

# Short-Term Adverse Cardiovascular Events After Electroconvulsive Therapy

Gurina TS<sup>1\*</sup>, Bhamber I<sup>1</sup>, Maguire J<sup>2</sup>, Butler FK<sup>1</sup>, Steinhoff JP<sup>1</sup>

<sup>1</sup>HCA Healthcare / USF Morsani College of Medicine GME: HCA Florida Largo Hospital, Largo, FL

<sup>2</sup>Baptist Heart Specialists, Jacksonville, FL, USA

\***Corresponding author:** Tatyana S Gurina, HCA Healthcare / USF Morsani College of Medicine GME: HCA Florida Largo Hospital, Largo, FL USA

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## Abstract

### Background

Electroconvulsive Therapy (ECT) is a pivotal treatment for severe psychiatric disorders, including Major Depressive Disorder (MDD) and bipolar disorder. Despite its effectiveness, there have been cases of adverse cardiac events reported following ECT. The primary objective of this study was to determine the correlation of short term adverse cardiac events amongst those with and without cardiac comorbidities.

### Methods

This retrospective cohort study utilized data collected from HCA Healthcare. The primary endpoint was incidence of adverse cardiac events, including angina, arrhythmia, heart failure, and myocardial infarction. Data was collected using ICD 9 and 10 codes and unique subject codes for ECT. Demographic information was characterized by age, length of stay, sex, and race/ethnicity; our study excluded pregnant patients.

### Results

This study analyzed 146,575 ECT treatments administered to 37,721 patients between 2015 and 2022. The study identified a low adverse cardiac event rate of 0.44% per ECT treatment, encompassing events like angina, arrhythmia, heart failure, and myocardial infarction. Of the 640 total cardiac events, 168 (26%), 201 (31%), and 277 (43%) events were observed in patients with known hypertension, hyperlipidemia, and arrhythmias, respectively, while 472 (74%), 439 (69%), and 363 (57%) events were observed in patients with no previously diagnosed hypertension, hyperlipidemia, arrhythmia, respectively.

### Conclusions

While ECT procedures are known to induce transient hemodynamic fluctuations and potentially trigger minor cardiac events, these findings align with previous literature showing similar results, reinforcing ECT's safety as a therapeutic option for patients with complex psychiatric conditions.

## 1. Introduction

Electroconvulsive Therapy (ECT) plays a crucial role in treating advanced psychiatric illnesses including severe Major Depressive Disorder (MDD) and bipolar disorder [1]. Although it is considered a generally safe and effective adjunctive therapy to medication, there have been numerous case reports describing cardiac arrhythmia, acute coronary syndrome, hemodynamic disturbance and acute decompensated heart failure after ECT administration [2-5]. These reports suggest an association between cardiac events and electroconvulsive therapy. The aim of this study was to investigate the occurrence of short term adverse cardiac events in patients receiving electroconvulsive therapy

## 2. Methods and Materials

### 2.1. Data collection

This study is a retrospective cohort study that used deidentified patient data from the HCA Healthcare Database in accordance with HIPAA guidelines. Internal Review Board exemption was provided. Adult non-critical care patients with a diagnosis of Major Depressive Disorder and Bipolar Disorder who were undergoing ECT between the dates of January 1, 2015 to December 31, 2022 were selected for this study. The study excluded pregnant patients. The data was collected using ICD 9 and 10 codes and unique subject codes for ECT. From this population, adverse cardiac events were identified in that population. Cardiac events were identified as angina, arrhythmia, heart failure, and myocardial infarction. Demographic information was characterized by age, length of stay, sex, and race/ethnicity.

## 2.2. ECT Protocol

Patients were provided MAC anesthesia with intravenous propofol, methohexital, etomidate and at times, ketamine. Supplements including intravenous caffeine prior to ECT were administered to enhance seizure duration. The electrode placements included the right unilateral electrode placement location, bilateral electrode placement location and rarely, a bifrontal electrode placement. Mecta and Thymatron machines were used in all treatments. ECT stimulus was applied for 8 seconds, with brief and ultra-brief pulse-widths, 800mA current and 100J. Treatment frequencies in Hz were individualized per the Columbia University Titration parameters. Continuous 5 lead EEG was used to monitor seizure activity for a goal of 30 seconds. Patients were observed post-procedure for hemodynamic monitoring and return of baseline mentation after post-ictal state.

## 3. Results

37,721 patients were identified that received ECT. Of the 146,575 treatments administered, 640 cardiac events were identified and the adverse cardiac event rate per ECT treatment was 0.44% (Table 1). Adverse cardiac events include angina, arrhythmia, heart failure, and myocardial infarction.

**Table 1:** Rate of short-term cardiac events per ECT treatment.

Variable	Value
Number of Patients	37,721
Number of ECT treatments	146,575
Number of cardiac events	640
Adverse cardiac event rate per ECT treatment	0.44%

Among the patients that exhibited an adverse cardiac event, mean age was 67, and the mean number of ECT treatments was 6 (Table 2). This study included 24,640 female patients comprising 65% of the sampled population and 13,081 male patients comprising 35% of the sampled population. This study included 30,968 white patients, 2292 African-American, 1817 Hispanic patients, and 2644 identified as other race/ethnicity.

**Table 2:** Number Of Patients and Patient Demographic Information Undergoing ECT Treatments.

	TOTAL N = 37,721	EXPERIENCED CARDIAC EVENT	
		No N = 37,081	Yes, N = 640
AGE		52.65	67.57
LENGTH OF STAY		17.65	19.7
NUMBER ECT TREATMENTS		3.84	6.76
SEX			
FEMALE GENDER	24,640 (65%)	24,249 (65%)	391 (61%)
MALE GENDER	13,081 (35%)	12,832 (35%)	249 (39%)
RACE/ETHNICITY			
AFRICAN-AMERICAN	2,292 (6.1%)	2,224 (6.0%)	68 (11%)
HISPANIC	1,817 (4.8%)	1,796 (4.8%)	21 (3.3%)
WHITE	30,968 (82%)	30,451 (82%)	517 (81%)
OTHER	2,644 (7.0%)	2,610 (7.0%)	34 (5.3%)

640 cardiac events were identified in our study of 146,757 treatments completed by 37,721 patients. Of the 640 total cardiac events, 168 events (26%) were observed in patients with previously known hypertension, 201 events (31%) were observed in patients with previously known hyperlipidemia, and 277 events (43%) were observed in patients with a previously known history of arrhythmia. Of the 640 total cardiac events, 472 events (74%) were observed in patients without hypertension, 439 events (69%) were observed in patients without hyperlipidemia, and 363 events (57%) were observed in patients without any arrhythmia (Table 3).

**Table 3:** Cardiovascular history of the patients undergoing ECT treatment.

	TOTAL	EXPERIENCED CARDIAC EVENT	
	N = 37,721	No, N = 37,081	Yes, N = 640
<b>HISTORY OF HYPERTENSION</b>			
NO	34,717 (92%)	34,245 (92%)	472 (74%)
YES	3,004 (8.0%)	2,836 (7.6%)	168 (26%)
<b>HISTORY OF HYPERLIPIDEMIA</b>			
NO	35,148 (93%)	34,709 (93.6%)	439 (69%)
YES	2,573 (6.8%)	2,372 (6.4%)	201 (31%)
<b>HISTORY OF ARRHYTHMIA</b>			
NO	37,444 (99%)	37,081 (100%)	363 (57%)
YES	277 (0.7%)	0 (0%)	277 (43%)

#### 4. Discussion

Electroconvulsive therapy is used by psychiatrists in both inpatient and outpatient settings for the treatment of a variety of psychiatric conditions [5]. ECT is considered a generally safe procedure with rare death or complications. One study reported two deaths per 100,000 treatments between the years of 1977-1983 [6]. In a systemic review and meta-analysis investigating cardiac events after ECT, the estimated incidence rate from 82 studies collected showed that major events occur in approximately 2% of patients [7]. These studies were collected from a span of 1980 to 2016, from facilities in the US and internationally. ECT practice models and machines vary significantly across each facility and advancements have been made over time. In our study, all data was collected from HCA Healthcare facilities and from the same period of time.

Our study identified 363 events of arrhythmia in patients without a previously known history of arrhythmia, and 277 events in patients with a known history. ECT is performed by the delivery of electric current through electrodes to provide a sub-convulsant seizure and requires induction with several anesthetics administered by anesthesiologists. The induction causes significant hemodynamic changes as vagal tone increases with electric current followed by catecholamines surge in recovery [8]. Thus, the patients' heart rates are typically bradycardic with sedation through induction of anesthesia and electrocurrent delivery. Immediately afterwards, the patient becomes tachycardic and hypertensive, and recover within 20 minutes. The procedure also requires the use of sedation with anesthesia, which alter hemodynamics on their own in conjunction with ECT.

Case reports and cohort studies have demonstrated minor and transient cardiovascular events after ECT, including persistent hypertension, transient arrhythmias, premature atrial or ventricular beats, ST changes on the ECG, and bradycardia. ECT has also been associated with regional left ventricular wall motion abnormalities on echocardiography, but the effects were transient and resolved [2]. Cardiac biomarker evaluation, like troponin assays, are often used in the clinical environment to evaluate for cardiac myocyte damage. In a prospective cohort study looking at the association between ECT and troponin elevation, an elevation in troponin level was not always seen after ECT and there was no consistency in the troponin elevation among ECT treatments delivered [9]. Of note, these studies were before the advent of high-sensitivity troponins. Additionally, case reports note T-wave inversions on EKG, but that also resolved within 4 days with no lasting changes on the patients' electrocardiograms. Several patients with known cardiovascular comorbidities have undergone ECT safely with less than 1% of patients experiencing cardiac or pulmonary complications [10]. In one study investigating safety of ECT for depressed patients with preexisting serious cardiac

disease, where a mean of 11.3 ECT treatments per patient were administered, the cardiac complications seen were atrial and ventricular arrhythmias, ischemic events and sinus bradycardia [11]. Most of the effects seen were transient minor complications but some persisted and were referred to as major complications, overall, there were no significant differences in age, cardiac medications, amount of ECT or electrode placement modalities between major and minor complications [11]. Our results show a remarkably low event rate of adverse acute cardiac events, even in patients with a history of hypertension, hyperlipidemia and arrhythmia.

## 5. Limitation

One potential limitation to our study was that the data was collected using ICD-10 codes to identify adverse events and patient history. Due to their reliance on accurate documentation, there is a possibility of identifying patients as developing arrhythmia or heart failure due to the ECT when it may have been for confounding reasons. Another potential limitation would be that patients' race and genders are not equally represented in the sample population.

## 6. Conclusion

ECT is an important modality in treating severe psychiatric disease. There have been case reports suggesting an association between cardiac events and electroconvulsive therapy. Our study investigated the occurrence of short term adverse cardiac events in patients receiving electroconvulsive therapy and showed a remarkably low event rate. This further supports the idea that ECT is an overall safe procedure from a cardiovascular standpoint.

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