BRIEF REPORT

Arrhythmic causes of in-hospital cardiac arrest among patients with heart failure with preserved ejection fraction

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Introduction

More than half of all heart failure (HF) cases in the United States are due to HF with preserved ejection fraction (HFpEF), which has no medical treatments proven to reduce its mortality rate.[1] Sudden cardiac death (SCD) comprises ~25% of all deaths in HFpEF, and may be a potential therapeutic target.[2] However, whether the SCD in HFpEF is due to ventricular tachycardia (VT) or ventricular fibrillation (VF), amenable to termination by implantable cardioverter-defibrillator (ICD) therapy, is unclear.[3,4] We aimed to determine the incidence of VT/VF as the initial arrhythmia detected at in-hospital cardiac arrests (IHCA) among patients with HFpEF, HF with reduced ejection fraction (HFrEF), and no heart failure (NoHF).

Methods

The research reported in this paper adhered to Helsinki Declaration guidelines. This study was approved by the Minneapolis VA Medical Center institutional review board. Informed consent requirement was waived because of the retrospective study design.

Consecutive patients who experienced IHCA and underwent cardiopulmonary resuscitation from 2011 through 2020 with documented initial cardiac rhythm were included in this study. Those without adequate documentation (n = 36), patients brought to the emergency department after an out-of-hospital cardiac arrest (OHCA) (n = 13), and those with IHCA directly related to procedures (n = 2) were excluded. Patients were categorized according to their HF diagnosis/hospitalization history and most recent left ventricular ejection fraction (EF) prior to IHCA as either HFpEF (EF ≥50%), HFrEF (EF <50%), or NoHF.

The primary outcome variable was the initial arrhythmia detected during the IHCA. Secondary outcome variables were return of spontaneous circulation (ROSC) for >20 minutes, and 30-day survival.

Statistical analysis

Categorical variables were compared using the Pearson χ^2 test. Continuous variables were compared using analysis of variance. All analyses were 2-tailed ($\alpha = 0.05$).

Results

The baseline characteristics of the 286 patients (mean age 70.2 ± 9.1) are displayed in Table 1. Fifty-one (17.8%) patients had HFpEF, 77 (26.9%) had HFrEF, and 158 (55.2%) had NoHF. IHCA occurred in a general ward (148, 51.7%), intensive care unit (83, 29.0%), emergency department (32, 11.2%), or diagnostic/procedural suite (23, 8.0%).

The hospital admission diagnoses are categorized in Table 1. Patients had acute myocardial infarction (43, 15.0%), decompensated HF (16, 5.6%), arrhythmias (16, 5.6%), hyperkalemia (34, 11.9%), hypomagnesemia (28, 9.8%), sepsis (53, 18.5%), and bleeding complications (22, 7.7%). Furthermore, 34 (11.9%) patients had IHCA after cardiac surgery and 25 (8.7%) after noncardiac surgery.

Initial arrhythmia at cardiac arrest

The initial arrhythmia at IHCA was VT/VF in 89 (31.1%) patients, asystole in 27 (9.5%), and pulseless electrical activity (PEA) in 170 (59.7%). VT/VF was more common in patients with HFpEF (47.1%) and HFrEF (39.0%) than in those with NoHF (22.2%; $P < .01$) (Figure 1). Six (2.1%) patients had torsade de pointes.

Cardiac arrest outcomes

Of those with VT/VF, 64 (71.9%) achieved ROSC and 38 (42.7%) survived for 30 days after IHCA. Of those with PEA/asystole, 98 (45.8%) achieved ROSC and 37 (18.8%) survived beyond 30 days. There was no significant difference in ROSC or 30-day survival between HF groupings, within the initial rhythm categories of VT/VF or PEA/asystole (Table 2).

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Table 1 Baseline demographics and comorbidities based on heart failure status

	All patients N = 286	HFpEF N = 51	HFrEF N = 77	No HF N = 158	*P* value
Age, years (± sd)	70.18 (9.1)	72.92 (7.5)	70.52 (7.7)	69.13 (10.6)	.04
Male, n (%)	279 (97.6%)	51 (100%)	76 (98.7%)	152 (96.2%)	.23
Coronary artery disease, n (%)	136 (47.6%)	34 (66.7%)	55 (71.4%)	47 (29.7%)	<.01
Diabetes mellitus, n (%)	136 (47.6%)	31 (60.8%)	45 (58.4%)	60 (38.0%)	<.01
Hypertension, n (%)	224 (78.3%)	46 (90.2%)	61 (79.2%)	117 (74.1%)	.05
Renal dysfunction, n (%)	179 (62.6%)	37 (72.6%)	56 (72.7%)	86 (54.4%)	<.01
End-stage renal disease, n (%)	25 (8.7%)	8 (15.7%)	9 (11.7%)	8 (5.1%)	.04
Beta blocker, n (%)	161 (56.3%)	40 (78.4%)	55 (71.4%)	66 (41.8%)	<.01
Diuretic, n (%)	108 (37.8%)	31 (60.8%)	48 (62.4%)	29 (18.4%)	<.01
ACEi/ARB, n (%)	122 (42.7%)	22 (43.1%)	42 (54.6%)	58 (36.7%)	.03
MI on presentation, n (%)	43 (15.0%)	8 (15.7%)	15 (19.5%)	20 (12.7%)	.38
Admission diagnosis category					
Medical – cardiac, n (%)	72 (25.2%)	13 (25.5%)	36 (46.8%)	23 (14.6%)	<.01
Medical – noncardiac, n (%)	151 (52.8%)	23 (45.1%)	33 (42.9%)	95 (60.1%)	
Surgical – cardiac, n (%)	34 (11.9%)	11 (21.6%)	8 (10.4%)	15 (9.5%)	
Surgical – noncardiac, n (%)	25 (8.7%)	3 (5.9%)	0 (0%)	22 (13.9%)	
Psychiatric, n (%)	4 (2.2%)	1 (2.0%)	0 (0%)	3 (1.9%)	

ACEi/ARB = angiotensin-converting enzyme inhibitor / aldosterone receptor antagonist; HF = heart failure; HFpEF = heart failure with preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction; MI = myocardial infarction.

The proportions of patients achieving ROSC (58.2% vs 50%, $P = .51$) and surviving >3 days (16.4% vs 22.7%, $P = .52$) were not significantly different between patients with ischemic and nonischemic cardiomyopathy, respectively. Achievement of ROSC did not differ by location of IHCA ($P = .11$).

Discussion

This study showed that VT/VF was the initial rhythm in almost 50% of the IHCA that occurred among patients with HFpEF. The proportion of VT/VF, ROSC, and the 30-day survival were similar in patients with HFpEF and HFrEF. These results complement previous work showing that ventricular arrhythmias were recorded in 30%–45% of patients with HFpEF.[5]

Identifying VT/VF as the mechanism of SCD is clinically important given that SCD is a significant mode of death among patients with HFpEF.[2] Previously, we have created and validated a multivariable model predicting SCD risk among patients with HFpEF.[6,7] If the results of the present study are confirmed in OHCA, studies to assess the efficacy of ICD therapy among high-risk patients with HFpEF might be considered.

Patients who had IHCA are inherently different than those who had OHCA.[8–10] These results should not be extrapolated to OHCA. In a recent study of OHCA, patients with HFpEF had a lower incidence of shockable rhythms than those with HFrEF.[11]

Conclusion

VT/VF was the initial rhythm in ~50% of the IHCA among patients with HFpEF. Patients with HFpEF and HFrEF had similar incidence of VT/VF, ROSC, and 30-day mortality

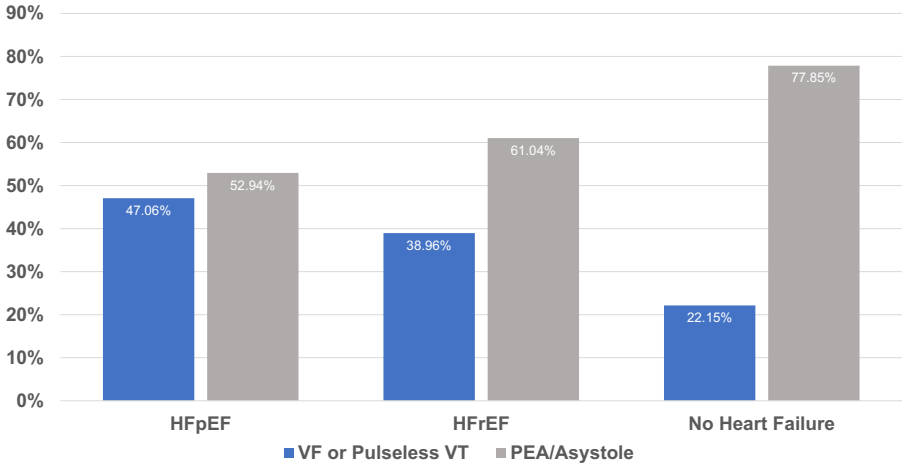

Figure 1 Initial rhythm detected at in-hospital cardiac arrest in relation to heart failure status. HFpEF = heart failure with preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia.

Table 2 Outcomes based on heart failure status and type of cardiac arrest

	All patients	HFpEF	HFrEF	No HF	*P* value
VT/VF arrest	N = 89	N = 24	N = 30	N = 35	
ROSC >20 min, n (%)	64 (71.9%)	16 (66.7%)	22 (73.3%)	26 (74.3%)	.80
30-day survival, n (%)	38 (42.7%)	13 (54.2%)	8 (26.7%)	17 (48.6%)	.08
PEA/asystole arrest	n=197	n=27	n=47	n=123	
ROSC >20 min, n (%)	98 (49.8%)	15 (55.6%)	21 (44.7%)	62 (50.4%)	.65
30-day survival, n (%)	37 (18.8%)	5 (18.5%)	6 (12.8%)	26 (21.1%)	.46

HF = heart failure; HFpEF = heart failure with preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction; PEA = pulseless electrical activity; ROSC = return of spontaneous circulation; VT/VF = ventricular tachycardia / ventricular fibrillation.

after IHCA. Larger, multicenter studies are needed to confirm these results.

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Disclosures

The authors have no conflicts to disclose.

Authorship

All authors attest they meet the current ICMJE criteria for authorship.

Patient Consent

Informed consent requirement was waived because of the retrospective study design.

Ethics Statement

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