RESEARCH LETTER

Outcomes of patients with malignancy undergoing catheter ablation for ventricular tachycardia in the United States

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Despite the notable advancements in cancer treatment leading to improved prognosis and survival rates, there has been a concerning increase in cardiovascular diseases, including ventricular arrhythmias (VAs), likely exacerbated or induced by the direct and indirect effects of cancer treatments.[1] Managing ventricular arrhythmias in cancer patients poses a challenge, especially due to potential drug-drug interactions between antiarrhythmic drugs and antineoplastic therapies, which can elevate the risk of QT prolongation and arrhythmias.[1] In addition, certain cancer therapies can also cause nonischemic cardiomyopathy and put patients at higher risk for VAs.[1] Catheter ablation for ventricular tachycardia (VT) is frequently utilized as an initial therapy, as an alternative to or in combination with antiarrhythmic drugs, in patients who experience recurrent implantable cardioverter-defibrillator shocks, or in those not eligible for or unwilling to undergo implantable cardioverter-defibrillator implantation.[2] Nonetheless, there is a scarcity of data regarding the safety and clinical outcomes of catheter ablation for VT in patients with malignancy. This observational study investigates the outcomes of patients with malignancy undergoing catheter ablation for VT within a nationally representative cohort.

The Nationwide Readmissions Database (NRD) was analyzed from 2016 to 2019 to identify patients ≥18 years of age undergoing VT ablation, as described previously.[3,4] The NRD is the largest, publicly available, all-payer inpatient database in the United States that contains longitudinal, nationally representative information on hospital readmissions for all ages and contains data from approximately 18 million discharges annually.[4] Due to the de-identified nature of the NRD dataset, the need for informed consent, and Institutional Review Board approval was waived. The NRD adheres to the 2013 Declaration of Helsinki for the conduct of human research.

KEY FINDINGS

- In patients undergoing catheter ablation for ventricular tachycardia from 2016 to 2019, 8.0% had a history of cancer and 2.0% had active cancer.
- Compared with patients without cancer, having a diagnosis of active cancer was associated with similar adjusted odds of periprocedural complications along with 30/180-day all-cause, ventricular tachycardia–related, and heart failure–related readmissions.
- There was no significant difference in the odds of periprocedural complications and 30/180-day readmissions in patients with a history of cancer as compared with those without cancer.

Patients were categorized into three groups based on their cancer status: those without cancer, those with active cancer (identified by International Classification of Diseases–Tenth Revision–Clinical Modification [ICD-10-CM] codes: C00.x-C97.x), and those with a previous history of cancer (identified by ICD-10-CM codes: Z85.xx). Baseline characteristics were compared using Pearson's chi-square test and Fisher's exact test for categorical variables, and 1-way analysis of variance for continuous variables. A multivariable regression model (utilizing logistic regression for categorical outcomes and linear regression for continuous outcomes) was employed to evaluate the independent association of active cancer and cancer history with in-hospital, 30-day, and 180-day outcomes after adjusting for age, sex, and comorbidities as outlined in Table 1. Definitions of the outcomes of interest are provided in Table 1, defined using their respective

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Table 1 Baseline characteristics, outcomes, and procedure-related complications stratified by cancer status.

Variable	No cancer	History of cancer	Active cancer	*P* value
Patients	11,131 (90.0)	989 (8.0)	248 (2.0)	
Female	23.4	22.3	19.3	.51
Age, y	60.8 ± 0.20	68.8 ± 0.48	67.8 ± 1.05	<.01
Type of cancer				
Esophageal	—	1.2	1.5	—
Colorectal	—	8.0	1.6	—
Lung	—	7.1	13.6	—
Breast	—	8.2	8.2	—
Uterine	—	4.7	0.0	—
Prostate	—	25.6	25.9	—
Leukemia	—	7.5	17.8	—
Lymphoma	—	6.0	12.1	—
Other	—	31.5	19.3	—
Metastatic	—	—	6.0	—
Type of ventricular tachycardia				
Idiopathic ventricular tachycardia	27.4	26.3	24.1	.65
Structural heart disease–related ventricular tachycardia	72.6	73.7	75.9	
Comorbidities				
Iron deficiency anemia	2.6	2.7	4.7	.36
Congestive heart failure	69.8	71.2	72.4	.54
Valvular heart disease	15.5	19.9	14.7	.04
Chronic obstructive pulmonary disease	20.1	25.6	26.4	<.01
Coronary artery disease	61.8	70.6	73.5	<.01
Prior myocardial infarction	28.7	37.9	35.8	<.01
Prior stroke	6.9	7.0	11.4	.21
Prior percutaneous coronary intervention	2.5	2.6	4.5	.36
Prior coronary artery bypass grafting	17.7	23.1	19.7	.01
Diabetes	29.4	25.2	31.7	.12
Hypertension	69.4	81.0	73.9	<.01
Liver disease	3.9	3.7	5.9	.59
Renal failure	22.2	25.7	35.5	<.01
Peripheral vascular disorder	49.2	54.1	53.8	.08
Coagulopathy	6.5	5.0	9.6	.14
Obesity	19.6	15.5	14.9	.05
Prior implantable cardioverter-defibrillator	45.2	49.9	47.0	.14
Prior permanent pacemaker	2.7	3.4	3.6	.61
Outcomes				
In-hospital mortality	3.2	2.1	7.4	.03
Adjusted OR (95% CI), *P**	Reference	0.51 (0.23 to 1.14), .10	1.50 (0.64 to 3.53), .35	
Any cardiovascular complication†	15.8	14.8	21.7	.20
Adjusted OR (95% CI), *P**	Reference	0.94 (0.72 to 1.22), .64	0.99 (0.63 to 1.57), .98	
Any peripheral vascular complication‡	2.7	1.5	5.5	.03
Adjusted OR (95% CI), *P*	Reference	0.54 (0.25 to 1.15), .11	1.99 (0.96 to 4.09), .06	
Any bleeding complication§	2.7	3.0	6.1	.07
Adjusted OR (95% CI), *P**	Reference	1.15 (0.64 to 2.05), .64	1.87 (0.90 to 3.87), .09	
Any pulmonary complication‖	2.7	2.0	9.8	<.01
Adjusted OR (95% CI), *P**	Reference	0.60 (0.40 to 1.09), .06	1.62 (0.97 to 2.70), .06	
Any neurological complication¶	1.1	1.0	0.7	.87
Adjusted OR (95% CI), *P**	Reference	0.99 (0.43 to 2.28), .99	0.53 (0.07 to 3.90), .53	
Discharge to home	80.6	80.9	68.2	<.01
Adjusted OR (95% CI), *P**	Reference	1.27 (0.98 to 1.65), .72	0.75 (0.50 to 1.14), .18	
Length of stay, d	6.9 ± 0.15	5.7 ± 0.30	8.7 ± 0.96	.63
Adjusted mean difference (range), *P*, d*	Reference	−1.14 (−1.76 to 0.51), .06	0.96 (−0.87 to 2.81), .30	
30-d all-cause readmissions	11.8	11.0	18.7	.09
Adjusted OR (95% CI), *P**	Reference	0.86 (0.62 to 1.20), .37	1.57 (0.96 to 2.58), .07	
30-day ventricular tachycardia–related readmissions	5.2	4.2	8.2	.21
Adjusted OR (95% CI), *P**	Reference	0.78 (0.49 to 1.23), .28	1.58 (0.78 to 1.23), .20	
30-day heart failure- related admissions	1.6	1.7	3.9	.20
Adjusted OR (95% CI), *P**	Reference	0.93 (0.42 to 2.09), .87	1.91 (0.73 to 4.99), .18	

(*Continued*)

Table 1 (*Continued*)

Variable	No cancer	History of cancer	Active cancer	*P* value
180-d all-cause readmissions	24.6	22.3	29.9	.49
Adjusted OR (95% CI), *P**	Reference	0.78 (0.56 to 1.09), .15	1.15 (0.61 to 2.14), .67	
180-d ventricular tachycardia–related readmissions	10.6	7.2	8.5	.18
Adjusted OR (95% CI), *P**	Reference	0.55 (0.26 to 1.18), .13	0.62 (0.24 to 1.59), .32	
180-d heart failure–related admissions	4.0	3.8	4.7	.96
Adjusted OR (95% CI), *P**	Reference	0.86 (0.39 to 1.89), .71	1.08 (0.33 to 3.56), .90	

Values are n (%), %, or mean ± SE, unless otherwise indicated.

*Adjusted for the following variables: age, sex, hypertension, diabetes mellitus, peripheral vascular disease, chronic lung disease, heart failure, coronary artery disease, chronic liver disease, prior stroke, history of percutaneous coronary intervention, history of coronary artery bypass graft, chronic renal failure, anemia, obesity, prior permanent pacemaker, or prior implantable cardioverter-defibrillator.

†Cardiovascular complications (including cardiac arrest, myocardial infarction, cardiogenic shock, and pericardial effusion requiring intervention).

‡Peripheral vascular complication (including arteriovenous fistula, pseudoaneurysm, and access site hematoma).

§Bleeding complications (gastrointestinal bleeding, blood transfusion, and retroperitoneal bleeding).

||Pulmonary complications (including respiratory failure, pneumothorax, pleural effusion requiring thoracentesis, and pneumonia).

¶Neurological complications (including ischemic stroke, hemorrhagic stroke, and transient ischemic attack).

ICD-10-CM codes. Statistical analysis was conducted using STATA 17.0 (StataCorp LLC), and a P value of $<.05$ was considered statistically significant.

Our cohort included 12,368 VT ablation procedures (Table 1), of which 989 (8.0%) were performed in patients with a history of cancer and 248 (2.0%) were performed in patients with active cancer. Patients with a history of cancer and active cancer were older at the time of ablation as compared with patients without cancer (68.8 ± 0.48 years vs 67.8 ± 1.05 years vs 60.8 ± 0.20 years, $P < .01$) and had a higher burden of key comorbidities, including coronary artery disease (73.5% vs 70.6% vs 61.8%, $P < .01$), renal failure (35.5% vs 25.7% vs 22.2%, $P < .01$), and chronic pulmonary disease (26.4% vs 25.6% vs 20.1%, $P < .01$) (Table 1).

On crude analysis, patients with active cancer undergoing VT ablation had a significantly higher prevalence of in-hospital mortality (7.4% vs 2.1% vs 3.2%, $P = .03$), peripheral vascular complications (5.5% vs 1.5% vs 2.7%, $P = .03$), and pulmonary complications (9.8% vs 2.0% vs 2.7%, $P < .01$), along with lower odds of routine home discharge (68.2% vs 80.9% vs 80.6%, $P < .01$), as compared with those with a history of cancer and those without cancer, respectively. On a multivariable-adjusted analysis after adjusting for age, sex, and underlying comorbidities, the presence of active cancer was not associated with any statistically significant difference in the odds of in-hospital mortality, periprocedural complications, length of stay, routine home discharge, or 30/180-day all-cause, VT-related, or heart failure (HF)–related readmissions, as compared with those without cancer. Similarly, patients with a history of cancer had similar odds of periprocedural complications along with 30/180-day readmissions as compared with those with no cancer. We also performed a subgroup analysis based on the type of VT (idiopathic VT and structural heart disease–related VT) with similar results.

There are limited data on outcomes of VT ablation in patients with malignancy, and to the best of our knowledge, this is the first study to address this critical topic using a large national claims-based database. The significant findings include the following: (1) in patients undergoing catheter ablation for VT, 8.0% had a history of cancer and 2.0% had active cancer; (2) compared with patients without cancer, having a diagnosis of active cancer was associated with similar adjusted odds of periprocedural complications along with 30/180-day all-cause readmissions, VT-related admissions, and HF-related readmissions; and (3) there was no significant difference in the odds of periprocedural complications and 30/180-day readmissions in patients with a history of cancer as compared with those without cancer.

Although chemotherapy-induced VA is uncommon, its incidence increases in patients with advanced cancer and those with a higher burden of cardiovascular comorbidities.[1] Potential mechanisms include the presence of a permanent arrhythmogenic substrate created by cancer and the resulting systemic inflammation along with the direct effects of chemotherapeutic drugs on ionic channels that regulate the ventricular action potential.[1] Furthermore, certain chemotherapeutic agents such as anthracyclines and HER-2–targeted therapeutic agents can lead to cancer therapy–related cardiac dysfunction and cardiomyopathy, which in itself can increase the risk of developing VA.[1] The 2022 European Society of Cardiology cardio-oncology guidelines recommend that the decision on the use of antiarrhythmic drugs or device therapy in patients with cancer and VA should consider life expectancy, quality of life, and complication risks.[1] However, the administration of class IA, IC, and III antiarrhythmic drugs is challenging in patients with cancer due to significant drug-drug interactions, more specifically QTc prolongation.[1] Additionally, the presence of active cancer has been associated with increased mortality and complications in patients undergoing de novo cardiac implantable electronic device implantation due to mechanisms related to immunosuppression, cardiotoxic chemotherapies, direct metastases to the myocardium and conduction system, and vagal reflex from emesis and radiotherapy.[5] Our study

demonstrates that patients with cancer undergoing VT ablation derive similar benefits compared with those without cancer, therefore suggesting catheter ablation as a potentially safe and efficacious treatment strategy in patients with cancer and VT.

Our findings are best interpreted in the context of their limitations. These include the absence of patient-level data verification resulting from the utilization of a de-identified database, the retrospective nature of the observational cohort study design, potential coding errors associated with the use of International Classification of Diseases codes, the presence of unmeasured confounding variables, and the absence of data on extended follow-up periods. Furthermore, due to the lack of data on out-of-hospital mortality, we were unable to ascertain mortality during follow-up in each group. Additionally, we lacked comprehensive data on the specific type, dosage, and duration of chemotherapy and/or radiotherapy administered to patients with active cancer or a history of cancer along with data on the success of ablation or use of antiarrhythmic therapy. Consequently, our study's conclusions should be viewed as hypothesis-generating at most.

In conclusion, our study suggests that patients with malignancies undergoing VT catheter ablation have no difference in the adjusted odds of in-hospital mortality, periprocedural complications, and 30/180-day all-cause, VT-related, or HF-related hospital readmissions, as compared with those without malignancy. Further prospective studies are required to confirm these findings and explore the outcomes of VT ablation in such high-risk patients.

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