess the extent of variation in anaesthesia practices across units and to identify recent modifications in these practices. Additionally, the survey examined the occurrence of ECT-related AEs as well as the medical interventions employed to prevent and manage them.

No detailed patient data or other sensitive information was collected; therefore, in accordance with Finnish legislation, this type of survey study did not require a research permit.

4.1.1 Design and platform

At the end of 2022, our research team created an electronic survey using the commercial Webropol platform (Webropol Oy, 2022), a survey and research tool for creating online questionnaires. It has been widely used prior to our study to collect data for research in Finland.

4.1.2 Survey structure and content

The survey consisted of a total of 72 queries, divided into thematic sections. The first section gathered basic information about the participating neuromodulation units, including available staff resources, the educational background of the personnel, and the number of patients treated weekly. This demographic data was collected through multiple-choice questions.

The second set of questions, consisting of 41 items, focused on the selection and application of various anaesthetic agents, as well as the use of adjunctive medications to prevent and manage AEs. Some questions were multiple-choice, while others utilized a numeric sliding scale to record responses as a percentage (0–100).

The third section of the survey examined the methods used by the units for airway management, intraoperative monitoring of vital functions and for evaluating the quality and duration of seizures.

The fourth section concentrated on the frequency of AEs and included eight questions about the occurrence of specific AEs. These survey questions were solely centred on short-term AEs of ECT treatment, recognizing the possibility of using pharmacological interventions to address these issues. Questions related to memory-related AEs of ECT were excluded from this survey.

The final set of questions focused on whether any changes had been made to the unit's ECT protocol over the past five years and whether the unit had created protocols for preventing AEs, such as an assessment and premedication protocol to prevent the aspiration of gastric contents. For these questions, participants were invited to provide their answers in a free-text format in a designated response field. Finally, they were given the opportunity to offer feedback and share comments about the survey. At the end of the questionnaire, respondents were also asked to specify their workplace unit, allowing for follow-up with units that had not yet responded. However, the survey responses were not linked to this identifying information.

The complete survey form is presented in the appendix.

4.1.3 Survey distribution and participant recruitment

The questionnaire was sent to Finnish neuromodulation units via a shared email list of ECT providers in December 2022. Attached was a letter in which our research team introduced itself and explained the study's goals. We instructed recipients to select someone in the unit who was well-acquainted with the unit’s operations and anesthesia practices related to ECT treatments. However, we did not limit the professional background of the respondent, as we believed that overly strict guidelines could decrease the number of survey participants. Therefore, the respondent could be the head anaesthesiologist, one of the anaesthesiologists providing ECT services, an anaesthesia nurse involved in such services, a psychiatrist, or a psychiatric nurse from the neuromodulation unit. The unit was thus free to choose the person they felt was most suitable to respond.

We began by collecting responses over an initial two-week period. Following this, a reminder email was sent to the mailing list to encourage participation from those who had not yet responded. At the six-week point, our research team personally contacted some of the remaining non-responding ECT providers by phone or email. In total, the survey remained open for eight weeks.

4.1.4 Data Collection and Processing

Once the survey responses were collected, the data was exported directly from Webropol into an Excel spreadsheet. Answers to multiple-choice and other numerically analysable questions were tabulated. The responses to open-ended questions, such as those regarding changes made by the neuromodulation unit in the past five years, were also collected in a separate Word document for ease and practicality of reading.

4.1.5 Survey Response Management

The responses were sorted in Excel based on the size of the neuromodulation unit. A unit was considered large if it administered more than 30 ECT treatments per week. Medium-sized units were defined as those providing 10–30 treatments per week, while small units were those with fewer than 10 treatments per week. This classification helped to clarify the patient volume represented by the responses.

4.2 Systematic review and meta-analysis (study III)

The third sub-study is a systematic review and meta-analysis utilizing studies that compare propofol and methohexital as anaesthetic agents during ECT, focusing specifically on their effects on treatment efficacy and AEs.

4.2.1 Registration

This systematic review, along with its predefined protocol, was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Before its execution, this review was formally registered in the International Prospective Register of Systematic Reviews (PROSPERO) and is listed under the registration number CRD42024520709.

4.2.2 Eligibility Criteria

4.2.2.1 Types of studies

Original published studies that utilized a validated numerical scale to assess improvements in depression were eligible for inclusion in this review and meta-analysis. There were no restrictions regarding language or publication date. Review articles, meta-analyses, case reports, conference abstracts, letters, and non-peer-reviewed publications were excluded.

4.2.2.2 Participants

Studies involving adult patients aged 18 years or older who were diagnosed with depression or a depressive episode of bipolar disorder and who received ECT treatment were eligible. Studies involving animal subjects or patients receiving ECT for non-depressive conditions were excluded.

4.2.2.3 Intervention and control groups

One group of patients received propofol while another group received methohexital as the anaesthetic during ECT. Trials with multiple comparator groups were not excluded, as long as they included at least the propofol and methohexital groups.

4.2.2.4 Outcome

The objective of this study was to compare propofol and methohexital as anaesthetic agents for ECT in patients diagnosed with depression. The primary outcome was clinical treatment response, assessed by the number of ECT sessions needed to achieve remission and changes in quantitative depression rating scores. The secondary outcome involved evaluating and comparing the types, frequency, and severity of AEs between the propofol and methohexital groups.

4.2.3 Information sources

Literature searches were carried out in the following databases: PubMed/Medline, Embase, Cochrane Library, Scopus, PsycINFO, and Web of Science. The time frame extended from the inception of each database to January 21, 2025. Additionally, the reference lists of all eligible studies were reviewed to identify further studies not captured by the database search.

4.2.4 Search strategy

A broad search was conducted using the terms *propofol, methohexital*, and *electroconvulsive therapy (ECT)*, along with their synonyms. Although depression, AEs, and specific depression rating scales were not included in the search strings, they were considered during data screening.

4.2.5 Selection process

Records retrieved from database searches were managed using Zotero (Version 6.0; Roy Rosenzweig Center for History and New Media, 2025), a reference management

software. The software's duplicate recognition automation identified and removed duplicates.

Two researchers independently screened all titles and abstracts to exclude non-peer-reviewed reports, review articles, meta-analyses, and studies that did not meet the inclusion criteria. Full-text screening was also conducted independently by both researchers, with any discrepancies resolved through discussion. The author of this thesis also reviewed the reference lists of included studies and relevant systematic reviews for further eligible studies.

It was anticipated that various depression rating scales could be utilized across studies to evaluate treatment outcomes. The following scales were considered eligible:

1. MADRS (The Montgomery-Åsberg Depression Rating Scale)
2. HDRS (The Hamilton Depression Rating Scale)
3. CGI (The Clinical Global Impression Scale)
4. BDI (The Beck Depression Inventory)

Table 4 provides further information on these scales.

Table 4. Depression assessment scales (Study III). Author's own drawing.

Scale	Description	Score Range	Interpretation
Montgomery-Åsberg Depression Rating Scale (MADRS)	A ten-item structured questionnaire to assess the severity of depression.	0 to 6 per item (total: 0-60)	Higher scores indicate greater severity of depression. **Reduction >50% or a score of ≤10 indicates remission**
Hamilton Depression Rating Scale (HDRS)	A 29-item scale used to assess depression severity in patients.	0 to 4 per item (total: 0-116)	A higher score indicates more severe depression. **A Score of ≤8 indicates remission**
Beck Depression Inventory (BDI)	A self-administered questionnaire with 21 items	0 to 3 per item (total: 0-63)	Higher scores indicate more severe depression. **A Score of ≤10 indicates remission**
Clinical Global Impression Scale (CGI)	Assesses the degree of mental illness or the progression of illness. It has 7 options: 1 (complete health) to 7 (most severe illness).	1 to 7	For illness progression: 1 (fully recovered), 7 (significant deterioration). Experienced clinicians can use this scale. **A Score of ≤2 indicates remission**

4.2.6 Data collection process

A data extraction template was created and initially tested on two articles that met the inclusion criteria. After refining the template based on pilot results, the author of this thesis completed data extraction for all included studies.

Data extracted from the studies included:

1. Study demographics
2. Mean depression scores before and after ECT series for both propofol and methohexital groups
3. The average number of ECT treatments needed for treatment response
4. Reported ECT-related AEs (type, incidence, severity)
5. Authors' conclusions regarding treatment efficacy and safety

From studies that reported depression scores at multiple time points, only the baseline score (prior to the first ECT session) and the first available score following the final ECT treatment were included in the analysis.

If a study employed more than one depression rating scale, preference was given to clinician-administered assessments (such as MADRS, HDRS, and CGI) over self-reported measures (such as the BDI). The depression scores were utilized as reported, without any data conversion.

4.2.7 Risk of bias assessment

The risk of bias was assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018), a validated instrument designed to evaluate the quality of mixed-methods research, which can include both qualitative and quantitative approaches. The MMAT provides specific criteria for assessing various study designs, including qualitative research, randomized controlled trials, non-randomized studies, and retrospective studies. It utilizes a scoring system that aids researchers in systematically appraising the methodological quality of studies, making it particularly valuable for systematic reviews and evidence synthesis. This tool enables the evaluation of bias risk across various study designs. The two researchers independently assessed the studies, and a third researcher resolved discrepancies.

4.2.8 Effect measures

For the meta-analysis, Hedge's g was calculated using the reported means and standard deviations (SD). If only standard errors (SE) were provided, they were converted into SDs.

4.2.9 Synthesis methods

The meta-analysis utilized IBM SPSS Statistics (Version 29.0; IBM Corp., 2023) to calculate effect sizes and generate a forest plot. Outcomes not included in the meta-analysis were presented narratively, with supporting tables provided for greater clarity. The study demographics, individual study results, and the incidence and severity of AEs were summarized in matrix tables. The findings were categorized by study design into the subgroups of randomized controlled trials (RCTs) and retrospective cohort studies.

4.2.10 Reporting bias and heterogeneity assessment

In addition to the forest plot, a funnel plot was created to assess heterogeneity and small study or publication bias. If asymmetry in the funnel plot was observed, the trial characteristics were reviewed to determine whether the asymmetry was caused by publication bias or heterogeneity factors, such as differences in study methodology or clinical characteristics. Heterogeneity was quantitatively assessed using Cochran's Q test, the I^2 statistic, and Tau^2.

4.2.11 Certainty assessment

The author of this thesis evaluated the certainty of the evidence using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system (Schünemann et al., 2023), a validated method for assessing the quality of evidence and strength of recommendations in healthcare. GRADE was specifically applied to the outcomes of the meta-analysis. The evidence was categorized into one of four quality levels: very low, low, moderate, or high.

Evidence from RCTs is initially considered high quality. However, factors that significantly reduce confidence in a study's results, such as serious risk of bias, inconsistency, indirectness, imprecision, or potential publication bias, lead to a downgrade in quality, shifting the evidence from high to moderate, low, or very low.

5 Results

5.1 Survey studies

5.1.1 Participation and response rate

By the end of the two-week survey period in December 2022, 13 neuromodulation units had completed the online questionnaire. Following a reminder email about the open survey, three additional responses were received. After personalized follow-up via email and phone calls, two more units submitted their responses. In total, 18 units participated in the survey, representing a 69% response rate among all ECT units in Finland and offering a comprehensive overview of current practices nationwide.

However, one of the participating units did not respond to specific sections of the survey related to AEs, patient monitoring, and the use of neuromuscular blocking agents. Consequently, the percentages for these categories were calculated based on the responses from 17 units instead of 18.

Some smaller units chose not to participate in the survey. One such unit contacted us via email to clarify their situation. They confirmed that they provide ECT treatments but explained that the extremely low frequency, fewer than one patient per week, made them feel that their data would not significantly contribute to the study, so they opted out of completing the survey.

In conclusion, contact was successfully established with 19 out of the 26 ECT units in Finland, ensuring a broad representation of practices while recognizing the limited participation of smaller, less active units.

5.1.2 Overview of ECT practices in Finnish neuromodulation units

Survey responses revealed a variety of practices among Finnish ECT units concerning patient treatment volumes, anaesthesia protocols, monitoring methods, and management of AEs.

5.1.2.1 Treatment volumes and staffing

Units were classified based on the number of weekly ECT treatments:

1. Eight units (45%) conducted over 30 treatments per week and were thus categorized as large units.
2. Nine units (50%) conducted 10–30 treatments each week and were regarded as medium-sized units.
3. One unit (5%) conducted fewer than 10 treatments weekly and was thus categorized as a small unit.

All units provided anaesthesia with at least some involvement from consultant anaesthesiologists and 11 units included trainee anaesthesiologists in ECT work. Additionally, one unit employed consultant emergency physicians, three units reported participation by trainee emergency physicians, and three units involved specialists or trainees from other medical fields in administering anaesthesia.

5.1.2.2 Patient monitoring and airway management

Monitoring vital functions during ECT treatments was consistent across all units and included non-invasive blood pressure measurement, pulse oximetry for oxygen saturation, and three-channel ECG. BMV was the standard method for airway management; a LMA was used only occasionally, and no units reported the use of intubation.

Half of the units utilized a variation of the WHO checklist or an equivalent safety protocol before ECT.

5.1.2.3 Anaesthesia induction agents

Propofol was the most commonly used induction agent, reported as the primary choice in 14 units (75–100% of their cases). Methohexital was also frequently used in three centers providing ECT (80–100% of their cases), while 10 units reported never using methohexital. Four units reported sporadic use (2–5% of cases). S-ketamine was utilized in one unit for 25% of cases and sporadically in three other units (1–8%). Etomidate was mentioned in one unit, accounting for 15% of cases. No units used thiopentone, racemic ketamine, or sevoflurane. Additionally, no units used opioids as part of their general anaesthesia protocols either.

The selection of the induction agent varied across units. In three (17%) units, the choice was made solely by the anaesthesiologist. In eight (44%) units, the selection was a joint decision between the anaesthesiologist and psychiatrist, while seven (39%) units reported routinely using the same induction agent for all patients.

5.1.2.4 Neuromuscular blocking agents

Suxamethonium (succinylcholine) was the only NMBA used in 12 units. The non-depolarizing NMBA rocuronium was occasionally utilized in four units, accounting for 1–2% of their cases. In one unit, however, its use was significantly higher, being administered to up to 15% of patients.

5.1.2.5 Seizure monitoring and neuromuscular recovery

An inflated blood pressure cuff was employed in eight (44%) units to isolate a limb for seizure monitoring. EMG was utilized in five (63%) of these units, while the others depended on visual observation to evaluate motor convulsions. Ten (56%) units did not assess motor convulsions at all. The use of EEG monitoring was a consistent standard across all units. Neuromuscular recovery was quantitatively measured in only one unit.

5.1.2.6 Postoperative monitoring

The time patients spent in the recovery room varied, with 12 (71%) units discharging patients to a psychiatric ward or home within an hour of treatment. No units reported monitoring patients for more than 120 minutes.

5.1.2.7 Protocol changes and safety measures

Half of the units had updated their ECT protocols in the past five years, with some of these changes focusing on anaesthesia practices. Nine units (53%) had implemented a version of the WHO Surgical Checklist or an equivalent safety protocol into their ECT practices.

Local safety protocols aimed at preventing complications such as aspiration were implemented in 13 out of 18 units (76%). A summary of reported protocol changes is presented in Table 5.

Table 5. Modifications to ECT protocols during the past five years (Study I)

Unit ID	Modifications to ECT protocols made by different units during the past five years
1	Ensuring the patient is asleep before administering NMBA by asking the patient to lift a thumb. The ECT nurse verbalizes the patient's induction agent before induction. Timing the administration of ECT treatment appropriately during the patient's sleep. Sufficient preoxygenation with hyperventilation (approximately 2 minutes). Consideration of aspiration risk.
2	Discontinued the use of EMG.
3	Discontinued the use of EMG.
5	A new neuromodulation unit was established, and anaesthesia practices were standardized.
8	Discontinued the use of EMG.
9	Standardization of anaesthesia practices, adjustment of amounts of induction agents. Discontinued the use of methohexital.
15	An anaesthesia protocol has been developed according to which all patients are treated.
16	A temporary shortage of methohexital led to the use of propofol for a period of three months. During this time, an increase in postictal confusion was observed among patients, which prompted a return to methohexital.
18	Standardization of anesthesia practices.

5.1.3 Overview of adverse effects and their management

Based on the survey responses, a comprehensive overview of the adverse effects associated with ECT, their recognition, and their management in Finnish neuromodulation units was formed.

5.1.3.1 Headache

Headaches requiring medication were frequently reported in three units (18%) and occasionally in eight units (47%). The remaining units reported that headaches were a rare occurrence. Paracetamol and NSAIDs were the most commonly used medications for both prevention and post-treatment relief.

5.1.3.2 Myalgia

Muscle pain was frequently reported in one unit (6%), occasionally in six units (35%), and rarely in ten units (59%).

5.1.3.3 Injection pain

Although the survey did not specifically address pain caused by intravenous anaesthetic injections, eight units (47%) reported using intravenous lidocaine as needed to alleviate this discomfort. Notably, in six units (35%) that primarily used propofol, injection pain was never treated with lidocaine.

5.1.3.4 Post-ECT nausea and vomiting

Post-ECT Nausea or Vomiting (PENV) requiring medical treatment was reported occasionally by five units (29%), rarely by ten units (59%), and never by two units (12%). The most commonly used medications for the prevention and treatment of PENV were 5-HT3 receptor antagonists such as ondansetron.

5.1.3.5 Hypertension

Significantly increased blood pressure requiring pharmacological treatment occurred frequently in one unit (6%), occasionally in six units (35%), rarely in nine units (53%), and never in one unit (6%). Beta-blockers were the most common intervention, with clonidine, nitroglycerin, and propofol also being used.

5.1.3.6 Post-ictal confusion and aggression

PIC and related aggression requiring pharmacological intervention were reported occasionally by eight units (47%) and rarely by nine units (53%). Benzodiazepines or propofol were the most common treatments, with one unit noting the use of haloperidol.

5.1.3.7 Aspiration and accidental awareness during anaesthesia

Aspiration of gastric contents was reported to be extremely rare, and was reported by only two units (12%), while the remaining units had never encountered such an occurrence. Accidental awareness during general anaesthesia was reported as rare by four units (24 %), while 12 units (71 %) stated it had never occurred. However, one unit reported occasional instances of awareness during ECT.

5.1.4 Insights on AE prevention and treatment

Five units (29%) reported rare or no occurrences of headaches, myalgia, or nausea that required medication. Two of these units were large (conducting over 30 treatments weekly), while three were medium-sized (10–30 treatments weekly).

These findings suggest that the weekly treatment volume in these units is between 100 and 200.

Despite the recognition of AEs like pain or nausea, some units did not consistently utilize pharmacological interventions to address these issues for their patients. For instance, several units relied solely on as-needed paracetamol for pain relief, while others employed no prophylactic treatment for PENV.

5.2 Review and meta-analysis

5.2.1 Study selection

A total of 488 studies were initially identified through database searches. After excluding 151 duplicate records, 337 unique titles and abstracts were screened. Among these, 28 articles were selected for full-text review, and eight met the predefined inclusion criteria. No additional relevant studies were found through the reference screening of the included articles or related systematic reviews. The study selection process is illustrated in the PRISMA flow diagram in Figure 2.

5.2.2 Study characteristics and risk of bias

Among the eight studies that met the inclusion criteria, five were randomized controlled trials (Fear et al., 1994; Geretsegger et al., 2007; Kirkby et al., 1995; Malsch et al., 1994; Mårtensson et al., 1994) and three were retrospective cohort studies (Eser et al., 2010; Pulia et al., 2013; Vaidya et al., 2012). The risk of bias in each study was evaluated using MMAT. Overall, seven studies (Eser et al., 2010; Fear et al., 1994; Geretsegger et al., 2007; Kirkby et al., 1995; Malsch et al., 1994; Mårtensson et al., 1994; Pulia et al., 2013) raised concerns regarding potential bias, with three (Eser et al., 2010; Kirkby et al., 1995; Malsch et al., 1994) presenting major concerns. It is also worth noting that although the study by Vaidya (Vaidya et al., 2012) received a full MMAT score, its retrospective design may limit the strength of its evidence. A detailed summary of the risk of bias assessments is presented in Tables 6 and 7.

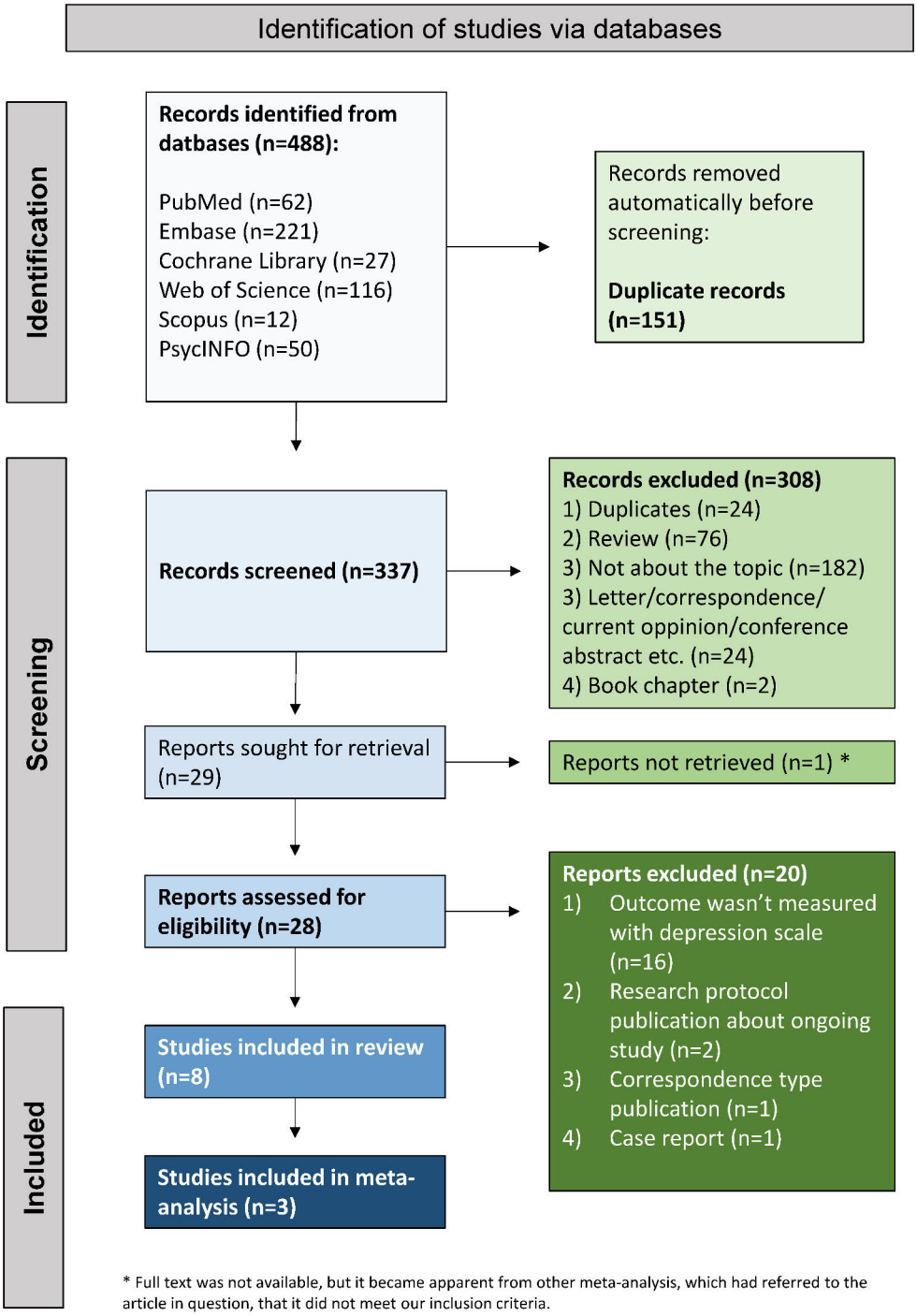


Figure 2. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow-diagram (Study III)

Table 6. Mixed Methods Appraisal Tool: Explanation.

Mixed Methods Appraisal Tool (MMAT), version 2018

The following MMAT questions are designed to assess the quality and reliability of the studies included in a review or meta-analysis. The possible answers are Yes (Y), No (N), or Can't Tell (CT). The more No (N) or Can't Tell (CT) responses there are, the greater the concerns about the quality and reliability of the study.

The first two questions are 'screening questions,' and the answer to both must be 'Yes.' Answering 'No' or 'Can't Tell' to either one or both questions may indicate that the paper is not an empirical study, and thus, it cannot be evaluated using the MMAT.

Screening questions:	**S1:** Are there clear research questions? **S2:** Do the collected data allow to address the research questions?

Questions for Quantitative randomized controlled trials:	**Questions for Quantitative, non-randomized studies:**
2.1. Is randomization performed appropriately? **2.2.** Are the groups comparable at baseline? **2.3.** Are there complete outcome data? **2.4.** Are outcome assessors blinded to the intervention provided? **2.5.** Did the participants adhere to the assigned intervention?	**3.1.** Are the pariticipants representative of the target population? **3.2.** Are measurements appropriate regarding both the outcome and intervention? **3.3.** Are there complete outcome data? **3.4.** Are the confounders accounted for in the design and analysis? **3.5.** During the study period, is the intervention administered (or exposure occured) as intended?

Modification from MMAT (2018)
http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/fetch/127916259/MMAT_2018_criteria-manual_2018-08-01_ENG.pdf

Table 7. Mixed Methods Appraisal Tool: Results from individual studies (Study III).

Mixed Methods Appraisal Tool (MMAT)

MMAT Question	2,1	2,2	2,3	2,4	2,5	Overall
Malsch, 1994	CT	Y	N	Y	N	40 %
Mårtenssen, 1994	Y	Y*	N	Y	Y	80 %
Kirkby, 1995	CT	N	N	Y	N*	20 %
Fear, 1994	CT	Y	Y*	Y	Y*	80 %
Geretsegger, 2007	CT	CT	Y	Y	Y	60 %
MMAT Question	**3,1**	**3,2**	**3,3**	**3,4**	**3,5**	
Eser, 2010	N	N	N*	N	Y	20 %
Vaidya, 2012	Y	Y	Y*	Y	Y	100 %
Pulia, 2013	Y	Y*	N	N	Y	60 %

Y = Yes, N = No, CT = Can't tell, 5 x Y = 100%, *A third researcher's opinion was sought

Concern for risk of bias

100 %	Low concern
60-80%	There are some concerns
0-40%	There are major concerns

5.2.3 Results from individual studies

In all included studies, both the propofol and methohexital groups demonstrated significant reductions in depression scores from baseline, suggesting that ECT was effective in alleviating depressive symptoms regardless of the anaesthetic used. A summary of study characteristics and individual results is presented in Table 8.

5.2.4 Meta-analysis results

Three randomized controlled trials (Fear et al., 1994; Malsch et al., 1994; Mårtensson et al., 1994) provided data on the number of ECT sessions needed to achieve remission, enabling a meta-analysis of this outcome.

The analysis included 62 patients treated with propofol and 69 with methohexital. The findings indicated no statistically significant difference in the mean number of ECT sessions required for remission between the two anaesthetic groups (for further details, see Figure 3). Based on GRADE guidelines, the overall certainty of the evidence regarding the number of ECT sessions needed to achieve remission was assessed as low.

Although the initial intention was to perform a meta-analysis comparing the reduction in depression scores between the groups, the literature search yielded only one additional RCT (Mårtensson et al., 1994) beyond those included in the previous meta-analysis (Lihua et al., 2014). Therefore, the decision was made not to proceed with a new meta-analysis on that outcome.

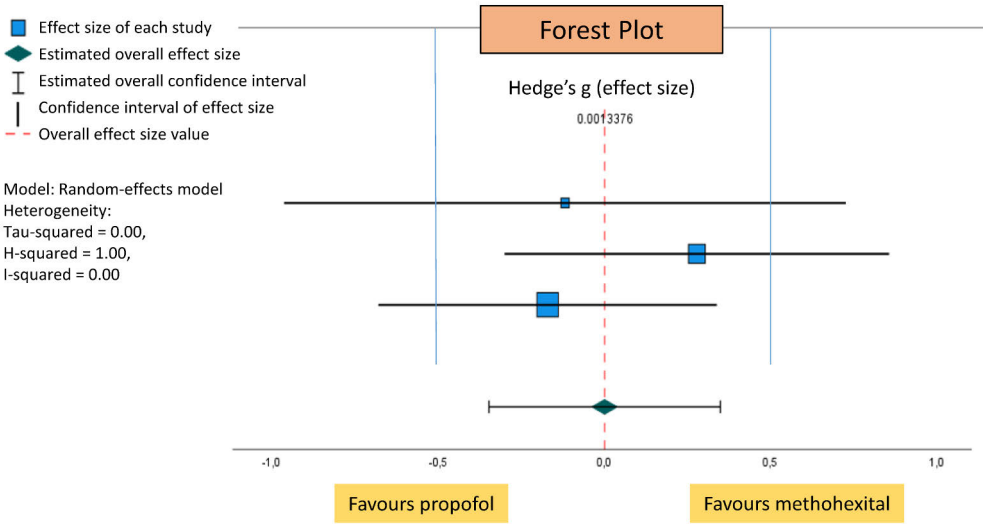
Table 8. Study characteristics and individual results (Study III).

Author (year)	Depression scale	Electrode placement	Number of patients propofol vs methohexital	DS before ECT series, mean (SD) propofol vs methohexital	DS after ECT series, mean (SD) propofol vs methohexital	Mean (SD) nr of ECTs needed propofol vs methohexital	Authors conclusions
Randomized Controlled Trials							
Fear (1994)	HDRS	BL	9 / 11	20.9 (6.4) vs 24.7 (6.7)	7.9 (9.2) vs 11.5 (10.8)	6.6 (2.6) vs 7 (3.7)	Despite reducing seizure duration by over 25%, propofol showed no difference on the HDRS and BDI, indicating it remains a viable induction agent for ECT.
Malsch (1994)	HDRS	RUL/BL	29 / 29	27.5 (4.69) vs 30.7 (6.89)	4.4 (5.12) vs 6.9 (9.21)	7.48 (1.45) vs 7.76 (1.78)	The finding that propofol does not affect efficacy and patients recover from depression at a similar rate to methohexital may surprise those who link seizure duration with adequacy.
Mårtensson (1994)	MADRS	RUL	24 / 29 (21 / 24)*	34.7 (8.3) vs 32.8 (7.3)	12.6 (9.9) vs 15.7 (12.0)	10.4 (2.6) vs 9.6 (3.0)	Both propofol and methohexital are effective ECT agents, and reduced seizure duration does not justify discontinuing the use of propofol.
Kirkby (1995)	HDRS	RUL	19 / 18 (16 / 16)*	19.63 (5.7) vs 21.10 (4.8)	7.31 (5.44) vs 8.56 (7.51)	6 vs 6	If further research confirms the findings of this study then propofol may be a suitable agent for ECT.
Geretsegger (2007)	HDRS	UL	25 / 25	26.5 (7.1) vs 31.3 (8.2)	9.8 (6.9) vs 13.7 (11.5)	NR	Results indicate that propofol, with comparable seizure quality and minimal blood pressure increase, is an effective anesthetic for ECT.

Retrospective Cohort Studies

Eser (2010)	CGI	UL/BL	180 / 81 **	NR	2.25 vs 1.25	NR	Patients who underwent propofol anesthesia had significantly better outcomes than those with methohexital anesthesia.
Vaidya (2012)	MADRS	RUL/BL	48 / 48 (within subject design)	27.4 (8.9) vs 29.8 (9.5)	-14.3 (9.1) vs. -15.6 (12.9)***	8.5 (4.5) vs 7.8 (4.6)	For RUL electrodeplacement, methohexital anesthesia requires fewer ECT treatments for remission than propofol.
Pulia (2013)	MADRS	RUL/BL	40 / 38	31.42 (n=24) vs 31.91 (n=34)	14.96 (n=24) vs 16.38 (n=34)	10.58 vs 9.26	Switching from propofol to methohexital and adjusting the charge dose regimen in RUL ECT may enhance recovery

*number of patients after dropouts
**number of treatments
***mean reduction of DS from the baseline
DS = depression score, NR = not reported, BL = bilateral, RUL = right unilateral, UL = unilateral
HDRS= Hamilton Depression Rating Scale, MADRS = Montgomery-Åsberg Depression Rating Scale, CGI = Clinical Global Impression



Study	Hedges' g	SE	CI (lower limit)	CI (upper limit)	P - value	Weight	Weight %
Fear	-0.12	0.43	-0.96	0.73	0.78	5.39	16.98
Mårtensson	0.28	0.29	-0.30	0.86	0.34	11.49	36.23
Malsch	-0.17	0.26	-0.68	0.34	0.51	14.84	46.79
Overall	0.00	0.18	-0.35	0.35	0.99		

SE= standard error CI= confidence interval

Figure 3. Meta-analysis: The difference in numbers of ECT sessions needed for remission between propofol and methohexital groups. (Study III).

5.2.5 Results regarding the adverse effects

The studies included in this review provided limited data on AEs related to ECT treatment. Reporting primarily focused on cognitive and cardiovascular side effects, while common ECT-related AEs, such as headache, myalgia, nausea, and vomiting, were not documented in any of the eligible studies. Detailed information on AEs is summarized in Table 9.

5.2.6 Findings from retrospective cohort studies

The retrospective studies by Vaidya et al. (2013) and Pulia et al. (2012) were conducted by the same research group with partially overlapping patient populations, both suggesting in their conclusions that methohexital may be more effective than propofol in RUL ECT, as fewer sessions were needed for remission. Despite this, their results demonstrated that both anaesthetics were similarly effective in reducing depression scores. In contrast, the study by Eser et al. (2010) found better clinical outcomes (CGI scores) with propofol.

Table 9. ECT-related adverse effects: conclusions from the individual studies (Study III).

Author	Evaluated AEs/ used measurements	Authors conclusions
Randomized controlled trials		
Fear 1994	NA	Propofol is better tolerated and provides greater hemodynamic stability, making it ideal for patients sensitive to hemodynamic changes.
Geretsegger 2007	Blood pressure measurements. Several different tests to assess cognitive function before and after ECT series.	Cognitive performance improved with propofol compared to methohexital, though only two tests showed significant differences. Blood pressure increases were also more moderate with propofol.
Kirkby 1995	NA	Propofol may be especially suitable for patients where controlling hypertension during ECT is crucial, as it helps mitigate this complication.
Malsch 1994	NA	NA
Mårtensson 1994	MMSE and other Cognitive test were done before, after fifth ECT and after entire ECT series to indicate possible variety in neuropsychological recovery	Neuropsychological tests showed no significant group differences. MMSE scores temporarily declined after the fifth ECT but normalized post-treatment, with no lasting memory effects. Propofol may help reduce seizure-related blood pressure increases, especially in high-risk cardiovascular patients.
Retrospective cohorts studies		
Eser 2010	Retrospective evaluation of cardiovascular and cognitive AEs	Transient cardiovascular AEs occurred in 11.5% of cases, with no significant group differences. Propofol caused less memory impairment than methohexital and was favored for its effective ECT outcomes and better tolerability.
Pulia 2013	NA	NA
Vaidya 2012	MMSE had been evaluated before and after ECT course to indicate cognitive impairment.	Mean MMSE scores before and after ECT were similar for methohexital and propofol groups.

AE= Adverse effect, NA= Not available, MMSE= Mini-Mental State Examination

5.2.7 Reporting bias and heterogeneity

To evaluate heterogeneity, potential small-study effects, and publication bias, an Egger's funnel plot was constructed. Visual inspection of the plot suggested symmetry, indicating no apparent publication bias. Additionally, Cochran's Q test, along with the I^2 and Tau^2 statistics, showed no evidence of heterogeneity among the three included studies. The funnel plot is presented in Figure 4.

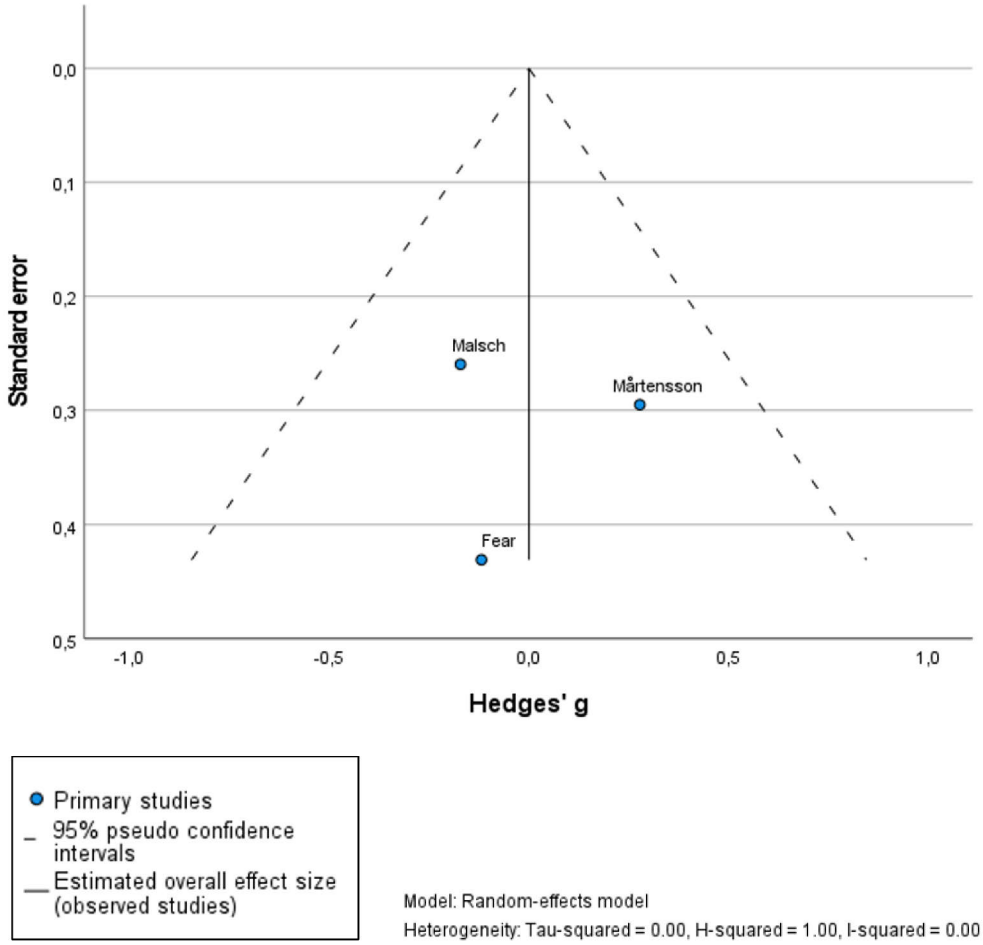


Figure 4. Funnel plot: Evaluation of reporting bias and heterogeneity. Modified from study III.

6 Discussion

6.1 Who should administer anaesthesia for ECT patients?

The survey results of substudies I–II indicate that, in many Finnish hospitals, the responsibility for administering anaesthesia during ECT often falls significantly to trainees. Additionally, some units delegate this responsibility to non-anaesthesiologists, such as consultant emergency physicians, trainee emergency physicians, and specialists or trainees from other medical fields. While this practice may not significantly impact clinical outcomes, provided that the individual responsible for ECT anaesthesia possesses adequate experience and skills, and has access to senior anaesthesiologists for consultation and immediate support in complex situations, prior research has nonetheless raised concerns. ECT anaesthesia may be perceived as an easy and straightforward routine procedure, which likely explains why it is often delegated to less experienced physicians. However, psychiatric patients are often medically complex and frequently present with undiagnosed or poorly managed medical comorbidities. Unpleasant surprises and sudden complications may arise during ECT anaesthesia, which underscores the importance of approaching these procedures with utmost seriousness. Studies have highlighted the increased risks associated with trainees administering anaesthesia to ECT patients who have multiple somatic comorbidities (Bwalya et al., 2011.)

The use of succinylcholine, the preferred NMBA for ECT, is diminishing in other areas of anaesthesia practice. Anaesthetists need to have not only sufficient experience but also up-to-date theoretical knowledge of this now uncommon drug, enabling them to administer it safely and determine whether it is contraindicated for specific patients. This highlights the importance of comprehensive education and training specifically in ECT-related anaesthesia theory and practice for those who provide it.

6.2 Induction agents for ECT anaesthesia

The survey results from substudies I–II indicate that significant variation exists among Finnish hospitals in the selection of anaesthesia induction agents for ECT. In

fewer than half of the units, there is collaborative decision-making between anaesthesia providers and psychiatrists regarding the choice of induction agent.

In half of the Finnish units surveyed, propofol is used exclusively as the induction agent, meaning that all patients receive the same medication regardless of individual factors, such as variations in seizure thresholds. One potential advantage of propofol is that it reduces the risk of postoperative nausea and vomiting in some surgical patient populations (Tramèr et al., 1997). This might partly explain the variation observed in the reported occurrence of PENV as an AE across different Finnish neuromodulation units, given that nausea and vomiting may be more common with other induction agents used in ECT.

Although studies show that propofol shortens EEG and EMG seizure duration, its clinical significance regarding ECT response remains debated. Some studies suggest that seizure duration does not significantly affect treatment outcomes (Bauer et al., 2009; Geretsegger et al., 2007). Conversely, a recent large-scale Swedish registry study demonstrated that patients with EEG-recorded seizure durations between 60 and 69 seconds achieved the highest remission rates, compared to those with seizure durations shorter than 20 seconds. (Gillving et al., 2024.)

6.2.1 Comparison of propofol and methohexital

What is the best available induction drug for ECT anaesthesia? According to the author's experience, thiopental was previously quite commonly used in ECT anaesthesia in Finland, but its use has now nearly ceased. This decline may be partly due to the requirement to dilute the drug, a restriction not applicable to propofol. Additionally, there were periods when the availability of thiopental was problematic. Nowadays in Finland, propofol and methohexital dominate the market, as they do in many other countries, but is one better than the other?

Our systematic review of substudy III indicates that both propofol and methohexital can function as effective anaesthetic agents for ECT, with comparable improvements in depression scores. Our meta-analysis supports this conclusion, revealing no significant variation in the average number of ECT sessions between the two drugs. These findings suggest that the therapeutic benefit is mainly attributable to the ECT procedure itself, rather than the choice of anaesthetic.

Retrospective studies by Vaidya et al. (2012) and Pulia et al. (2013) suggest that methohexital may offer some advantages in specific contexts, particularly with RUL electrode placement. In these instances, fewer sessions were required for remission with methohexital. Pulia also reported shorter hospital stays in the methohexital group.

A retrospective study by Eser et al. (2010) favoured propofol, although the strength of these findings is limited by methodological concerns. Notably, the

propofol group primarily included patients with depression, while the methohexital group also included individuals with schizophrenia. Furthermore, outcomes were reported by the total number of ECT sessions rather than per patient, which diminishes the clarity and comparability of the results.

Unfortunately, the current research on this topic relies on a few small and outdated RCTs. The results of previous studies need to be validated through randomized prospective trials. Reliable conclusions in this matter cannot be drawn solely from retrospective research, so randomized prospective trials are necessary to find a definitive answer to whether one induction drug should be preferred over the other, particularly in the context of depression treatment outcomes.

Table 10 summarizes the differences between propofol and methohexital.

Table 10. Comparison of propofol and methohexital as ECT anaesthetics.

Effect	Propofol	Methohexital
EEG/EMG seizure duration	↓↓	→
Postoperative bloodpressure	→	↑
Post-ECT nausea and vomiting	may be beneficial	LRD
Postictal confusion	may be beneficial	LRD
Alleviation of depression	Equally good	

LRD= lack of research data, ↓ = shortens / lowers, → = neutral, ↑ = rises
Modified from Rasmussen (2014), Rampton et al. (1989) and Sienart et al. (2004)

6.3 Monitoring during ECT

Monitoring patients' physiological parameters during ECT appears largely standardized at the national level in Finland. The monitoring protocol is non-invasive and includes measuring blood pressure with an inflatable cuff, pulse oximetry to assess oxygen saturation, and three-channel ECG. Notably, only one unit employed quantitative methods to monitor neuromuscular blockade, despite a European guideline recommending this when neuromuscular blocking agents are used (Fuchs-Buder et al., 2023) as well as a similar national recommendation (Olkkola et al., 2012).

Discharge times for patients in Finnish neuromodulation units were largely consistent, suggesting a unified approach to monitoring vital functions and post-procedure observation.

One area that showed notable variation in the survey results was the assessment and monitoring of the seizure itself. While all units used EEG to evaluate the seizure, EMG monitoring was performed either with EMG or only visually in eight units.

EMG monitoring via electrodes is considered unnecessary by some units, which reported ceasing electrode-based EMG monitoring in the past five years. However, it is noteworthy that ten units did not monitor motor seizure activity either with EMG or through visual observation. Since the upper limb is not isolated from circulation before administering the NMBA, patients are unable to communicate with staff when, for example, the depth of anesthesia may be inadequate. This is a concern, as ECT anaesthesia should be kept as light as possible (Gasteiger et al., 2022). Therefore, isolating a limb from circulation before administering the neuromuscular blocking agent is also a matter of patient safety. This issue deserves further discussion in the future.

6.4 Adverse effects

6.4.1 Pain as an adverse effect of ECT

The results of our survey indicate that headaches were the most frequently reported AEs, with 11 (65%) units identifying them as common or occasional issues for their patients. This aligns with findings from previous studies. Myalgia was reported as a frequent or occasional problem in seven (41%) Finnish units.

To manage these symptoms, units typically treat headache and myalgia with paracetamol or NSAIDs. Studies suggest that both paracetamol and NSAIDs are equally effective in alleviating tension-type headache (Alnasser et al., 2023), and they may also be equally beneficial in reducing post-ECT headache (Karaaslan et al., 2019). For myalgia, evidence indicates that NSAIDs are particularly effective (Karaaslan et al., 2019). However, the use of NSAIDs is contingent upon the absence of contraindications in the patient.

There is substantial evidence supporting the efficacy of lidocaine in reducing the pain associated with propofol injections (Euasobhon et al., 2016). However, nine units in our survey reported avoiding lidocaine, possibly due to its known effect of shortening the duration of the seizure induced by ECT (López-Ilundain et al., 2023). An alternative way to reduce injection pain is to prefer cannulation of an antecubital vein rather than more distal veins (Jalota et al., 2011). Recent studies also suggest that 5-HT3 antagonists may be effective in reducing propofol-induced pain (Bakhtiari et al., 2021), and their potential dual benefits in preventing nausea and alleviating injection pain in ECT should be explored further.

6.4.2 Postictal confusion

Eight (47%) of the units reported occasional cases of PIC requiring medication. PIC presents a challenge in ECT units; the agitated patient's stay in the recovery room is

often prolonged, and their behaviour can pose risks to both the patient and staff, as well as be alarming for other patients. The medications used to manage confusion, typically sedative benzodiazepines or propofol, can further extend recovery times and affect cognitive function post-treatment.

Previous studies have shown that dexmedetomidine can help alleviate PIC in subsequent treatment sessions (Feenstra et al., 2023). However, none of the surveyed units reported using dexmedetomidine, despite its widespread use in other medical contexts in Finnish hospitals. This highlights a potential area for improvement in ECT practices, as the findings suggest that dexmedetomidine may be a preferable treatment for post-ECT agitation and confusion. Future discussions within the Finnish ECT community regarding this option are pertinent.

6.4.3 Hypertension

Seven (41%) units reported that patients experienced hypertension requiring intervention either frequently or occasionally. The hemodynamic changes associated with ECT, resulting in an increase in blood pressure during the procedure, are well-documented. (Andrade & Bolwig, 2014.) Blood pressure typically rises immediately after ECT due to the hypertensive surge but tends to return to baseline levels soon after. In some cases, antihypertensive medication may be necessary. According to our survey, beta-blockers are the most commonly chosen treatment for managing post-ECT hypertension in Finland.

Patients with severe depression may struggle to manage long-term medical conditions, which could result in undiagnosed or poorly managed hypertension. This highlights the importance of conducting thorough preoperative evaluations to identify any undiagnosed somatic conditions in patients undergoing ECT. Persistent high blood pressure after ECT could suggest untreated hypertension, making pre-treatment screening essential. From an anaesthesiological perspective, pre-treatment evaluation is particularly vital for patients who have cerebral or aortic aneurysms, as rapid and significant changes in blood pressure may increase the risk of rupture.

Limited data from the studies included in the systematic review of substudy III suggest that propofol may be more suitable for patients with cardiovascular concerns, such as high blood pressure, as it seems effective in reducing post-treatment hypertension.

6.4.4 Post-ECT nausea and vomiting

Based on our research group's experiences at the Turku University Hospital's neuromodulation unit, which is a large ECT centre providing more than 30 treatments per week, PENV appears to be relatively common. Prophylactic treatment

for PENV is therefore administered to a significant number of patients undergoing ECT at Turku University Hospital. In stark contrast, five (29%) of the units responding to our survey reported occasional occurrences of PENV requiring medication, while the rest indicated even lower frequencies. The survey also revealed that several units provide neither prophylaxis nor on-demand medication for PENV.

Is the incidence truly lower in these units, or is this AE simply not recognized as often? Or could other factors explain the discrepancy? To find answers, we undertook further analysis of the data to see whether the induction agent used could explain the differences in reported incidence and, consequently, the differences in treatment needs. Disappointingly, the data collected do not allow for a definitive conclusion, and further research is necessary to investigate this connection.

Propofol, the most commonly used anaesthetic in Finnish ECT units, has been shown to reduce the risk of postoperative nausea and vomiting in surgical patients (Apfel et al., 2004). Our theory is that the relatively lower use of propofol at Turku University Hospital's neuromodulation unit (compared to other Finnish units) may contribute to the higher incidence of PENV observed at Turku.

6.4.5 Overview of variations in the recognition and treatment of adverse effects

The author’s clinical experience aligns with the survey findings, indicating that headache, myalgia, and nausea are frequently encountered AEs in ECT patients. At Turku University Hospital, a significant proportion of patients receive pharmacological treatment for these AEs, often as preventive measures. This includes antiemetic and anti-inflammatory medications to alleviate post-ECT headache, myalgia, and nausea. However, not all patients spontaneously report these symptoms, and many mention them only when specifically asked about experiences such as vomiting occurring during the day following ECT.

The national survey results appear to reveal a gap in the recognition and management of several common AEs. While some units acknowledge the occurrence of headaches and myalgia, they do not administer preventive treatments, such as NSAIDs, despite evidence suggesting their effectiveness, particularly for myalgia. Similarly, although PENV was reported in several units' patient populations, prophylactic or on-demand treatment is not universally provided.

When comparing the treatment of PIC, there is a clear consensus on the use of pharmacological treatment, even in units where PIC is reported to be infrequent. This is understandable, given how easily confusion and agitation can be recognized and the impact that withholding medication can have on both patient and staff safety.

6.4.6 Room for improvement in the recognition and treatment of ECT related adverse effects in Finland

Recent research has highlighted variations in healthcare professionals' understanding of pain and its treatment, particularly in cancer care (Galligan et al., 2024; Makhlouf et al., 2020). Might similar issues exist in ECT care? The survey results of substudies I and II may reflect not only the challenges this vulnerable patient group faces in communicating their symptoms but also the varying perceptions of these symptoms among healthcare providers. Some AEs may be viewed as an inherent and unavoidable aspect of ECT, leading to less emphasis on their prevention or treatment. However, these AEs can significantly affect patients' willingness to continue their ECT series. Given the availability and efficacy of pharmacological treatment and prophylaxis for these AEs, should they not be offered to all patients who could benefit in order to ensure maximal treatment compliance?

The variability in recognizing and managing PENV and post-ECT pain across different Finnish neuromodulation units suggests that introducing a standardized scale for assessing these AEs could be valuable. Such a scale, specifically validated for ECT patients, could enhance consistency in identifying and treating these common side effects.

If there is room for improvement in Finland, this may also hold true internationally, as the studies included in the systematic review of sub-study III did not comprehensively report on the AEs associated with ECT. Only four of the reviewed studies reported on AEs, and those primarily involved cognitive issues. Evaluating the superiority of one anaesthetic over another based solely on depression scores or the number of ECT sessions needed for remission would be inadequate, since AEs significantly impact the patient's treatment experience and their willingness to undergo ECT. Therefore, considering AEs and their frequency should be of great importance when assessing the relative advantages of propofol and methohexital.

6.5 Strengths and limitations

6.5.1 The survey studies

One of the main strengths of this survey study is its novelty: it is the first survey conducted in Finland to specifically examine anaesthesia practices in ECT, including the management and prevalence of treatment-related side effects. So far, no other studies have looked into the anaesthesiological aspects of ECT within the Finnish neuromodulation field, highlighting the unique contribution of this research.

However, the study also has important limitations. The survey was conducted retrospectively, without patient follow-up or direct collection of patient data. This is arguably the most significant weakness of the study design. The reliability of the data is inherently limited by the subjective nature of responses, which depend on the respondent's personal experience, expertise, and perception. Other factors such as motivation, interest, and time constraints may also have affected the quality of the responses.

Surveys like this are not the most reliable way to study clinical practices or AEs. More precise and objective data could have been gathered through structured interviews with neuromodulation units or a prospective survey where participating units recorded data, such as anaesthetic agents used and observed side effects, over a set period (e.g., one month). Because the current survey is retrospective and opinion-based, it might not fully reflect the true incidence of AEs or give a completely accurate picture of treatment practices. For example, one respondent may perceive post-treatment nausea as a common, while a colleague in the same unit might see it as rare. Such differences are especially likely in settings with high staff turnover, where no single staff member may have a complete view of current practices.

The diverse professional backgrounds of the respondents and their varying familiarity with anaesthesiology may have also affected their responses. However, we decided not to limit participation solely to anaesthesiologists, as doing so would likely have significantly lowered the response rate and the overall representativeness of the findings.

In a small country like Finland, with about 5.5 million people and only a few neuromodulation units, the potential survey respondents for ECT practices are naturally limited. Therefore, achieving a high response rate is essential for the results to be generalizable.

The survey response rate was 69%, which is considered adequate in medical research. Various types of bias and error can influence any survey, but the most notable is non-response bias, which happens when non-respondents differ significantly from respondents regarding the variables of interest. Therefore, a response rate below 60% is generally regarded as insufficient for medical publications (Livingston & Wislar, 2012). Additionally, the timing of survey responses may be important; those who respond late (after reminders) are likely more similar to the group that does not respond at all (Brasel et al., 2020). It is possible that responses received only after reminder messages or calls came from less motivated respondents, leading to less time and thought given to the answers, and consequently, lower reliability of those responses.

Most respondents represented large or medium-sized units by Finnish standards, suggesting that the results likely reflect the practices used to treat a substantial

portion of the Finnish ECT patient population. However, some smaller units did not participate. In these units, anaesthesia services for ECT may be provided on an "on-demand" basis by rotating staff, with a different anaesthetists, and psychiatric personnel may have lacked the specialised expertise required to respond accurately to the survey. Additionally, it is possible that units located in predominantly Swedish-speaking regions did not respond, as the survey was only available in Finnish.

The questionnaire was extensive, and respondents might have found it time-consuming to complete. This could lead to decreased attention and response quality toward the end of the survey. Additionally, the survey used a slide-switch scale (1–100) for most items, which, in retrospect may have been less user-friendly than a matrix scale and could have impacted the consistency of responses.

Therefore, it is important to recognize that while the survey offers useful insights and perspectives, it does not provide definitive conclusions. The findings should be interpreted with caution and seen as exploratory rather than conclusive. Particularly regarding the incidence of AEs, the survey's results should be interpreted carefully.

Despite its limitations, this survey has served as a valuable starting point for further ECT anaesthesia-related research at the neuromodulation unit of Turku University Hospital.

6.5.2 The systematic literature review and meta-analysis

The strength of the systematic literature review and meta-analysis lies in its methodology, which adheres strictly to the PRISMA protocol. It includes all published studies comparing methohexital and propofol as anaesthetics for ECT, where the primary outcome was the improvement in depression, i.e., treatment response.

However, there were several limitations to the conclusiveness of the answers that the research data reviewed could provide. Among the studies that met the inclusion criteria for the review, eight were identified, with only five being RCTs. The sample sizes, particularly in the RCTs, were small, ranging from 9 to 29 patients. The risk of bias was considered moderate or high in 7 out of the 8 studies. Furthermore, there is a lack of recent research on this topic. The three retrospective cohort studies carry an inherent risk of bias. Additionally, there was considerable heterogeneity in study designs, comparator group settings, depression scales used, patient characteristics, and the reporting of AEs.

In our research protocol, registered in PROSPERO, we indicated that AEs in ECT treatment would be examined. However, most of the included studies did not report on AEs, which prevents a quantitative analysis of this issue. This limitation impacts the final analysis, as understanding the AEs experienced by various control

groups is crucial for evaluating the relative efficacy of propofol and methohexital as ECT anaesthetics.

6.5.3 Future prospects

Given the limited evidence available, well-designed RCTs are essential. These trials should assess depression outcomes related to propofol and methohexital, as well as the number of ECT sessions required. Additionally, they should examine the incidence and frequency of AEs across different anaesthetic groups. Such studies would provide a robust foundation for developing evidence-based guidelines to optimise anaesthetic selection for ECT patients.

Following the initial ECT studies included in this thesis, our research group is compiling a large retrospective dataset of patients who have undergone ECT at Turku University Hospital in recent years. This analysis will examine the incidence of AEs and assess the impact of different anaesthetic agents on patient outcomes after ECT. Furthermore, research ethics approval has been sought for an upcoming RCT that will compare various ECT anaesthetics with respect to treatment effectiveness, seizure duration, and the occurrence of AEs.

As part of this RCT, our group is also examining EEG changes that occur after anaesthesia induction and just before administering the electrical stimulus, using continuous EEG monitoring. The goal is to see if these EEG changes can help identify the best timing for stimulus delivery. Additionally, we aim to investigate whether epileptiform activity appears during recovery and specifically whether some patients develop non-convulsive epilepsy as the ECT series advances.

Looking ahead, we plan to conduct a broader, systematic, prospective study focused on the incidence of AEs. This could be carried out as a multicenter investigation involving not only Finnish sites but also potential international collaborators, such as other Nordic countries. Additionally, it would be valuable to compare AEs associated with ECT not only across different anaesthetic agents but also among various patient populations. For example, we could explore whether the incidence of AEs differs between patients diagnosed with schizophrenia and those with depression.

Development of a national ECT anaesthesia guideline should be considered by Finnish neuromodulation providers in the future. Adopting a unified treatment protocol is recommended to reduce AEs and improve the quality of care. Additionally, training healthcare staff is crucial for minimizing AEs and further enhancing patient care.

7 Summary/Conclusions

The key findings of the research components of the dissertation and the conclusions drawn from them are as follows:

1. The survey results revealed variations in anaesthesia practices among units administering ECT in Finland. Half of the surveyed units had updated their treatment protocols in the past five years.

   The findings still emphasize a lack of standardization in ECT anaesthesia practices in Finland, particularly regarding the selection of anaesthetic agents for ECT. Varying treatment methods could result in inconsistent patient outcomes.

2. ECT related AEs, such as headache, myalgia, and postictal confusion, are common in Finnish ECT practice. However, serious AEs (such as aspiration of gastric content) are reassuringly rare. There seems to be considerable variation in how Finnish ECT providers identify, prevent, and manage AEs.

   The study raises the question of whether healthcare professionals might overlook or downplay the subjective AEs reported by patients, which could lead to insufficient pharmacological treatment. Severely depressed patients, particularly early in their treatment, may struggle to express these symptoms due to their unstable mental state. Recognizing and addressing AEs is essential for patient satisfaction and treatment adherence, especially during the early ECT sessions before psychiatric benefits are observed. However, since survey research is susceptible to various sources of error, these findings should be validated in future studies, and further research on the topic is needed.

3. Reviewed previous studies suggest that the choice of anaesthetic (propofol versus methohexital) does not significantly affect depression relief or the number of ECT sessions needed for remission. However, these studies are limited by their small sample sizes and outdated designs, highlighting a lack of robust evidence on the topic. Unfortunately, the incidence or management of AEs could not be

assessed based on the reviewed articles, as reporting was sparse or altogether absent.

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Appendix

Kysely koskien psykiatrisen ECT- eli sähköhoidon (anestesia)käytäntöjä

Pyydämme sinua vastaamaan tähän lyhyeen kyselyyn. Selvitämme ect-potilaiden anestesiakäytäntöjä suomalaisissa sairaaloissa. Tutkimus antaa tärkeää tietoa eri yksiköiden anestesiatoiminnasta ja tarjoaa mahdollisuuden kehittää jatkossa kansallisia suuntaviivoja toiminnan yhtenäistämiseksi. Tämä tutkimus on osa väitöskirjatyötä.

Vastaamiseen kuluu aikaa muutama minuutti. Kiitos ajastasi! Jokainen vastaus on tärkeä!

LL, EL Saara Huoponen; LL, EL Katrin Sisa; LT, EL Ulla Ahlmen-Laiho ja Dos, EL Markku Taittonen
Tyksin Totek-yksikkö ja Turun yliopiston Anestesiologian ja tehohoidon oppiaine
Yhteyshenkilö: Saara Huoponen (saara.huoponen@tyks.fi) puh 02 313 0000 (keskus)

1. Ketkä nukuttavat yksikössänne ect-potilaita? (Voit valita useamman vaihtoehdon.)

- ☐ Anestesiologian erikoislääkärit
- ☐ Anestesiologiaan erikoistuvat lääkärit
- ☐ Akuuttilääketieteen erikoislääkärit
- ☐ Akuuttilääketieteeseen erikoistuvat lääkärit
- ☐ Muut kuin anestesiologiaan tai akuuttilääketieteeseen erikoistumassa olevat ns. reunapalveluiden tekijät

Jatkossa termillä anestesialääkäri tarkoitetaan potilaan nukuttavaa lääkäriä, riippumatta hänen koulutustaustastaan.

2. Onko ect-potilaiden nukuttaminen yksikössänne keskitetty tai rajattu toimintaan erikseen perehdytetylle joukolle anestesialääkäreitä?

- ○ Kyllä
- ○ Ei

3. Tekeekö psykiatri (tai muu potilasta hoitava lääkäri) preoperatiivisia konsultaatiopyyntöjä potilaiden anestesiakelpoisuudesta?

- ○ Kyllä
- ○ Ei

4. Montako ect-hoitokertaa yksikössänne annetaan keskimäärin viikon aikana?

- ○ Alle 10
- ○ 10–30
- ○ Yli 30

5. Kuka valitsee potilaan hoidossa käytettävän yleisanestesia-aineen?

- ◯ Anestesialääkäri
- ◯ Psykiatri
- ◯ Anestesialääkäri ja psykiatri yhdessä
- ◯ Kaikilla potilailla käytetään samaa lääkeainetta, ellei vasta-aiheita

Arvioi seuraavien **yleisanestesia-aineiden käyttöä ect-yksikössäsi potilaiden nukuttamiseen**. 0= kukaan potilas ei saa, 100= kaikki potilaat saavat. Jos esimerkiksi käytätte kaikilla potilailla propofolia ja puolet heistä saavat lisäksi S-ketamiinia, valitse: propofoli 100 ja S-ketamiini 50.

6. Propofoli

7. Metoheksitaali

8. Tiopentaali

9. S-ketamiini

10. Raseeminen ketamiini

11. Etomidaatti

12. Sevofluraani

13. Saavatko potilaat rutiinisti opioidia osana ect-anestesiaa?

- ☐ Eivät
- ☐ Kyllä, fentanyylia
- ☐ Kyllä, remifentaniilia
- ☐ Kyllä, alfentaniilia
- ☐ Kyllä, oksikodonia

Arvioi seuraavaksi, **mitä lihasrelaksantteja käytätte ect-potilaillanne**. 0= kukaan ei saa, 100= kaikki saavat

14. Suksinyylikoliini

15. Rokuroni, kumotaan glykopyrroni + neostigmiini yhdistelmällä

16. Rokuroni, kumotaan sugammadexilla

17. Muu lihasrelaksantti

18. Eristättekö rutiinisti potilaan raajan (esim. toisen käden) staassilla verenkierrosta ennen lihasrelaksantin antoa?

- ◯ Kyllä
- ◯ Ei

19. Mittaatteko sähkönannon jälkeen lihaskouristuksen pituutta?

- ◯ Ei
- ◯ Kyllä, silmämääräisesti
- ◯ Kyllä, elektrodeilla

Arvioi seuraavaksi, **saavatko ect-potilaanne esilääkkeinä seuraavia pahoinvoinnin estolääkkeitä ennen ect-hoitoa**. 0= kukaan ei saa, 100= kaikki saavat

20. Serotoniiniantagonisti (5-HT3-salpaaja, "setroni")

21. Droperidoli (DHBP)

22. Beetametasoni

23. Deksametasoni

24. Metoklopramidi

Arvioi seuraavaksi, **saavatko ect-potilaanne esilääkkeinä seuraavia kipulääkkeitä ennen ect-hoitoa**. 0= kukaan ei saa, 100= kaikki saavat

25. Parasetamoli

26. Tulehduskipulääke

Arvioi vielä, **saavatko ect-potilaanne esilääkkeinä seuraavia lääkeaineita ennen ect-hoitoa**. 0= kukaan ei saa, 100= kaikki saavat

27. Beetasalpaaja

28. Glykopyrroni tai muu antikolinergi

29. Lidokaiini

Arvioi seuraavaksi, **saavatko ect-potilaanne seuraavia lääkeaineita pahoinvoinnin tai oksentelun hoitoonect-hoidon jälkeen**. 0= kukaan ei saa, 100= kaikki saavat

30. Serotoniinantagonisti (5-HT3-salpaaja, "setroni")

31. Droperidoli (DHBP)

32. Metoklopramidi

33. Deksametasoni

34. Beetametasoni

35. Muu, mikä?

Arvioi saavatko ect-potilaanne seuraavia lääkeaineita **levottomuuden/sekavuuden hoitoon ect-hoidon jälkeen.** 0= kukaan ei saa, 100= kaikki saavat

36. Bentsodiatsepiini

37. Propofoli

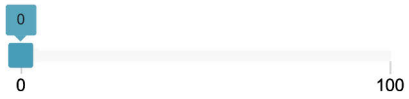
38. Haloperidoli

39. Muu, mikä?

Arvioi saavatko ect-potilaanne seuraavia lääkeaineita **lihaskivun ja/tai päänsäryn hoitoon ect-hoidon jälkeen** 0= kukaan ei saa, 100= kaikki saavat

40. Parasetamoli

41. Tulehduskipulääke



42. Opioidi

Arvioi vielä, saavatko ect-potilaanne seuraavia lääkeaineita **korkean verenpaineen hoitoon ect-hoidon jälkeen.** 0= kukaan ei saa, 100= kaikki saavat

43. Beetasalpaaja

44. Klonidiini

45. Propofoli

46. Muu, mikä?

Arvioi seuraavaksi ect-potilailla käytettäviä eri **hengitysteiden hallintamenetelmiä**. 0= ei käytetä kenelläkään, 100= käytetään kaikilla.

47. Maskiventilaatio

48. Nieluputki

49. Supraglottinen väline (esim. I-gel tai muu kurkunpäänaamari)

50. Intubaatio

51. Korkeavirtaus- (High flow-) viikset

52. Happiviikset tai happimaski potilaan hengittäessä itse

Arvioi seuraavaksi ect-potilaillanne käytettäviä **elintoimintojen seurantamenetelmiä**. 0= kenelläkään ei käytetä, 100= kaikilla käytetään

53. Pulssioksimetria

54. 3-kanavainen EKG

55. 5-kanavainen EKG

56. Non-invasiivinen verenpaineen mittaus

57. Invasiivinen verenpaineen mittaus (valtimopaineen mittaus)

58. EEG

59. EMG

60. Lihasrelaksaatio (TOF)

61. Mikä on potilaiden keskimääräinen seuranta-aika ect-toimenpiteen jälkeen ennen kotiuttamista tai osastolle siirtymistä?

- ◯ Alle 60 min
- ◯ 1–2 tuntia
- ◯ Yli 2 tuntia

Arvioi seuraavaksi, **kuinka monta kertaa viimeisen 6 kk aikana ect-potilaillanne on esiintynyt seuraavia sivu-/haittavaikutuksia**. Valitse parhaiten sopiva vaihtoehto alasvetovalikosta.

62. Jälkirelaksaatiota heräämisvaiheessa

- ◯ Ei lainkaan
- ◯ Alle viisi kertaa
- ◯ Viisi kertaa tai useammin
- ◯ En osaa sanoa

63. Tahatonta hereilläoloa anestesian aikana

- ◯ Ei lainkaan
- ◯ Alle viisi kertaa
- ◯ Viisi kertaa tai useammin
- ◯ En osaa sanoa

64. Mahansisällön aspiraatiota

- ◯ Ei lainkaan
- ◯ Alle viisi kertaa
- ◯ Viisi kertaa tai useammin
- ◯ En osaa sanoa

Arvioi seuraavaksi, **kuinka usein ect-potilaillanne esiintyy seuraavia sivu-/haittavaikutuksia**. Valitse parhaiten sopiva vaihtoehto alasvetovalikosta.

65. Lääkitsemistä vaativaa verenpaineen nousua

- ◯ Ei koskaan
- ◯ Harvoin
- ◯ Toisinaan
- ◯ Usein
- ◯ Aina
- ◯ En osaa sanoa

66. Lääkitsemistä vaativaa päänsärkyä

- ◯ Ei koskaan
- ◯ Harvoin
- ◯ Toisinaan
- ◯ Usein
- ◯ Aina
- ◯ En osaa sanoa

67. Lääkitsemistä vaativaa pahoinvointia tai oksentelua

- ◯ Ei koskaan
- ◯ Harvoin
- ◯ Toisinaan
- ◯ Usein
- ◯ Aina
- ◯ En osaa sanoa

68. Lääkitsemistä vaativaa lihaskipua

- ◯ Ei koskaan
- ◯ Harvoin
- ◯ Toisinaan
- ◯ Usein
- ◯ Aina
- ◯ En osaa sanoa

69. Lääkitsemistä vaativaa postoperatiivista aggressiivisuutta/agitaatiota

- ◯ Ei koskaan
- ◯ Harvoin
- ◯ Toisinaan
- ◯ Usein
- ◯ Aina
- ◯ En osaa sanoa

70. Käytättekö ect-potilaiden hoidossa rutiinisti WHO:n kirurgiseen tarkistuslistaan perustuvaa työkalua (ns. check-list)?

- ◯ Kyllä
- ◯ Ei

71. Onko yksikössänne protokolla tai erikseen sovittuja käytäntöjä toimenpiteeseen liittyvän aspiraatioriskin vähentämiseen?

- ◯ Kyllä
- ◯ Ei

72. Onko ect-potilaille annettavia anestesiakäytäntöjä muutettu viimeisen 5 vuoden aikana?

- ◯ Kyllä
- ◯ Ei

73. Millä tavoin anestesiakäytäntöjä on muutettu viimeisten 5 vuoden aikana?

74. Varsinainen kysely päättyy tähän. Onko sinulla jotakin kommentoitavaa ect-anestesiaan tai tähän kyselyyn liittyen?

Seuraavan kysymyksen vastausta ei käytetä kyselyn tulosten raportoinnissa, eikä sitä yhdistetä edellä esitettyihin kysmyksiin. Kysymys esitetään vain, jotta osaamme kohdentaa mahdolliset muistutusviestit oikein, mikäli jokin yksikkö ei vastaa kyselyyn määräaikaan mennessä.

75. Yksikkö jossa työskentelen

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