Effects of Electroconvulsive Therapy on Suicidal Behavior and Emergency Department Use Among Homeless Veterans: A Propensity Score–Matched Study

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ABSTRACT

Objective: This study examined the effects of electroconvulsive therapy (ECT) on suicidal ideation, suicide attempt, and emergency department use among homeless veterans receiving services in the Veterans Affairs (VA) health care system.

Methods: National VA administrative data from 2001 to 2017 were analyzed using propensity score matching to compare 1,524 homeless veterans who received ECT and 3,025 homeless veterans discharged from psychiatric inpatient units serving as matched controls.

Results: Homeless veterans who received ECT were significantly less likely to have used any ED services 30 and 90 days after their first ECT session compared to homeless veterans who did not receive ECT (OR = 0.65, 95% CI = 0.60–0.71; OR = 0.86, 95% CI = 0.81–0.93, respectively). Homeless veterans who received ECT showed reductions in suicidal ideation and suicide attempts after ECT, but these reductions were significantly less than homeless veterans who did not receive ECT 30 days, 90 days, and 1 year later (OR = 1.48–2.00).

Conclusions: ECT has the potential to reduce ED use among homeless veterans with ECT-responsive psychiatric conditions. Further study is needed on whether the treatment engagement required of ECT participants indirectly reduces use of acute services in this population.

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Homeless populations are known to disproportionately use emergency department (ED) services, which has implications on their individual health and well-being as well as the workload of health care systems. In the US Department of Veterans Affairs (VA) health care system—where eligible veterans have access to a comprehensive array of medical, mental health, and social services—one national study reported that homeless veterans are still 4 times more likely to use ED services compared to non-homeless veterans.[1] In addition, another study found that while 1% of domiciled VA users are frequent ED users (> 4 ED visits a year), 10% of homeless VA users are frequent ED users.[2] Use of ED services among homeless populations often involves addressing unmet mental health and substance abuse treatment needs or social service needs. Various interventions targeting these issues have been developed to try to mitigate use of ED services among homeless and at-risk populations with varying degrees of success and often at substantial cost because many interventions require a coordinated, multidisciplinary approach.[3,4]

Mental health challenges including depression and suicidal behaviors have consistently been within the top 10 presenting problems in EDs among homeless VA service users[5] and are major drivers of repeated acute care utilization.[6] Furthermore, homeless VA users are less likely to fill prescriptions, including those for antidepressant and antipsychotic medications.[7,8] The potential of electroconvulsive therapy (ECT) as a treatment that may improve mental health symptoms and therefore reduce ED services utilization has not been explored and is a novel area of inquiry. Numerous clinical trials have found that ECT can safely and effectively reduce symptoms of severe psychiatric conditions such as major depression and schizophrenia.[9–13] In fact, no other intervention has matched ECT in speed or likelihood of remission of major depressive episodes.[9] Among patients with treatment-resistant depression, ECT has demonstrated a 60%–80% response rate and 50%–60% remission rate.[11,13,14] Despite its demonstrated effectiveness and advancements in procedures, ECT is utilized in less than 0.5% of individuals with major depression in the United States, with utilization rates decreasing over time.[15–17] According to the American Psychiatric Association Practice Guideline for the Treatment of Patients with Major Depressive Disorder,[18] ECT is recommended for both treatment-resistant depression and active suicidal ideation (treatment-resistant or not).

Patients who receive ECT have shown rapid relief in suicide risk. For example, one study found dramatic reduction in suicidal intent after 1 week of 3 sessions of ECT, and the authors suggested ECT be considered earlier in treatment algorithms instead of reserving ECT for the treatment of "last resort."[19] There are a number of cohort studies finding that ECT is associated with a lower rate of all-cause mortality, including suicide.[20,21] However, other studies have had mixed or null findings with regard to ECT and its antisuicidal effects.[22–24] Perhaps the effects of ECT vary by different populations. However, no study, that we are aware of, has examined the effects of ECT in homeless populations.

Clinical Points

- There is high risk for suicide and high reliance on emergency department services in homeless populations but few effective interventions.
- Electroconvulsive therapy should be considered for homeless veterans who frequently use emergency department services.

Aims of the Study

In the current study, we used contemporary national VA administrative data and a quasi-experimental design to examine the effect of ECT on ED visits, suicidal ideation, and suicide attempts among VA homeless service users. We hypothesized that veterans who received ECT would have greater reductions in ED visits, suicidal ideation, and suicide attempts than veterans who did not receive ECT.

METHODS

Study Population

Veterans with indication of homelessness from 2001 through 2017 were identified using VA's Corporate Data Warehouse (CDW), which contains data from VA electronic medical records nationally and can be available to VA-affiliated researchers through a data request platform (https://www.data.va.gov/dataset/Corporate-Data-Warehouse-CDW-/ftpi-epf7). A large timeframe for inclusion in this analysis was selected to ensure an adequately powered analysis in this unique patient subpopulation. Definitions and coding for homelessness, ECT, and suicidal behaviors are detailed in Supplementary Table 1. Indication of homelessness was defined via presence of an *International Classification of Diseases* (*ICD*) diagnosis code or use of any VA homeless program as has been used in previous studies.[1] Case and control populations were selected from this patient population. Cases consisted of any individual who received at least 1 session of ECT within 365 days following indication of homelessness. If an individual met this criterion more than once during the study period, then only the first instance of ECT following homeless indication was selected for analysis. To allow for assessment of time-specific outcomes, a reference date for this population was defined as the date of first ECT following indication of homelessness. Individuals with at least 1 session of ECT were included in the case population regardless of the medical setting of ECT receipt. Among the cases who received ECT in inpatient settings, an alternate reference date equal to the date of inpatient discharge was used for assessment for emergency department visits to avoid potential confounding. The median time from reference ECT date to alternate reference date (inpatient discharge) was 12 days. In instances where the medical record indicated that individuals received only 1 session of ECT, validation checks against medical chart notes were conducted using a procedure developed in prior research on ECT delivery in the VA[25]; if text-based proof was not indicated (presence of the words "Electroconvulsive Therapy," "ECT," or "(ECT)"), individuals were excluded from analysis. Controls were identified as individuals with an acute mental health inpatient discharge within the 365 days following indication of homelessness. If an individual met this criterion more than once during the study period, then only the first inpatient discharge following homeless indication was selected for analysis. For outcomes assessment among these individuals, date of inpatient discharge was used as the reference date. Individuals were excluded from the control population if their medical record indicated previous receipt of ECT. This study was approved by the Veterans Institutional Review Board of Northern New England.

Covariates

To characterize the case and control populations, demographics, clinical, and service use characteristics were assessed from medical records. Clinical measures included mental health (MH) diagnoses in the 2 years prior to the reference date and psychotropic prescription fills in the year prior to the reference date. In addition to specific diagnoses of MH disorders, a composite score to estimate total burden of MH disorders was assessed, where patients were assigned 1 point for each unique diagnosis category, as defined by the *Diagnostic and Statistical Manual for Mental Disorders*, Fifth Edition (*DSM-5*). Using a previously established categorization system,[26] patients were characterized as having low (0), medium (1–2), or high (3+) burden of MH disorders. Additionally, a physical health (PH) index was calculated to characterize level medical comorbidities among the study population. Like the MH index, the component diagnoses of the PH index were assessed for the 2 years prior to the study's reference date. This PH index was derived from the Elixhauser score for comorbidity[27] but was modified to exclude depression and schizophrenia as these were captured by the MH index. Patients were characterized as having low (0), medium (1–2), or high (3+) PH burden.[26] To characterize VA health services use, indication of inpatient discharge (medical and mental health-related) as well as the presence and frequency of ED use was assessed for the year prior to the reference date.

Outcomes Variables

Outcome measures in this study included documented incidence of suicidal ideation and suicide attempts, as well as ED use in the 30, 90, and 365 days following the cases' and controls' respective study reference dates. Attempts and ideation were identified via presence of *ICD* codes or a documented incident in the VA's Suicide Prevention Applications Network/Suicide Behavior and Overdose Report (SPAN/SBOR) database.[28] Suicide attempt and ideation were also assessed in the study population for the year prior to patient reference date to allow for cases and controls to be matched at baseline for confounding with respect to their history of suicidal attempt and ideation.

SPAN contains reports of suicidal behavior events (ie, deaths, attempts, and serious suicidal ideation) made by suicide prevention coordinators at each VA facility. Suicide prevention coordinators are made aware of such events through providers and patient family members. Events are recorded regardless of whether care was received for the event in the VA hospital or at non-VA hospitals. Because this database only contains instances of recorded reports (and does not include indicators for non-suicidal behavior), missingness is difficult to ascertain. One previous study found that when all sources of data for suicide attempts across 4 years of patient data were compared, 42% of attempts were captured only in SPAN while 34% were captured by medical records.[28] However, the current study did not include assessment/estimation of suicide attempts that are undetected by the system entirely. To improve capture of suicide attempts in this study, we used both *ICD* codes and SPAN data. It should be noted that SPAN was replaced with the SBOR database in 2019 retaining the same methodology.

Statistical Analysis

Population characteristics and baseline differences between case and control populations were assessed prior to population matching. Significant differences were assessed using χ^2 and pooled *t* tests; effect sizes were calculated using relative risk ratios for categorical variables and Cohen *d* for continuous variables. Supplementary Table 2 displays the full unmatched population and baseline differences between cases and controls.

Case-control matching was conducted using a logistic regression model predicting receipt of ECT. Exact matching was specified for recent history of suicide attempt and ideation as these were the most important confounding variables at baseline. Indication of ED use in the year prior to ECT receipt or inpatient discharge was included in matching to ensure that case and control groups had similar baseline characteristics with regard to the outcome. In addition, this logistic model included 19 demographic, clinical, and pharmacologic variables predicting receipt of ECT. The variables used in matching are indicated in Table 1. Final variables were selected through iterative processes of backward covariate selection and log likelihood comparisons, as well as tests of multicollinearity among final variables. The area under the curve (AUC) of the final logistic model predicting ECT was 0.86. Controls were matched to cases using the propensity scores generated from this regression, using the nearest neighbor technique with a caliper of 0.25 (maximum permitted difference in propensity scores). Up to 2 controls were matched to each case, without replacement. The final matched cohort included 1,524 ECT cases (99.8% of the potential pool) and 3,025 matched controls (2.83% of the potential pool); 1,501 (98.4%) of all cases had 2 matches, while another 23 were matched to 1 appropriate control. Three cases were excluded due to matching. Balanced propensity for receipt of ECT was tested in the final population using a Kolmogorov-Smirnov 2-sample test. This yielded a *P* value = .99, indicating that the distribution of propensity to receive ECT was not significantly different between the case and control groups.

Logistic regressions were conducted in the matched population with receipt of ECT as the independent variable and ED use, suicidal ideation, and suicide attempt outcomes as dependent variables, adjusting for sociodemographic, clinical, and pharmacologic variables by including them as covariates. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for outcomes at 30 days, 90 days, and 1 year. Model building was conducted using a combination of statistical testing and a priori knowledge. Variables included in the final model were those that were selected by repeated iteration of backward and stepwise selection. Additional variables known to predict receipt of ECT and suicidal behavior in VA patient populations were included regardless of their selection in the present model. Three different estimates were provided: crude estimates with no covariates; adjusted estimates with a single set of covariates most associated with remaining differences between case and control groups; and estimates from a parsimonious adjusted model, which only included covariates statistically selected through backward selection. The parsimonious adjusted estimates were provided to ensure adjusted estimates were not overparameterized or overgeneralized and were separately modeled for 3 main outcomes (ie, suicidal ideation, suicide attempt, and ED use). A correlation matrix assessing multicollinearity found all final variables included in the model had minimal intercorrelations, corresponding with a variance inflation factor (VIF) < 2 in a linear model.

RESULTS

Table 1 describes the background characteristics of propensity score–matched homeless veterans who did and did not receive ECT. Overall, the propensity-score matching was excellent at balancing the groups. Bivariate comparisons showed that after matching, homeless veterans who received ECT were significantly more likely to be unmarried and were less likely to have any VA service-connected disability and to report any combat exposure than homeless veterans who did not receive ECT. In addition, homeless veterans who received ECT were more likely to have a psychotic disorder, opioid use disorder, sleep disorder, and obsessive-compulsive disorder than their counterparts who did not receive ECT; homeless veterans who received ECT were also more likely to have received various psychotropic medications, including mood stabilizers, benzodiazepines, and other anxiolytics. Thus, these differences were controlled for in multivariable analyses. There was no significant difference between homeless veterans who did and did not receive ECT in past-year utilization of inpatient mental health or ED services.

Among homeless veterans who received ECT (n = 1,524), the mean number of ECT sessions veterans attended was 12.7 (standard deviation = 25.4; median = 7, interquartile range = 11), with 80.80% of veterans attending more than 1 session. Further, 36.7% of homeless veterans who received

Table 1. Propensity Score–Matched Groups of Homeless Veterans Who Did and Did Not Receive Electroconvulsive Therapy (ECT)

History of suicidal behavior	Did not receive ECT (n = 3,025)		Received ECT (n = 1,524)		Relative risk ratio	*P* value
	n	%	n	%		
Any suicidal ideation in previous year[a]	1,811	59.87	913	59.91	1.00	.98
Any suicide attempt in previous year[a]	875	28.93	444	29.13	1.01	.88
Sex[b,c]						
Female	343	11.34	170	11.15	0.98	.85
Age[b]						
18–29 y	242	8.00	98	6.43	0.80	.06
30–64 y	2,489	82.28	1,286	84.38	1.03	.07
65+ y	294	9.72	140	9.19	0.95	.56
Marital status						
Single	942	31.14	551	36.15	1.16	.001
Married	621	20.53	273	17.91	0.87	.04
Divorced	1,323	43.74	644	42.26	0.97	.34
Widowed	126	4.17	50	3.28	0.79	.14
Unknown	13	0.43	6	0.39	0.92	.86
Urban residence[b]	2,399	79.31	1,197	78.54	0.99	.55
Race/ethnicity[b]						
White	2,409	79.64	1,212	79.53	1.00	.93
Black	325	10.74	181	11.88	1.11	.25
Hispanic	179	5.92	77	5.05	0.85	.23
American Indian/ Alaska Native	40	1.32	20	1.31	0.99	.98
Asian/Pacific Islander	56	1.85	26	1.71	0.92	.73
Unknown	16	0.53	8	0.52	0.99	.99
Service connection[b]						
None	1,808	59.77	976	64.04	1.07	.005
0%–60%	626	20.69	247	16.21	0.78	<.001
61%–100%	591	19.54	301	19.75	1.01	.86
Service history						
Any combat exposure	352	11.64	138	9.06	0.78	.01
Military sexual trauma	355	11.74	178	11.68	1.00	.96
Operations Enduring/ Iraqi Freedom deployment[b]	563	18.61	267	17.52	0.94	.37
Psychotropic prescriptions						
Clonazepam	637	21.06	384	25.20	1.12	.002
Lorazepam	457	15.11	294	19.29	1.28	<.001
Mirtazapine[b]	878	29.02	463	30.38	1.05	.34
Zolpidem[b]	510	16.86	263	17.26	1.02	.74
Sedative anxiolytics	1,050	34.71	609	39.96	1.15	.001
Stimulants[b]	172	5.69	92	6.04	1.06	.63
Anticonvulsive mood stabilizer	1,805	59.67	1,018	66.80	1.12	<.001
Antidepressants[b]	2,686	88.79	1,353	88.78	1.00	.99
Antipsychotics[b]	2,296	75.90	1,151	75.52	1.00	.78
Benzodiazepines	1,622	53.62	878	57.61	1.07	.01
Physical Health (PH) Index						
Low PH (0 diagnoses)	345	11.40	183	12.01	1.05	.55
Med PH (1–2 diagnoses)	1,063	35.14	509	33.40	0.95	.24
High PH (3 or more diagnoses)[b]	1,617	53.45	832	54.59	1.02	.47
Mental Health (MH) Index						
Low MH (0 diagnoses)	…	…	…	…	…	…
Med MH (1–2 diagnoses)	2,891	95.57	1,458	95.67	1.00	.88
High MH (3 or more diagnoses)	134	4.43	65	4.27	0.96	.80
Diagnoses						
Chronic pain[b]	465	15.37	242	15.88	1.00	.66
Anxiety[b]	1,777	58.74	898	58.92	1.00	.91
Conduct disorder	288	9.52	141	9.25	0.97	.77
Bipolar disorder[b]	1,645	54.38	824	54.07	0.99	.84
Dementia	176	5.82	89	5.84	1.00	.98
Depression[b]	2,626	86.81	1,320	86.61	1.00	.85
Dissociative	48	1.59	20	1.31	0.83	.47
Neurodevelopmental disorder	252	8.33	121	7.94	0.95	.65
Obsessive-compulsive disorder	104	3.44	75	4.92	1.43	.02
Other psychosis	619	20.46	338	22.18	1.08	.18
Other mental health disorder	1,293	42.74	678	44.49	1.04	.26
Personality disorder[b]	1,282	42.38	661	43.37	1.02	.52
Psychotic disorder	1,203	39.77	655	42.98	1.08	.04
Sleeping disorder	1,156	38.21	680	44.62	1.17	<.001
Somatic disorder	249	8.23	145	9.51	1.16	.15
Major depressive disorder[b]	2,188	72.33	1,106	72.57	1.00	.86
Posttraumatic stress disorder	1,358	44.89	657	43.11	0.96	.25
Any substance use disorder[b]	2,306	76.23	1,163	76.31	1.00	.95
Alcohol use disorder	1,785	59.01	865	56.76	0.96	.15
Cannabis use disorder	770	25.45	362	23.75	0.93	.21
Cocaine use disorder	778	25.72	360	23.62	0.92	.12
Opioid use disorder	670	22.15	256	16.80	0.76	<.001
Service use (year prior)						
Any mental health inpatient service[b]	2,114	69.88	1,062	69.69	1.00	.89
Any emergency department (ED) service	2,074	68.56	1,036	67.98	0.99	.69
Number of ED visits	2.79	2.66	2.84	2.63	0.013[d]	.68

[a]Variable was used in exact matching.
[b]Variable was used in matching.
[c]Data on sex were missing for 1 individual (0.03%). Missing data on other relevant variables (eg, marital status, urban residence) are displayed under Unknown in the table.
[d]Cohen *d* statistic.

ECT attended 5 sessions within 15 days, 46.7% attended 5 sessions within 30 days, 26.0% attended 6 sessions within 15 days, and 38.1% attended 6 sessions within 30 days.

As shown in Table 2, bivariate analyses of outcomes revealed that homeless veterans who received ECT were significantly less likely to have used any EDs in the following 30 and 90 days following their reference date compared to homeless veterans who did not receive ECT; however, there was no significant difference in ED use after 1 year (decrease from 68% to 54% with any ED use among those who received ECT; decrease from 69% to 56% among those who did not receive ECT).

Homeless veterans who received ECT showed reductions in any suicidal ideation and suicide attempt the following year (decrease from 59% to 42% with any suicidal ideation, decrease from 29% to 19% with any suicidal attempt). However, these decreases were significantly greater among those who did not receive ECT at 30 days, 90 days, and 1 year following their reference date (59% to 28% for any suicidal ideation in following year, 29% to 13% for any

suicide attempt in following year). Since these bivariate analyses did not adjust for residual baseline differences, further logistic regressions were conducted.

Table 3 shows results of logistic regressions that largely confirmed the bivariate results even after adjusting for baseline characteristics. The crude, adjusted, and parsimonious adjusted estimates all showed that homeless veterans who received ECT were significantly less likely to have used any ED services 30 and 90 days after their reference date compared to homeless veterans who did not receive ECT (OR = 0.65–0.87), but homeless veterans who received ECT were more likely to have had suicidal ideation or made a suicide attempt at 30 days, 90 days, and 1 year after their reference date than those who did not receive ECT (OR = 1.48–2.00).

Because some homeless veterans had an inpatient readmission following their reference date that may have influenced the results, a sensitivity analysis was conducted. When readmission rates between homeless veterans who did and did not receive ECT were compared, they were found to be similar. Within 30 days from their reference date, 14.63% of homeless veterans who received ECT and 14.78% who did not receive ECT had an inpatient readmission. Within 90 days, 29.00% and 25.42% of homeless veterans who did and did not receive ECT had an inpatient readmission, respectively. Within 1 year, 48.03% and 44.56% of homeless veterans who did and did not receive ECT had an inpatient readmission, respectively. As shown in Supplementary Table 3, when logistic regressions were repeated comparing homeless veterans who did and did not receive ECT on outcomes with sensitivity to any inpatient readmission within the same time frames, the results were similar to those reported in Table 3 except homeless veterans who received ECT were significantly less likely to have used any ED services even 1 year after their reference date.

Table 2. Outcomes Between Propensity Score–Matched Groups of Homeless Veterans Who Did and Did Not Receive Electroconvulsive Therapy (ECT) at 30 Days, 90 Days, and 1 Year Following Their Reference Date

Outcome measure	Did not receive ECT (n = 3,025)[a]	Received ECT (n = 1,524)[a]	Relative risk ratio	*P* value
Any suicidal ideation in following 30 days	324 (10.71)	234 (15.35)	1.43	<.001
Any suicidal ideation in following 90 days	510 (16.86)	403 (26.44)	1.57	<.001
Any suicidal ideation in following year	850 (28.10)	644 (42.26)	1.50	<.001
Any suicide attempt in following 30 days	120 (3.97)	88 (5.77)	1.46	.006
Any suicide attempt in following 90 days	219 (7.24)	160 (10.50)	1.45	<.001
Any suicide attempt in following year	394 (13.03)	284 (18.64)	1.43	<.001
Any emergency department (ED) visit in following 30 days	628 (20.76)	227 (14.90)	0.72	<.001
Any ED visit in following 90 days	1,053 (34.81)	484 (31.76)	0.91	.04
Any ED visit in following year	1,695 (56.03)	823 (54.00)	0.96	.20
Number of ED visits in following year, mean (SD)	2.24 (3.70)	2.08 (3.50)	0.05	.10

[a]Values shown as n (%) unless otherwise noted.

DISCUSSION

In this national study, we found that ECT was infrequently used for homeless veterans, but homeless veterans who received ECT had 35% lower odds of using EDs 1 month later and 14% lower odds of using EDs 3 months later when compared to homeless veterans who did not receive ECT. Homeless veterans who received ECT attended a median of 7 sessions, which most experts agree constitutes a typical course of ECT.[29,30] Contrary to our expectations, homeless veterans who received ECT did not have lower rates of suicidal ideation or suicide attempts, so the greater decrease in the group's ED use did not appear to be mediated by a greater decrease in suicidal ideation or suicide attempts. This is the first study that we are aware of to report these findings; a literature search yielded no previous study on the effects of ECT on ED use. Because homeless veterans disproportionately use ED services,[1,2] there is a need for targeted interventions

Table 3. Logistic Regressions Comparing Propensity Score–Matched Groups of Homeless Veterans Who Did and Did Not Receive Electroconvulsive Therapy on Any Emergency Department (ED) Use, Suicidal Ideation, and Suicide Attempt

	Crude estimates			Adjusted estimates[a]			Parsimonious adjusted estimates[b]		
	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI	*P* value
Any suicidal ideation, 30 days after	1.51	(1.26–1.81)	<.001	1.53	(1.39–1.68)	<.001	1.57	(1.43–1.72)	<.001
Any suicidal ideation, 90 days after	1.77	(1.53–2.06)	<.001	1.81	(1.68–1.96)	<.001	1.86	(1.72–2.01)	<.001
Any suicidal ideation, 1 year after	1.87	(1.65–2.13)	<.001	1.96	(1.83–2.10)	<.001	2.00	(1.87–2.15)	<.001
Any suicide attempt, 30 days	1.48	(1.12–1.97)	.016	1.53	(1.32–1.77)	.004	1.48	(1.28–1.72)	.007
Any suicide attempt, 90 days	1.50	(1.21–1.86)	<.001	1.57	(1.40–1.75)	<.001	1.52	(1.36–1.70)	<.001
Any suicide attempt, 1 year	1.53	(1.29–1.81)	<.001	1.59	(1.46–1.74)	<.001	1.57	(1.43–1.71)	<.001
Any ED use, 30 days after	0.67	(0.57–0.79)	<.001	0.65	(0.60–0.71)	<.001	0.65	(0.59–0.71)	<.001
Any ED use, 90 days after	0.87	(0.76–0.99)	.04	0.86	(0.81–0.93)	.03	0.86	(0.80–0.93)	.04
Any ED use, 1 year after	0.92	(0.81–1.04)	.19	0.92	(0.86–0.98)	.21	0.92	(0.85–0.98)	<.001

[a]Estimates were adjusted for age, sex, race, marital status, urban residence, VA service connection (ie, high service connection), deployment to Operations Enduring/Iraq Freedom, psychotropic prescriptions, diagnoses, physical and mental health indices, and past-year mental health inpatient and emergency department use.
[b]The parsimonious adjusted model was a sensitivity analysis that including adjustment for all variables statistically selected using backward selection, separately modeled for suicidal ideation, suicide attempt, and emergency department use.
Abbreviations: CI = confidence interval, OR = odds ratio.

to address this issue. With the paucity of evidence-based solutions that can be readily deployed, our findings are informative in suggesting ECT may represent an on-the-shelf intervention that may be underutilized for homeless populations in addressing their mental health needs and disproportionate use of acute services. Certainly, the finding needs to be replicated and deserves further study.

In addition, various supportive services may be needed to reduce and maintain reductions in ED use in this population. ECT often requires periodic maintenance sessions, which depends on treatment adherence, which many homeless veterans struggle with as found in medication studies.[31,32] In fact, it may be this required treatment engagement that explains at least some of the benefits of ECT on ED use that we have observed. The multiple ECT sessions and nonspecific aspects of the procedure along with ancillary services that are offered may provide opportunities to address acute needs that can lead to reductions in ED use. For example, ECT requires regular follow-up care, arrangements for transportation and other health care needs, and engagement with providers that may have "spillover" beneficial effects on acute care use. This speculation needs to be further investigated before conclusions can be made. And if true, this effect does not preclude benefits that ECT may confer on depression broadly which may then reduce ED use. These effects of ECT should also be further studied in the context of potential cost savings in reduced ED use in this population.

The pathway in which ECT reduced ED use among homeless veterans did not seem to occur through reductions in suicidal ideation/attempt. While homeless veterans who received ECT showed notable reductions in suicidal ideation and suicide attempts, these reductions were not as great as in homeless veterans who did not receive ECT. This finding did not support our study hypothesis but is consistent with some studies in the mixed literature that have found no effects of ECT on suicide risk.[22–24] It is certainly possible that because we did not have data to control for symptom severity, those who received ECT had more severe depression that progressed, which is conceivable since those who received ECT continued to exhibit increased suicide risk even a year after their first ECT session. There may be other factors besides the ECT that may account for continued suicide risk in this group. Recent work on ECT provision in the VA indicates that clinicians consistently select patients who are at the very highest risk for suicide to receive ECT.[24,33] There are likely important factors beyond symptom severity that contribute to clinician's judgments about suicide risk that we cannot capture using VA medical records data, and therefore we could not account for these factors in our propensity score matching procedure. It is also plausible that suicidal ideation and behaviors are not important drivers of homeless veterans seeking services through emergency rooms. A randomized controlled study would need to be conducted to fully determine the effects of ECT on suicidal behaviors among homeless veterans. Since suicide risk among homeless veterans is elevated,[34–36] it may be that housing and other social services have greater effects on suicide risk for those unstably housed[36] than psychiatric procedures like ECT. Thus, further research is needed on how housing and case management services offered in conjunction with ECT might reduce suicide risk among homeless veterans.

This study had several limitations worth noting. This was an observational study so the causal effects of ECT could not be inferred. We did not have detailed data on housing status which may have changed over time and affected the results because this was sample was homeless or unstably housed. While we used a national sample, we still had a relatively small sample size because ECT was infrequently used. The majority of homeless veterans who received ECT had multiple sessions, but we did not compare those who had a full course of ECT versus those who did not because of lack of statistical power, and this needs further study. Since we focused on homeless veterans receiving VA services, it is unclear whether these findings extend to other homeless veterans or other homeless populations. These limitations were counterbalanced by the strengths of the study, including the use of administrative records instead of self-report, analyses using propensity score matching, and statistical modeling that accounted for a range of psychiatric disorders and psychotropic medication prescriptions. Together, these findings point to potential benefits of ECT for homeless veterans in reducing their ED use and may have broader implications on how to improve functioning and alleviate their burden on health care systems, but further study is needed to understand mechanisms of action.

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Editor's Note: We encourage authors to submit papers for consideration as a part of our Focus on Suicide section. Please contact Philippe Courtet, MD, PhD, at pcourtet@psychiatrist.com.

See supplementary material for this article at PSYCHIATRIST.COM.

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Supplementary Material

Article Title: Effects of Electroconvulsive Therapy on Suicidal Behavior and Emergency Department Use Among Homeless Veterans: A Propensity Score–Matched Study

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Disclaimer

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Supplementary Table 1. Core definitions used in analysis

Term	Codes
Homelessness	**Stop Codes:** 501, 504, 507, 508, 511,515,522,528,529,530,555,556,590 **ICD9 Diagnoses**: V600 **ICD10 Diagnoses**: Z590 **Inpatient Bed Section**: 28, 29, 37, 39
ECT	**CPT Codes** 90870 90871 4066F **ICD9 Procedure Codes:** 9426 9427 **ICD10 Procedure Codes:** GZB0ZZZ GZB1ZZZ GZB2ZZZ GZB3ZZZ
Suicidal Ideation	**ICD9 Code:** V6284 **ICD10 Code:** R45851 ***From SPAN, SBOR reports****: Event type= "Ideation"*
Suicide Attempt	**ICD9 Code:** E950, E951, E952, E953, E954, E955, E956, E957, E958 **ICD10 Code:** T14.91, T36-65 or T71 ending in 2A, 2D, 2XA, or 2XD, X71-X83 *Excluding any of the above codes ending in "S"* ***From SPAN, SBOR reports****: Event type= "Attempt"*
Emergency Department Visit	**Stop Codes**: 131, 130, 297

Supplementary Table 2. Characteristics in the unmatched patient population demonstrating differences in matched and unmatched populations at baseline

	Did not receive ECT (n= 106836)		Received ECT (n= 1527)		Relative risk ratio	*p* value
History of Suicidal Behavior	N	%	N	%		
Any suicide attempt in previous year^	6599	6.18	285	18.66	3.02	<0.001
Any suicidal ideation in previous year^	10801	10.11	447	29.27	2.90	<0.001
Sex#						
Female	7394	6.92	171	11.20	1.62	<0.001
Age#						
18-29	10819	10.13	98	6.42	0.63	<0.001
30-64	89502	83.78	1288	84.35	1.01	0.546
65+	6511	6.09	141	9.23	1.52	<0.001
Marital Status						
Single	40899	38.28	552	36.15	0.94	0.089
Married	19007	17.79	273	17.88	1.00	0.929
Divorced	42582	39.86	646	42.31	1.06	0.052
Widowed	3221	3.01	50	3.27	1.09	0.556
Unknown	1127	1.05	6	0.39	0.37	0.012
Urban Residence#	83964	78.59	1200	78.59	1.00	0.023
Race/Ethnicity#						
White	65579	61.38	1215	79.57	1.30	<0.001
Black	32863	30.76	181	11.85	0.39	<0.001
Hispanic	4942	4.63	77	5.04	1.09	0.442
American Indian/Alaska Native	1238	1.16	20	1.31	1.13	0.584
Asian/Pacific Islander	1340	1.25	26	1.70	1.36	0.119
Unknown	874	0.82	8	0.52	0.64	0.204
Service Connection						
None	68336	63.96	978	64.05	1.00	0.946
0-60%	22216	20.79	248	16.24	0.78	<0.001
61-100%	16284	15.24	301	19.71	1.29	<0.001
Service History						
Any combat exposure	12654	11.84	138	9.04	0.76	0.001
Military sexual trauma	8288	7.76	179	11.72	1.51	0.000
OEF/OIF deployment#	20042	18.76	267	17.49	0.93	0.205
RX						
Clonazepam	10571	9.89	385	25.21	2.55	<0.001
Lorazepam	9310	8.71	294	19.25	2.21	<0.001
Mirtazapine	11149	10.44	466	30.52	2.92	<0.001

Zolpidem	7115	6.66	265	17.35	2.61	<0.001
Sedative Anxiolytics	19978	18.70	610	39.95	2.14	<0.001
Stimulants[#]	1581	1.48	92	6.02	4.07	<0.001
Anticonvulsive Mood Stabilizer	39706	37.17	1021	66.86	1.80	<0.001
Antidepressants[#]	69102	64.68	1356	88.80	1.37	<0.001
Antipsychotics[#]	43367	40.59	1154	75.57	1.86	<0.001
Benzodiazepines	33161	31.04	881	57.69	1.86	<0.001
Physical Health (PH) Index						
Low PH (0 diagnoses)	24563	22.99	183	11.98	0.52	<0.001
Med PH (1-2 diagnoses)	46910	43.91	509	33.33	0.76	<0.001
High PH (3 or more diagnoses) [#]	35363	33.10	835	54.68	1.65	<0.001
Mental Health (MH) Index						
Low MH (0 diagnoses)						
Med MH (1-2 diagnoses)	16153	15.12	65	4.26	0.28	<0.001
High MH (3 or more diagnoses)	90677	84.87	1461	95.68	1.13	<0.001
Diagnoses						
Chronic Pain[#]	7980	7.47	244	15.98	2.14	<0.001
Anxiety[#]	39901	37.35	899	58.87	1.58	<0.001
Conduct disorder [#]	12429	11.63	141	9.23	0.79	0.004
Bipolar disorder[#]	30957	28.98	826	54.09	1.87	<0.001
Dementia	4597	4.30	89	5.83	1.35	0.004
Depression[#]	86188	80.67	1485	97.25	1.21	<0.001
Dissociative	655	0.61	20	1.31	2.14	0.001
Neuro-developmental Disorder	4570	4.28	121	7.92	1.85	<0.001
Obsessive Compulsive Disorder	2148	2.01	75	4.91	2.44	<0.001
Other Psychosis	18486	17.30	339	22.20	1.28	<0.001
Other Mental Health disorder	35223	32.97	678	44.40	1.35	<0.001
Personality disorder[#]	31392	29.38	664	43.48	1.48	<0.001
Psychotic disorder	36993	34.63	657	43.03	1.24	<0.001
Sleeping disorder[#]	26379	24.69	683	44.73	1.81	<0.001
Somatic disorder	4881	4.57	146	9.56	2.09	<0.001
MDD[#]	39768	37.22	1109	72.63	1.95	<0.001
PTSD	34905	32.67	657	43.03	1.32	<0.001
Substance Use Disorder (Any) [#]	91772	85.90	1165	76.29	0.89	<0.001
Alcohol use disorder	70947	66.41	867	56.78	0.85	<0.001
Cannabis use disorder	29361	27.48	362	23.71	0.86	0.001
Cocaine use disorder	37866	35.44	360	23.58	0.67	<0.001
Opioid use disorder	19935	18.66	256	16.76	0.90	0.059
Service Use (year prior)						

Mental Health Inpatient service[#]	51202	47.9	1065	69.7	1.5	<0.001
Emergency Department (ED) service	67455	63.1	1038	68.0	1.10	<0.001
Number of ED visits N±STD	1.86±2.70		2.85±4.10		0.40*	<0.001

Note: ^ denotes the variable was used in exact matching; # denotes the variable was used in matching; * denotes Cohen's *d* statistic

Supplementary Table 3. Logistic regressions comparing propensity-matched groups of homeless veterans who did and did not receive electroconvulsive therapy with sensitivity to any inpatient readmissions

	Crude estimates		
	OR	95% CI	*p* value
Any suicidal ideation, 30 days after	1.64	(1.34-1.99)	<0.001
Any suicidal ideation, 90 days after	2.00	(1.74-2.31)	<0.001
Any suicidal ideation, 1 year after	1.82	(1.54-2.15)	<0.001
Any suicide attempt, 30 days after	1.50	(1.13-2.00)	<0.001
Any suicide attempt, 90 days after	1.43	(1.15-1.79	0.001
Any suicide attempt, 1 year after	1.49	(1.26-1.78)	<0.001
Any emergency department use, 30 days after	0.63	(0.52-0.75)	<.001
Any emergency department use, 90 days after	0.79	(0.69-0.92)	0.001
Any emergency department use, 1 year after	0.87	(0.77-1.00)	0.04

Note: Values shown are with sensitivity to any inpatient readmissions within the same time frames. For example, any suicidal ideation 30 days after with sensitivity to any inpatient readmission within 30 days or any emergency department use 1 year after with sensitivity to any inpatient readmission within 1 year.