Effects of Electroconvulsive Therapy on Short-Term Suicide Mortality in a Risk-Matched Patient Population

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Objective: Although evidence has suggested that electroconvulsive therapy (ECT) is effective in reducing suicidal ideation, research establishing the effectiveness of ECT in reducing short-term risk of death by suicide is less conclusive. This study assessed whether receipt of ECT reduced suicide mortality among patients seeking healthcare in Veterans Health Administration hospitals.

Methods: Annual cohorts of patients who received ECT between 2006 and 2015 were propensity score matched with mental health patients who did not receive ECT. After matching, population averaged adjusted odds were calculated to assess the risk of suicide in the year after receipt of ECT, compared with a control group.

Results: The study population consisted of 14,810 patients in the ECT cohort and 58,369 matched controls. Matching successfully reduced clinical and demographic differences between cohorts of patients who received ECT and those who did not (asymptotic Kolmogorov-Smirnov statistic = 0.02, $P > 0.99$). After matching and controlling for remaining between-group differences in an adjusted logistic regression, the odds of suicide in the year after receipt of ECT were not statistically different from those of matched patients who did not receive the procedure (odds ratio = 1.31, 95% confidence interval = 0.94–1.96, $P = 0.095$).

Conclusions: Patients who received ECT were at a high risk for suicide. Electroconvulsive therapy did not seem to have a greater effect on decreasing short-term risk for suicide than other types of mental health treatment provided to patients with similar baseline risk.

Key Words: electroconvulsive therapy, ECT, suicide, Veterans Health Administration, propensity score matching, generalized estimating equations

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Research has clearly and consistently demonstrated the safety and efficacy of electroconvulsive therapy (ECT) in a variety of psychiatric conditions ranging from catatonia to mood disorders, such as depression and bipolar disorder, to psychotic disorders, such as schizophrenia.[1,2] In addition to targeting the primary symptoms of these disorders, ECT also seems to reduce suicidal ideation.[3–6] Although these findings have led experts to recommend ECT as a suicide prevention intervention,[7] research establishing the effectiveness of ECT in reducing risk of death by suicide (rather than suicidal ideation) is not conclusive.

Early studies of ECT's impact on suicide mortality were conducted in an era during which effective psychotropic medication was limited or inaccessible to most patients.[8–10] Although these studies demonstrated protective effects of ECT with regard to suicide, they are difficult to extrapolate to contemporary cohorts of patients for whom effective psychotropic medications are available and typically used as a first-line treatment.[11] As the patients for whom ECT is currently most typically used now represent those who are most refractory to prior treatment, including medications and psychotherapy,[12] the impact of ECT on preventing suicide is less clear for this more severely ill group. This is illustrated by recent studies, which report an elevated risk of suicide among patients undergoing ECT in unadjusted bivariate analyses, compared with patients in mental health treatment who did not receive ECT.[13,14] Other studies have attempted to control for this elevated baseline risk using risk-matched designs, but those studies assessed risk over almost a decade,[15,16] which is a much longer period than mortality risk could have plausibly been affected by ECT treatment.

Given the rarity of death by suicide even in the highest-risk populations,[17] constructing a prospective sham-controlled study of ECT as a suicide prevention strategy is not feasible. Given the relatively infrequent use of ECT as a treatment modality,[18,19] it would take a very large clinical cohort of mental health users to study ECT and suicide using quasi-experimental methods. Such a cohort would have to be contemporary to account for the reservation of ECT for higher-risk patients in modern practice and well characterized enough to identify matched controls using variables that are most important in assessing suicide risk. To better understand the relationship between ECT and short-term risk of death by suicide in a contemporary cohort of mental health patients, we conducted a retrospective cohort study of Veterans Health Administration (VHA) users. Our objectives were to determine the 1-year suicide mortality rate after ECT and to compare the risk of suicide among those who received ECT to a matched group of VHA users.

METHODS

Study Population

Individuals with recent VHA mental health use between 2006 and 2015 were identified using VHA electronic medical record data. Cohorts of recent users were defined to include all individuals with an inpatient or outpatient mental health encounter in the year (index) or year prior and who were alive at the start of the index year. Mortality was assessed for all users in the index year. Our study included 10 sequential cohorts, and patients could be counted in multiple cohorts. Individuals were considered to be in the ECT group in a given cohort if they received at least one session of ECT in the year or year prior. The no-ECT group consisted of all other mental health patients who accessed VHA mental services during the same period. Individuals could move between the ECT and no-ECT treatment groups given a 2-year clean period after indication of ECT.

Measures

Demographic, clinical, pharmacological, and service use variables were extracted from medical records. History of a recent suicide attempt was identified by the presence of International Classification of Disease (*ICD-9* and *ICD-10*) clinical

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modification codes indicating suicide attempt, excluding records with indication of attempt sequelae only. Demographic factors, such region of residence, sex, and age, were assessed as of the start of the year. Binary indicators for medical diagnoses were created based on presence of diagnosis in the cohort year or year prior. A similar approach was taken for prescription and service use indicators. In addition to binary indicators of medical diagnoses, a Charlson score was calculated to summarize severity of medical diagnoses in the year of VHA mental health care. The Charlson index is a composite measure of morbidity, the elements and scoring of which have been described elsewhere.[20] Mortality data were obtained from the VA's Mortality Data Repository,[21] a comprehensive database of VHA user deaths, including date and underlying cause of death, as determined by the Center for Disease Control and Prevention's National Death Index. Suicide deaths were identified using *ICD-10* death codes and included any death with an *ICD-10* code in the following range: X60-X84, U03, and Y87.0.

Statistical Analyses

Descriptive statistics were conducted to demonstrate baseline differences between all individuals who did and did not receive ECT. Counts with percentages and means with standardized deviations (SDs) were, respectively, supplemented by measures of relative risk (RR) and Cohen *d* to demonstrate magnitude of between-group differences (effect size). To account for baseline differences between the ECT and no-ECT groups, which would otherwise confound assessment of suicide risk, we used propensity score matching to build a population on which to perform suicide risk analysis. Propensity score matching is a technique used to select a control population in observational studies, where treatment assignment is nonrandom. Traditional statistical methods have relied on various forms of multivariate regression to reduce baseline differences between treated and nontreated groups, which would otherwise confound the outcome of interest. However, when baseline differences between treatment groups are quite significant, and when one population is much larger, and therefore contributes more to the overall fit of a model, propensity score matching has been demonstrated to be a better method, allowing for a valid assessment of outcomes.[22] In this study, logistic regression was used to assess and then case control match all individuals on their propensity to receive ECT. Variables selected for inclusion in matching the model were based on prior literature detailing characteristics of patients who received ECT[14,23,24] and descriptive bivariate assessment of patient characteristics in our study population. In total, 30 clinical, demographic, and service use variables were used to generate a model predicting receipt of ECT. In addition to cohort year, 10 variables were specified as requiring an exact match, whereas all other variables contributed as main effects to overall assessment of propensity for receipt of ECT (see Table 1 for full list of variables specified in matching). The result of this model was then used to match individuals based on the nearest neighbor technique without possibility of replacement in given cohort year. The maximum permitted propensity score difference between matched subjects was specified as 0.25. A maximum of 4 controls were allowed for each treated individual in the population. Descriptive, bivariate analyses, and standardized differences of means were conducted in the final matched population to test for balance between the characteristics of the treated and untreated groups. In addition, the Students *t* test for difference in means and a Kolmogorov–Smirnov 2-sample test for difference in distribution were used to compare propensity scores between ECT and the no-ECT group in the final matched sample.

A logistic regression was used to assess the crude and adjusted odds of short-term suicide mortality among individuals who received ECT as compared with the matched sample of individuals who did not receive ECT. To account for intrasubject correlation among repeated subjects in the study population, suicide within the year after VHA visit was modeled as a binary outcome in a generalized estimating equation (GEE), which controlled for repeated measures using a compound-symmetric (exchangeable) correlation structure. The compound-symmetric correlation structure was selected as it assumes that intrasubject correlation remains consistent over time, rather than following a specific trajectory. In addition, model estimates used robust standard errors as a conservative measure. Adjusted analysis considered all diagnostic, pharmacological, service use, and demographic variables provided in Table 1 excepting the outcome variable (suicide) and variables on which the cohort had been matched using the exact method. A final adjusted model was selected using stepwise selection; it included receipt of ECT as well as 19 additional covariates (see Table 2 for full list of covariates). In crude and adjusted models, β estimates for the ECT variable were exponentiated to produce a population averaged odds ratio (OR) and corresponding 95% confidence intervals (CIs) of suicide risk among those who received ECT relative to those who did not. Data management and statistical analyses were performed using SAS Enterprise Guide 7.1 (SAS Institute, Cary, NC).

RESULTS

Before matching, the population included 16,782,217 recent VHA mental health users, including 14,884 (0.089%) who received ECT in the year or year prior (Table 1, left side—*before matching*). The mean (SD) age of individuals in the population was 55.2 (13.1) years. Individuals who received ECT were more likely to be female and less likely to identify as African American. All mental health diagnoses were more prevalent in the ECT group as compared with the no-ECT group; schizophrenia, major depressive disorder (MDD), bipolar disorder, and personality disorder all had RRs greater than 3. The RR of a suicide attempt in the year or year prior was more than 16 times greater among individuals who received ECT compared with those who did not. Indication of recent psychiatric hospitalization was also more common among the ECT group (RR = 9.7), as was indication of multiple psychiatric hospitalizations in the year or year prior (RR = 18.4). In the full population of individuals accessing VHA mental health care, there were 10,066 suicides identified in the year after treatment. This resulted in an annual suicide rate of 60.3 per 100,000. Suicide in the year after mental health treatment was 5.8 times more prevalent in the ECT group than in the no-ECT group, relative to population size. Patients who received ECT had a suicide rate of 349.4 per 100,000 in the year after their procedure.

The propensity score matched sample included 14,810 individuals who received ECT and 58,369 matched controls (Table 1, right side—*after matching*). The maximum number of repeated observations was 10 for both the case and control cohorts, and the median number of observations contributed in both groups was 2. There were 305 instances of individuals who were in both the ECT and no-ECT group during difference cohort years; the maximum number of changes between case and control groups for the 10-year cohort period was 2. To assess balance of characteristics in the matched population, standardized differences of means were calculated for all continuous and categorical variables after matching[22]; differences were less than 2% between the ECT and no-ECT group. The results of the Kolmogorov–Smirnov 2-sample tests were nonsignificant for both the ECT and the no-ECT control group (asymptotic Kolmogorov-Smirnov statistic = 0.02, $P > 0.99$); the Student *t* test comparing differences in propensity score also yielded a nonsignificant

TABLE 1. Mortality, Demographic, Clinical, Prescription, and Service Use Characteristics Among Cohorts of ECT Recipients and No-ECT Mental Health Patient Controls in VHA Hospitals 2006 Through 2015, Before and After Conducting Propensity Score Matching

	Before Matching* N = 16,782,217						After Matching† N = 73,179					
	No ECT n = 16,767,333		With ECT n = 14,884		*Effect Size*		No ECT n = 58,369		With ECT n = 14,810		*Effect Size*	
	n	%	n	%	RR	Cohen *d*	n	%	n	%	RR	Cohen *d*
Suicide death	10,066	0.06	52	0.35	5.82		138	0.24	51	0.34	1.46	
Demographics												
Age‡, M ± SD	54.4 ± 15.58		55.21 ± 13.08			0.05	55.3 ± 11.86		55.2 ± 13.1	13.1		0.001
Male‡	15,184,705	90.56	12,522	84.13	0.93		50,774	86.99	12,474	84.23	0.97	
Race												
Asian	125,353	0.75	92	0.62	0.83		254	0.44	92	0.62	1.43	
Native American	309,875	1.85	187	1.26	0.68		1022	1.75	187	1.26	0.72	
African American‡§	3,367,287	20.08	1136	7.63	0.38		4313	7.39	1108	7.48	1.01	
Unknown race‡	1,309,168	7.81	713	4.79	0.61		3298	5.65	713	4.81	0.85	
White race	11,655,650	69.51	12,756	85.7	1.23		49,482	84.77	12,710	85.82	1.01	
Region												
Northeast‡	675,763	4.03	1234	8.29	2.06		2749	4.71	1230	8.31	1.76	
Southern Atlantic	3,837,944	22.89	2971	19.96	0.87		11,669	19.99	2954	19.94	1.00	
East North Central	2,211,997	13.19	2119	14.24	1.08		9140	15.66	2107	14.23	0.91	
East South Central	1,328,137	7.92	1059	7.12	0.90		3011	5.16	1056	7.13	1.38	
Middle Atlantic‡	1,498,666	8.94	841	5.65	0.63		6462	11.07	840	5.67	0.51	
Missing region	19,398	0.12	13	0.09	0.75		46	0.08	13	0.09	1.11	
Mountain	1,457,465	8.69	1327	8.92	1.03		5303	9.09	1319	8.91	0.98	
Outside 50 states, DC‡	211,220	1.26	518	3.48	2.76		1151	1.97	517	3.49	1.77	
Pacific	2,172,335	12.96	1678	11.27	0.87		5496	9.42	1674	11.30	1.20	
West North Central	1,166,268	6.96	1571	10.55	1.52		7383	12.65	1554	10.49	0.83	
West South Central	2,188,140	13.05	1553	10.43	0.80		5959	10.21	1546	10.44	1.02	
Service use												
Emergency department visit‡	6,329,305	37.75	11,539	77.5	2.01		43,795	75.03	11,478	77.50	1.03	
At least 1 mental health inpatient stay‡§	1,258,124	7.50	10,821	72.7	9.70		42,147	72.21	10,750	72.59	1.01	
≥2 mental health inpatient stays‡§	392,424	2.34	6423	43.15	18.44		24,707	42.33	6361	42.95	1.01	
At least 1 medical inpatient stay‡	2,182,646	13.01	3132	21.04	1.62		8594	14.72	3125	21.10	1.43	
≥2 medical inpatient stays‡	933,475	5.57	2641	17.74	3.19		8724	14.95	2631	17.77	1.19	
Diagnoses												
Chronic pain‡	977,411	5.83	2411	16.20	2.77		10,127	17.35	2397	16.19	0.93	
Headache pain‡	1,482,497	8.84	2975	19.87	2.24		9653	16.54	2935	19.81	1.19	
Any mental health diagnosis	14,583,271	86.97	14,866	99.87	1.14		58,161	99.64	14,792	99.87	1.00	
Substance use disorder‡§	4,413,452	26.32	7306	49.09	1.86		58,161	99.64	14,792	99.87	1.00	
Anxiety	4,536,309	27.05	7241	48.65	1.80		26,867	46.03	7199	48.60	1.05	
Bipolar disorder‡§	1,407,020	8.39	6801	45.69	5.45		26,470	45.35	6762	45.66	1.00	
Dementia‡	809,148	4.83	1747	11.74	2.43		5124	8.78	1741	11.76	1.34	
Depression	9,544,786	56.92	13,959	93.75	1.65		53,528	91.71	13,887	93.77	1.02	
Major depression disorder‡§	3,680,983	21.95	12,390	83.24	3.79		48,482	83.06	12,321	83.19	1.00	
Personality disorder‡§	684,933	4.08	4268	28.67	7.01		16,519	28.3	4222	28.51	1.00	
PTSD‡	6,057,534	36.13	6530	43.87	1.21		26,803	45.92	6490	43.82	0.95	

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TABLE 1. *(Continued)*

	Before Matching* N = 16,782,217						After Matching† N = 73,179					
	No ECT n = 16,767,333		With ECT n = 14,884		*Effect Size*		No ECT n = 58,369		With ECT n = 14,810		*Effect Size*	
	n	%	n	%	RR	Cohen *d*	n	%	n	%	RR	Cohen *d*
Other psychosis‡	683,884	4.08	2871	19.29	4.72		10,391	17.8	2848	19.23	1.08	
Schizophrenia‡§	985,194	5.88	3842	25.81	4.39		14,680	25.15	3787	25.57	1.01	
Suicide attempt‡§	150,024	0.89	2213	14.86	16.62		8451	14.48	2172	14.67	1.01	
Charlson score‡, M ± SD	0.72 ± 1.32		0.82 ± 1.29			0.07	0.97 ± 1.44		0.82 ± 1.28			0.10
Prescription receipt												
Mirtazapine	1,601,161	9.55	5050	33.93	3.55		13,309	22.80	5024	33.92	1.49	
Lorazepam	1,315,417	7.85	4664	31.34	3.99		12,328	21.12	4645	31.36	1.48	
Clonazepam	1,451,624	8.66	4997	33.57	3.88		13,953	23.90	4970	33.56	1.40	
Alprazolam	791,253	4.72	1208	8.12	1.72		4155	7.12	1194	8.06	1.13	
Analgesic	8,856,024	52.82	10,800	72.56	1.37		44,512	76.26	100,737	72.50	0.95	
Anticonvulsive mood stabilizer‡	5,159,196	30.77	10,748	72.21	2.35		3270	65.57	10,688	72.17	1.10	
Antidepressant‡	10,655,213	63.55	13,787	92.63	1.46		52,029	89.14	13,714	92.60	1.04	
Antipsychotic‡	3,689,633	22.00	12,058	81.01	3.68		37,220	63.77	11,992	80.97	1.27	
Statin	6,415,965	38.26	7184	48.27	1.26		26,982	46.23	7146	48.25	1.04	
Opioid	6,653,257	39.68	7476	50.23	1.27		32,842	56.27	7435	50.20	0.89	
Sedative anxiolytic‡	5,568,479	33.21	10,851	72.90	2.20		35,496	60.81	10,795	72.89	1.19	
Zolpidem	1,634,659	9.75	4116	27.65	2.84		11,609	19.89	4083	27.57	1.39	
Stimulant‡§	570,266	3.40	2529	16.99	5.00		9008	15.43	2455	16.58	1.07	

*Before matching, 99% of the ECT and 98% of the no-ECT population was in more than 1 cohort year, with a median number of 2 cohorts per individual for both groups; there were 346 individuals who moved between the case and control population.

†After matching, 99% of the ECT and 97% of the no-ECT population was in more than one cohort year, with a median number of 2 cohorts per individual for both groups; there were 305 individuals who moved between the case and control population.

‡Variable specified in propensity score matching model.

§Exact matching was specified for this field in propensity score matching model.

result ($t = -0.16$, $P = 0.87$). The mean (SD) age in the matched population was 55.3 (12.1). A total of 86.43% were male and 84.99% of the population identified as white. Given that this population was selected for propensity to receive ECT, the clinical profile reflected a high prevalence of mental health disorders: 83.09% of the matched population had a recent diagnosis of MDD and 45.41% had a recent diagnosis of bipolar disorder. Chronic pain was present in 17.11% of the matched population, and the mean (SD) Charlson score was 0.94 (1.42). The matched population included 189 suicide deaths; the rate of suicide in the full matched population was 278.6 per 100,000. After matching, suicide remained slightly more prevalent in the population that received ECT as compared with the no-ECT group; however, the RR was greatly reduced compared with the prematched population (RR = 1.46).

In analysis of the matched population (Table 2), the odds of suicide in the year after VHA mental health use for individuals who received ECT, with no additional adjustment for risk factors, and averaging across all correlated clusters was 1.56 (95% CI = 1.11–2.18) times that of individuals who did not receive ECT in the year or year prior ($P = 0.01$). When demographic, clinical, and service use characteristics were added to the logistic model, the relative odds of suicide for those who received ECT attenuated slightly to 1.31 (95% CI= 0.94–1.95) and were no longer significant ($P = 0.095$).

TABLE 2. Relative Odds of Suicide Death in the Year After Receipt of ECT (Case) or Other VHA Mental Health Care (Control) in a Risk-Matched Population of VHA Users, 2005–2016

	Unadjusted		Adjusted*	
	OR (95% CI)	*P*	OR (95% CI)	*P*
ECT (yes vs no)	1.56 (1.11–2.18)	0.010	1.31 (0.94, 1.96)	0.095

Crude and adjusted models were calculated by a population averaged logistic regression using the generalized estimating equations method; the covariance correlation structure was specified as compound symmetric. Population averaged OR and 95% CI were generated by exponentiating the resulting estimates for the ECT β.

*Adjusted for *demographics*: sex, age, region; s*ervice use*: medical inpatient stay (any, 2 or more), emergency department visit; d*iagnoses*: chronic pain, dementia, depression, anxiety disorder, other psychosis, PTSD, Charlson Index; *prescriptions*: mirtazapine, zolpidem, opioid, benzodiazepine (any receipt of clonazepam, alprazolam, lorazepam), antidepressant, antipsychotic.

DISCUSSION

This research confirms prior findings that patients who receive ECT in contemporary practice are at a significantly elevated risk for death by suicide. However, results of matched analysis illustrate that ECT does not cause this elevated suicide risk. Rather, it is a marker of association, as patients at high risk for suicide receive ECT. Indeed, many of the baseline characteristics that differed most between the ECT and the no-ECT receiving group are well-recognized risk factors for suicide. These include inpatient mental health treatment, serious mental illness diagnoses, and history of suicide attempt. When these between-group differences were controlled for by matching and adjusted logistic regression, the odds of suicide death did not significantly differ between the ECT group and the group of patients receiving other VHA mental health care. That this analysis did not find a significantly lower risk of death by suicide for the ECT group than the control group suggests that either there are factors unaccounted for in our risk-matching model or that ECT does not prevent suicide more than other mental health treatments in this high-risk group of patients.

A strength of the present work is its study design and the scope of analysis, which allowed for a well-powered assessment of short-term suicide risk after receipt of ECT in a large population, matched on key baseline risk factors. A significant limitation of this study is that it does not differentiate between patients who received high quality ECT care, those who received suboptimal ECT treatment, and those who did not tolerate the treatment. To allow for a sufficiently powered analysis, we assessed mortality in a population with any ECT treatment in the year or year prior. However, it is possible that some ECT delivery methods provide benefit while others do not. Additional work within ECT-treated cohorts could help indicate treatment patterns that are associated with lower short-term suicide risk. Another limitation of this work is the lack of specific measures that characterize mental health disorder severity. Although VA medical record data allow for robust determination of the presence or absence of a clinical diagnosis, there are no concise measures, which indicate that acuity at the time a diagnosis is given. Accordingly, it may be the case that, even given a similar diagnostic profile, ECT patients present with higher levels of clinical acuity, which are beyond the scope of measurement in the present study. In this regard, our matching may not have selected groups truly at equal risk for suicide. In addition, it should be noted that VHA patients differ from the general US population demographically and clinically. Accordingly, our findings regarding the impact of ECT provision may not generalize beyond this population.

This study diverges from research findings that demonstrate that ECT was effective at decreasing suicidal ideation.[3–6] One obvious explanation for this finding is the relatively moderate association between suicidal ideation and actual death by suicide; previous studies of VHA patients have found that as many as 71% of suicide decedents reported have no suicidal ideation before their death.[25,26] Thus, it is possible that ECT may both decrease suicidal ideation and not decrease actual suicide deaths. Our findings also diverge from 2 recent epidemiologic studies, which found ECT effective in decreasing suicide deaths compared with control groups.[15,16] One important difference between those studies and this work was their focus on long-term mortality. In both studies, patients were followed for almost a decade, whereas even among patients whose symptoms remit in community samples, most relapse quickly in a mean time of less than 9 weeks.[27] This indicates that ECT's protective effects are unlikely to last a decade. Furthermore, long periods of follow-up introduce multiple biases in measuring a treatment's impact. For instance, among patients who receive mental health care in the years after receipt of ECT, it is difficult—if not impossible—to disentangle the impact of this subsequent care from that of initial ECT, particularly without careful follow-up measurements. The same could be said of any additional risk factors introduced after receipt of ECT. We believe the study design reflected in our research adequately reflects an assessment of patients' risk of suicide for a period in which ECT could plausibly have an antisuicidal effect.

Both suicide and ECT research pose unique challenges. Our study points to the importance of these efforts. There is considerable research, which focuses on use of models to identify populations and patients at high risk for suicide. It seems that in the VA, receiving ECT represents a substantial marker for high suicide risk. It is reassuring that such patients are being identified and are receiving treatment recommended for complex and severe psychiatric diagnoses. Future work could develop a better understanding of whether specific ECT characteristics (number of treatments, bilateral versus unilateral) have greater effects on reduction of suicide risk. Similarly, a better understanding of which characteristics among patients who receive ECT are associated with reduced risk of suicide would be helpful to clinicians. Better characterization of patient acuity at the time of ECT is also an area for further refinement. Most of the matching characteristics used in this study rely on factors that would be present for years or even decades. A more precise characterization of clinical severity at time of referral to ECT was not possible in the present study. Ahmadi et al (2016) focused on veterans with comorbid posttraumatic stress disorder (PTSD) and MDD and restricted assessment to patients who had received at least one full course of ECT. Although this approach limited sample size (their analysis included 92 patients who received ECT), it had 2 important strengths. First, it allowed for assessment and matching based on clinical severity scales of PTSD and MDD. In addition, it controlled for completion of an ECT course, thus ensuring a measure of adequate treatment. Although data on diagnosis severity were not available for our current cohort, the approach by Amhadi et al provides some direction for future work.

In conclusion, our study found that patients who received ECT were at a high risk for suicide. Electroconvulsive therapy did not seem to have a greater effect on decreasing their suicide risk than other types of mental health treatment provided to patients with similar baseline characteristics. Understanding patterns of ECT practice and patient characteristics that provide the greatest antisuicidal effects are important next steps in understanding how ECT can most effectively be used for suicide prevention.

REFERENCES

1. Tharyan P, Adams CE. Electroconvulsive therapy for schizophrenia. *Cochrane Database Syst Rev.* 2005;2:CD000076.
2. Bahji A, Hawken ER, Sepehry AA, et al. ECT beyond unipolar major depression: systematic review and meta-analysis of electroconvulsive therapy in bipolar depression. *Acta Psychiatr Scand.* 2019;139:214–226.
3. Kellner CH, Fink M, Knapp R, et al. Relief of expressed suicidal intent by ECT: a consortium for research in ECT study. *Am J Psych.* 2005; 162:977–982.
4. UK ECT Review Group. Efficacy and safety of electroconvulsive therapy in depressive disorders: a systematic review and meta-analysis. *Lancet Lond Engl.* 2003;361:799–808.
5. Greenberg R, Kellner C. Electroconvulsive therapy: a selected review. *Am J Geriatr Psychiatry.* 2005;13:268–281.
6. Sackeim HA, Haskett RF, Mulsant BH, et al. Continuation pharmacotherapy in the prevention of relapse following electroconvulsive therapy a randomized controlled trial. *JAMA.* 2001;285:1299–1307.
7. Fink M, Kellner CH, McCall VW. The role of ECT in suicide prevention. *JECT.* 2014;30:5–9.
8. Ziskind E, Somerfeld-Ziskind E, Ziskind L. Metrazol and electric convulsive therapy of the affective psychosis. *Arch Neurol Psychiatry.* 1945;53:212–217.

9. Huston PE, Locher LM. Involutional psychosis: course when untreated and when treated with electric shock. *Arch Neurol Psychiatry.* 1948; 59:385–394.

10. Huston PE, Locher LM. Manic-depressive psychosis: course when untreated and when treated with electric shock. *Arch Neurol Psychiatry.* 1948;60:37–48.

11. Tanney BL. Electroconvulsive therapy and suicide. *Suicide Life Threat Behav.* 1986;16:116–140.

12. Ross EL, Zivin K, Maixner DF. Cost-effectiveness of electroconvulsive therapy vs pharmacotherapy/psychotherapy for treatment-resistant depression in the United States. *JAMA Psychiat*. 2018;75:713–722.

13. Munk-Olsen T, Laursen TM, Videbech P, et al. All-cause mortality among recipients of electroconvulsive therapy: register-based cohort study. *Br J Psychiatry.* 2007;190:435–439.

14. Peltzman T, Gottlieb DJ, Shiner B, et al. Electroconvulsive therapy in Veterans Health Administration Hospitals: prevalence, patterns of use, and patient characteristics. *J ECT.* 2020. DOI: 10.1097/ YCT.0000000000000635.

15. Ahmadi N, Moss L, Simon E, et al. Efficacy and long-term clinical outcome of comorbid posttraumatic stress disorder and major depressive disorder after electroconvulsive therapy. *Depress Anxiety.* 2016; 33:640–647.

16. Liang C-S, Chung C-H, Ho P-S, et al. Superior anti-suicidal effects of electroconvulsive therapy in unipolar disorder and bipolar depression. *Bipolar Disord*. 2017;20:539–546.

17. McCarthy JF, Bossarte RM, Katz IR, et al. Predictive modeling and concentration of the risk of suicide: implications for preventive interventions in the US Department of Veterans Affairs. *AJPH*. 2015; 105:1935–1942.

18. Case BG, Bertollo DN, Laska EM, et al. Declining use of electroconvulsive therapy in United States general hospitals. *Biol Psychiatry.* 2013; 73:119–126.

19. Weiner RD, Prudic J. Electroconvulsive therapy in the United States: how often is it used? *Biol Psychiatry.* 2013;73:105–106.

20. Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am J Epidemiol*. 2011;173: 676–682.

21. Center of Excellence for Suicide Prevention. Joint Department of Veterans Affairs (VA) and Department of Defense (DoD) Mortality Data Repository (SDR) – National Death Index (NDI). Published 2016.

22. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res*. 2011;46:399–424.

23. Wilkinson ST, Agbese E, Leslie DL, et al. Identifying recipients of electroconvulsive therapy: data from privately insured Americans. *Psychiatr Serv.* 2018;69:542–548.

24. Knight J, Jantzi M, Hirdes J, et al. Predictors of electroconvulsive therapy use in a large inpatient psychiatry population. *JECT.* 2018;34:35–39.

25. Louzon SA, Bossarte R, McCarthy JF, et al. Does suicidal ideation as measured by the PHQ-9 predict suicide among VA patients? *Psychiatr Serv.* 2016;67:517–522.

26. Simon GE, Rutter CM, Peterson D, et al. Et a. does response on the PHQ-9 depression questionnaire predict subsequent suicide attempt or suicide death? *Psychiatr Serv.* 2013;64:1195–1202.

27. Prudic J, Olfson M, Marcus SC, et al. Effectiveness of electroconvulsive therapy in community settings. *Biol Psychiatry.* 2004;55:301–312.

