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PII: S0002-9149(19)31161-0
DOI: https://doi.org/10.1016/j.amjcard.2019.10.014
Reference: AJC 24243

To appear in: *The American Journal of Cardiology*

Received date: 7 August 2019
Revised date: 9 October 2019
Accepted date: 10 October 2019

Please cite this article as: Chayakrit Krittanawong MD , Anirudh Kumar MD , Zhen Wang PhD , Kipp W. Johnson BS , Ujjwal Rastogi MD , Bharat Narasimhan MD , Scott Kaplin MD , Hafeez Ul Hassan Virk MD , Usman Baber MD, MS , W.H. Wilson Tang MD , Alexandra J. Lansky MD , Gregg W. Stone MD , Predictors of In-Hospital Mortality after Transcatheter Aortic Valve Implantation, *The American Journal of Cardiology* (2019), doi: https://doi.org/10.1016/j.amjcard.2019.10.014

Predictors of In-Hospital Mortality after Transcatheter Aortic Valve Implantation

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Word count: 1962

ABSTRACT

The development of aortic valve stenosis is strongly associated with older adults. Patients who undergo transcatheter aortic valve implantation (TAVI) for severe aortic stenosis (AS) frequently have heart failure (HF). We investigated the predictors of mortality after TAVI according to the presence of HF, and specifically HF with preserved ejection fraction (HFpEF) versus HF with reduced ejection fraction (HFrEF). Patients were identified from the Nationwide Inpatient Sample registry from January 2011 to September 2015 using the ICD-9 codes. Patients with HF who underwent TAVI were classified according to whether they were diagnosed with HFrEF or HFpEF. The principal outcome of interest was in-hospital mortality. Multivariable analysis was used to adjust for potential baseline confounders. Among 11,609 patients undergoing TAVI, 6,368 (54.9%) had baseline HF, including 4,290 (67.4%) with HFpEF and 2,078 (32.6%) with HFrEF. Among TAVI patients with HF, in-hospital mortality was also not significantly different in those with HFrEF compared with HFpEF (3.66% vs. 3.17% respectively; adjusted OR 1.14, 95%CI 0.84-1.53; p=0.38). Polyvalvular heart disease was an additional independent predictor of in-hospital mortality in HFrEF, whereas age, liver disease, and the absence of depression and anemia were additional independent predictors of mortality in HFpEF. In conclusion, baseline HF in patients undergoing TAVI is prevalent and is more commonly due to HFpEF than HFrEF. Mortality is similar in those with HFrEF and HFpEF. Knowledge of the specific predictors of mortality after TAVI in HF patients may be useful for patient selection and prognostic guidance.

Keywords: Transcatheter Aortic Valve Implantation, TAVI, Heart Failure, HFrEF, HFpEF

Introduction

Since its approval by the US Food and Drug Administration in 2011, transcatheter aortic valve replacement (TAVI) has been increasingly performed in symptomatic patients with severe aortic stenosis (AS) who have intermediate, high or prohibitive surgical risk. Recent studies have also demonstrated favorable outcomes after TAVI in low surgical risk patients[1, 2]. Patients who undergo TAVI frequently have heart failure (HF), particularly when elderly. Among patients without AS, the in-hospital mortality of those with HF and preserved ejection fraction (HFpEF) is lower than in those with HF and reduced ejection fraction (HFrEF)[3, 4]. However, the relative outcomes of severe AS patients with HFrEF and HFpEF treated with TAVI are unknown. We therefore sought to investigate the incidence and predictors of in-hospital mortality among patients with HFpEF and HFrEF following TAVI.

Methods

The study sample originated from the National Inpatient Sample (NIS) registry which includes data from hospitalized patients in the United States (US) between January 1, 2004, and September 30, 2015. The NIS registry is part of the Healthcare Cost and Utilization Project, sponsored by the Agency for Healthcare Research and Quality. The NIS is derived from billing data submitted by hospitals from 46 states representing 97% of the national population. These reports are published on the NIS website (http://www.hcup-us.ahrq.gov/db/nation/nis/nisrelatedreports.jsp).

For the present study, data were extracted from the entire NIS registry using ICD-9 codes. Patients with the primary or secondary diagnosis of TAVI (ICD-CM 9 code of 35.05)

were identified. Hospitalizations for HFpEF were identified based on ICD-9-CM codes 428.3, 428.30, 428.31, 428.32 and 428.33. Hospitalizations for HFrEF were identified based on ICD-9-CM codes 428.2, 428.20, 428.21, 428.22 and 428.23. We excluded cases that lacked definite classification of HFrEF vs. HFpEF (i.e. patients coded as both HFrEF and HFpEF). The Icahn School of Medicine at Mount Sinai institutional review board (IRB) reviewed the study protocol and determined the work to be exempt from IRB oversight. The methodological standards comply with the Agency for Healthcare Research and Quality's recommendations[5].

Demographics, conventional risk factors, and in-hospital outcomes were evaluated. A list of ICD-9-CM codes for the covariates included in the current analysis is described in the online supplementary Table 2. Percentages and means ± standard deviations were computed for categorical and continuous variables, respectively. Categorical variables were compared using the Chi-square test or Fisher's exact tests when appropriate, while continuous variables were analyzed using the two-tailed Student's t test or the Mann–Whitney-U test when appropriate. Univariable and multivariable logistic regression modeling were performed to determine predictors associated with in-patient mortality in HF patients after TAVI. Stepwise regression analysis was used to select variables. The following variables were entered into the multivariable models: age, gender, race, alcohol abuse, chronic pulmonary disease, depression, diabetes mellitus, hypertension, coronary artery disease, liver disease, rheumatoid arthritis, chronic kidney disease, psychoses, neurological disorders, electrolyte abnormalities, non-aortic valvular heart disease (not include aortic valve disease), anemia, solid tumor without metastasis, hyperlipidemia, atrial fibrillation, pulmonary hypertension, overweight, obesity, morbid obesity, intracranial hemorrhage, family history of coronary artery disease, prior myocardial infarction, percutaneous coronary intervention, permanent pacemaker, prior coronary artery bypass

grafting, and prior stroke/transient ischemic attack. All analyses were conducted using R 3.4.0 and Stata version 14.2. All p-values were two-sided and statistical significance was determined at $p<0.05$.

Results

Among 11,609 patients undergoing TAVI, 6,368 (54.9%) had baseline HF. Of those with HF, 4,290 (67.4%) had HFpEF and 2,078 (32.6%) had HFrEF. Baseline characteristics of TAVI patients with vs. without HF appear in Table 1. Compared to patients without HF, those with HF were older, more commonly female and more likely to have chronic pulmonary disease, diabetes mellitus and alcohol use disorder (Table 1). The baseline characteristics of TAVI patients with HFrEF vs. HFpEF appear in Table 2. Patients with HFrEF were younger, less often Caucasian and female, were less likely to have hypertension and prior neurologic disease, but more likely to have chronic kidney disease and Electrolyte abnormalities.

In-hospital mortality occurred in 421/11,609 patients (3.63%) undergoing TAVI. In-hospital mortality after TAVI trended slightly lower in patients with vs. without HF (212/6,368 (3.33%) vs. 209/5,241 (3.99%) respectively; OR=0.83, 95%CI 0.68-1.01; p=0.07) (Figure 1). Among TAVI patients with HF, in-hospital mortality was not significantly different among those with HFrEF compared with HFpEF (76/2,078 (3.66%) vs. 136/4,290 (3.17%) respectively; OR=0.86, 95%CI 0.65-1.15; p=0.35).

The univariable and multivariable correlates of in-hospital mortality of all 11,609 TAVI patients in the NIS are shown in Table 3. After multivariable adjustment for differences in baseline features, in-hospital mortality after TAVI was lower in patients with vs. without HF (adjusted OR 0.76, 95% CI 0.62-0.92; p=0.007). Additional independent predictors of in-

hospital mortality after TAVI included advanced age, female sex, diabetes mellitus, chronic kidney disease, Electrolyte abnormalities, paralysis, non-aortic valvular heart disease and the absence of hypertension, anemia or depression.

Among all patients with HF undergoing TAVI, HFrEF as compared with HFpEF was not significantly associated with in-hospital mortality (adjusted OR 1.14; 95% CI 0.85 1.54; P=0.38). Independent predictors of in-hospital mortality after TAVI in patients with HF included female sex, liver disease, Electrolyte abnormalities, chronic kidney or liver disease, non-aortic valvular heart disease, paralysis and the absence of hypertension, anemia or depression (Table 4).

The univariable and multivariable correlates of in-hospital mortality among the 2,078 HFrEF patients and the 4,290 HFpEF patients undergoing TAVI are shown in Tables 5 and 6. Chronic kidney disease, Electrolyte abnormalities and the absence of hypertension were independent predictors of mortality in both groups. Non-aortic valvular heart disease was an additional independent predictor of in-hospital mortality in HFrEF patients, whereas advanced age, liver disease, and the absence of depression and anemia were additional independent predictors of in-hospital mortality in HFpEF patients.

Discussion

The major findings from the present large-scale, national population-based analysis of patients with HF in whom TAVI is performed are as follows: 1) In-hospital mortality after TAVI was not increased in patients with compared to those without HF, and indeed may be slightly decreased; 2) Among TAVI patients with HF, in-hospital mortality was similar in those with HFrEF and HFpEF; 3) Chronic kidney disease and Electrolyte abnormalities were

independent predictors of in-hospital mortality in patients with both HFpEF and HFrEF after TAVI, whereas the presence of hypertension predicted lower in-hospital mortality in both groups; 4) The presence of non-aortic valvular heart disease was an independent predictor of in-hospital mortality in patients with HFrEF after TAVI, while the presence of advanced age and liver disease and the absence of anemia and depression were independent predictors of in-hospital mortality in patients with HFpEF after TAVI.

Although left ventricular ejection fraction (LVEF) is in general an important prognostic factor in patients with cardiovascular disease and is included in current operative risk scores[6-8], the relationship between left ventricular function and procedural risk with TAVI remains controversial. The present study demonstrates that the presence of heart failure may not portend excess in-hospital risk following TAVI, irrespective of LVEF. However, in-hospital mortality in patients with left ventricular systolic dysfunction undergoing TAVI was higher in those without baseline hypertension. Patients with hypertension may have a significantly greater increase in stroke volume, cardiac index, and cardiac output after TAVI compared with normotensive patients[9], representing greater myocardial contractile reserve[10-12]. Nonetheless, the relative risks and benefits of intensive blood pressure lowering in elderly patients before and after TAVI are uncertain[13, 14]. The mean age of the HF patients undergoing TAVI is >80 years, a high-risk cohort in whom optimal blood pressure targets remain unclear[15]. Our results support a close evaluation of hemodynamics, as opposed to LVEF itself, when considering the perioperative risks of TAVI.

Among HF patients undergoing TAVI, chronic kidney disease (CKD) and electrolyte disorders were independent predictors of higher in-hospital mortality, regardless of baseline LV function. Prior studies have reported that chronic kidney disease and electrolyte disorders are

associated with mortality in HF patients without AS, particularly in those with left ventricular systolic dysfunction[22], possibly due to inflammatory cytokines[16], neurohormonal changes[16], and malnutrition[17]. Patients with CKD have worse in-hospital outcomes and increased mortality after TAVI[18, 19]. Control of fluid overload, correction of electrolytes, and optimization of dialysis are essential to effectively treat HF in CKD patients. These management issues are likely even more critical in the TAVI patient. Particular attention should be paid to renal function in patients with severe AS being considered for TAVI.

Sex differences have been related to early and late survival after TAVI[20]. Although our results found a relationship between female sex and increased in-hospital mortality in all HF patients undergoing TAVI, sex was not significantly associated with mortality in the HFpEF or HFpEF cohorts. An even larger sample size may be required to examine the specific relationship between sex and outcomes in these subgroups.

In the present study, concomitant non-aortic valvular disease was a predictor of mortality in HFrEF but not HFpEF patients. Moderate or severe mitral regurgitation is not uncommon in patients with AS undergoing TAVI[21]. However, the prognostic implications of MR after TAVI in prior reports have been conflicting[22-25]. One study reported that secondary mitral regurgitation was associated with an increased risk of HF hospitalizations but not death after TAVI[25]. Both mitral stenosis and tricuspid regurgitation have been associated with higher in-hospital mortality rates after TAVI. Unfortunately the severity of non-aortic valve disease is not specified in the NIS database. Additional studies are required to understand the relationship between non-aortic valve disease and outcomes after TAVI in HF patients.

In the present study advanced age and liver disease, along with the absence of anemia and depression were independent predictors of in-hospital mortality in patients with HFpEF

after TAVI. These data complement the outcomes from prior reports examining prognostic factors in HFpEF patients without AS. Frailty may contribute to the increased mortality in elderly HFpEF patients, and such patients may benefit from guideline directed HF treatments[26]. Liver fibrosis has been associated with higher all-cause mortality in HFpEF patients without AS, possibly due to activation of the renin–angiotensin–aldosterone system, fibrogenesis, and increased collagen turnover[27]. In prior studies anemia has been associated with greater mortality in HFpEF patients compared with HFrEF without AS[28]. In the OPTIMIZE-HF registry of 5,117 HF patients, Young et al. found a significant interaction between HF type and hemoglobin level[29]. In addition, Latado et al. reported that the prevalence of anemia was higher and was associated with increased mortality in patients with HFpEF compared with HFrEF[30]. The present study surprisingly found that the absence of anemia was associated with in-hopsital mortality after TAVI. Further studies are thus warranted to determine the role of anemia in HFpEF patients undergoing TAVI. Depression was also not associated with increased mortality after TAVI in HF in the present study (either in patients with HFpEF and HFrEF), in contrast to earlier smaller studies in patients without HF.

Our study has additional limitations. First, as a non-randomized analysis we could not adjust for unmeasured confounders. The present results should thus be considered hypothesis-generating. Second, specific echocardiographic parameters (including LVEF) were unavailable in ICD-9. Third, we could not adjust for high-risk subgroups such as low-flow, low-gradient AS or AS with severe left ventricular outflow tract calcification. Fourth, we could not identify complications post TAVI such as pacemaker implantation after TAVI due to a lack of time related procedure data. Finally, data on long-term survival and other outcomes were not available.

In conclusion, in the present large-scale study of US patients, baseline HF was prevalent in patients with severe AS undergoing TAVI and was more commonly due to HFpEF than HFrEF. After adjustment for baseline characteristics, in-hospital mortality after TAVI was not increased and in fact was slightly lower in patients with compared to without HF, and was similar in those with HFrEF and HFpEF. The predictors of mortality after TAVI varied in patients with HFrEF and HFpEF, knowledge of which may be useful in patient selection, prognostic guidance and to inform future studies.

Disclosures: none

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Table 1. Baseline characteristics of patients with vs. without heart failure undergoing TAVI

	Heart Failure		
Variables	**Yes (n=6,368)**	**No (n=5,241)**	**p-value***
Age (years)	81.4 ± 8.1	80.3 ± 9.5	<0.001
Women	3,161 (49.6%)	2,351 (44.9%)	<0.001
White	5,188 (87.4%)	4,270 (87.4%)	1.00
Black	255 (4.3%)	180 (3.7%)	0.11
Hispanic	221(3.7%)	216 (4.4%)	0.07
Asian	55 (0.9%)	71 (1.5%)	0.01
Native American	10 (0.2%)	11 (0.2%)	0.50
Other	210 (3.5%)	141 (2.9%)	0.06
Alcohol use disorder	60 (0.9%)	70 (1.3%)	0.045
Chronic pulmonary disease	2,140 (33.6%)	1,666 (31.8%)	0.04
Coronary artery disease	2,965 (46.6%)	1,568 (29.9%)	<0.001
Depression	470 (7.9%)	396 (7.6%)	0.72
Diabetes mellitus	1,922 (30.2%)	1,482 (28.3%)	0.02
Hypertension	5,104 (80.6%)	4,250 (81.1%)	0.20
Liver disease	160 (2.5%)	144 (2.8%)	0.43
Chronic kidney disease	2,400 (37.7%)	1,717 (32.8%)	<0.001
Psychoses	97 (1.5%)	107 (2.1%)	0.03
Neurological disorders	415 (6.5%)	323 (6.2%)	0.44
Electrolyte abnormalities	1,636 (25.7%)	1,281 (24.4%)	0.12
Non-aortic valvular heart disease	155 (2.4%)	130 (2.5%)	0.87
Anemia	1,610 (25.3%)	1,273 (24.3%)	0.22
Solid tumor without metastasis	118 (1.9%)	105 (2.0%)	0.56
Rheumatological disease	305 (4.8%)	240 (4.6%)	0.59
Peptic ulcer disease	2 (0.04%)	1 (0.02%)	0.68
Percutaneous coronary intervention	545 (8.6%)	683 (13%)	<0.001
Coronary artery bypass grafting	35 (0.5%)	25 (0.47%)	0.81
Permanent pacemaker	287 (4.5%)	344 (6.6%)	<0.001

*Computed via two-sample t-test for continuous variables or chi-square for categorical variables

Table 2. Baseline characteristics of patients with HFpEF vs. HFrEF undergoing TAVI

Variables	HFpEF (n=4,290)	HFrEF (n=2,078)	p-value*
Age (years)	81.7 ± 8.02	80.8 ± 7.5	<0.001
Women	2,320 (54.1%)	841 (40.5%)	<0.001
White*	3,283 (76.5%)	1,335 (64.2%)	<0.001
Black*	156 (3.6%)	76 (3.6%)	0.97
Hispanic*	134 (3.1%)	73 (3.5%)	0.41
Asian*	32 (0.7%)	16 (0.8%)	0.92
Native American*	5 (0.1%)	1 (0.05%)	0.40
Other*	135 (3.1%)	60 (2.9%)	0.57
Alcohol use disorder	41 (1.0%)	19 (0.9%)	0.87
Chronic pulmonary disease	1,464 (34.1%)	676 (32.5%)	0.21
Coronary artery disease	404 (9.4%)	993 (47.8%)	<0.001
Depression	322 (7.5%)	148 (7.1%)	0.58
Diabetes mellitus	1,278 (29.8%)	644 (31.0%)	0.33
Hypertension	3,473 (81.0%)	1,631 (78.5%)	0.02
Liver disease	114 (2.7%)	46 (2.2%)	0.29
Rheumatological disease	219 (5.1%)	86 (4.1%)	0.09
Chronic kidney disease	1,572 (36.6%)	828 (39.9%)	0.01
Psychoses	63 (1.5%)	34 (1.6%)	0.61
Neurological disorders	304 (7.1%)	111 (5.3%)	0.01
Electrolyte abnormalities	1,057 (24.6%)	579 (27.9%)	0.01
Non-aortic valvular heart disease	94 (2.2%)	61 (2.9%)	0.07
Anemia	1,097 (25.6%)	513 (24.7%)	0.45
HIV/AIDs	1 (0.02%)	2 (0.1%)	0.21
Paralysis	88 (2.1%)	25 (1.2%)	0.02
Solid tumor without metastasis	82 (1.9%)	36 (1.7%)	0.62
Peptic ulcer disease	1 (0.02%)	1 (0.05%)	0.60
Percutaneous coronary intervention	373 (8.6%)	172 (8.3%)	0.68
Coronary artery bypass grafting	7 (0.16%)	3 (0.14%)	0.84
Permanent pacemaker	191 (4.45%)	96 (4.6%)	0.78

*Patients with an unclear diagnosis of HFrEF vs HFpEF were excluded. *Computed via two-sample t-test for continuous variables or chi-square for categorical variables

Table 3. Independent predictors of in-hospital mortality after TAVI in all patients

	In Hospital Death			
Variable	**Yes (n=421)**	**No (n=11,188)**	**Adjusted OR [95% CI]**	**Adjusted P value**
Age (years)	81.8 ± 9.2	80.9 ± 8.7	1.01 [1.00-1.03]	0.03
Women	226 (53.7%)	5,286 (47.3%)	1.36 [1.11-1.67]	0.003
Heart failure	212 (50.4%)	6,368 (56.9%)	0.76 [0.62-0.92]	0.006
Depression	15 (3.6%)	851 (7.6%)	0.48 [0.28-0.81]	0.006
Diabetes mellitus	88 (20.9%)	3,316 (29.6%)	0.69 [0.54-0.88]	0.003
Hypertension	276 (65.6%)	9,078 (81.1%)	0.44 [0.36-0.55]	<0.001
Anemia	89 (21.1%)	2,794 (25.0%)	0.69 [0.54-0.88]	0.003
Chronic kidney disease	189 (44.9%)	3,928 (35.1%)	1.64 [1.33-2.01]	<0.001
Electrolyte abnormalities	213 (50.6%)	2,704 (24.2%)	3.00 [2.45-3.67]	<0.001
Paralysis	22 (5.2%)	183 (1.6%)	3.04 [2.48-3.71]	<0.001
Non-aortic valvular heart disease	18 (4.3%)	267 (2.4%)	1.65 [1.00-2.72]	0.049
Coronary artery disease	305 (72.4%)	7,955 (71.%)	1.11 [0.88-1.40]	0.36
Percutaneous coronary intervention	147 (34.9%)	4,121 (36.8%)	0.87 [0.70 – 1.08]	0.21
Coronary artery bypass grafting	7 (1.6%)	328 (2.9%)	0.53 [0.25-1.14]	0.11
Permanent pacemaker	76 (18.1%)	2,002 (17.9%)	1.09 [0.84 – 1.40]	0.53

The following variables were not related to in-hospital mortality in multivariable analysis: Liver disease, alcohol use disorder, chronic pulmonary disease, psychosis, neurological disorders, solid tumor without metastases, HIV/AIDS, rheumatological disease, and peptic ulcer disease.

Table 4. Independent predictors of in-hospital mortality after TAVI in all HF patients

	In Hospital Death			
Variables	**Yes (n=212)**	**No (n=6,156)**	**Adjusted OR [95% CI]**	**Adjusted P value**
Women	121 (57.1%)	3,040 (49.4%)	1.44 [1.08-1.93]	0.01
HFrEF (vs. HFpEF)	76 (35.9%)	2,002 (32.5%)	1.14 [0.85-1.54]	0.37
Depression	2 (0.9%)	468 (7.6%)	0.13 [0.03-0.51]	0.004
Hypertension	144 (67.9%)	4,960 (80.6%)	0.52 [0.38-0.71]	<0.001
Liver disease	11 (52%)	149 (2.4%)	2.50 [1.27-4.91]	0.008
Chronic kidney disease	100 (47.2%)	2,300 (37.4%)	1.58 [1.18-2.11]	0.002
Electrolyte abnormalities	111 (52.4%)	1,525 (24.8%)	3.02 [2.28-4.01]	<0.001
Non-aortic valvular heart disease	12(5.7%)	143 (2.3%)	2.18 [1.17-4.08]	0.01
Anemia	42 (19.8%)	1,568 (25.5%)	0.62 [0.43-0.88]	0.007
Coronary artery disease	147 (69.3%)	4,436 (72.1%)	0.90 [0.65-1.23]	0.51
Percutaneous coronary intervention	73 (34.4%)	2,229 (36.2%)	0.96 [0.71-1.30]	0.79
Coronary artery bypass grafting	4 (1.9%)	172 (2.8%)	0.67 [0.24 – 1.86]	0.44
Permanent pacemaker	40 (18.9%)	1,146 (18.6%)	1.12 [0.79 – 1.61]	0.52

The following variables were not related to in-hospital mortality in multivariable analysis: Diabetes mellitus, paralysis, alcohol use disorder, rheumatological disease, chronic pulmonary disease, psychosis, neurological disorders, solid tumor without metastases, HIV/AIDS, and peptic ulcer disease.

Table 5. Independent predictors of in-hospital mortality after TAVI in HFrEF patients

	In Hospital Death			
Variables	**Yes (n=76)**	**No (n=2002)**	**Adjusted OR [95% CI]**	**Adjusted P value**
Hypertension	51 (67.1%)	1,580 (78.9%)	0.57 [0.34-0.97]	0.036
Chronic kidney disease	40 (52.6%)	788(39.4%)	1.74 [1.06-2.84]	0.03
Non-aortic valvular heart disease	6 (7.9%)	55 (2.8%)	2.64 [1.06-6.60]	0.038
Electrolyte abnormalities	47 (61.8%)	532 (26.6%)	4.23 [2.59-6.92]	<0.001
Coronary artery disease	53 (69.74%)	1,456 (72.73%)	0.85 [0.49 - 1.47]	0.57
Percutaneous coronary intervention	28 (36.84%)	750 (37.46%)	1.07 [0.64-1.80]	0.793
Coronary artery bypass grafting	1 (1.32%)	65 (3.25%)	0.38 [0.05 -2.92]	0.354
Permanent pacemaker	20 (26.32%)	375 (18.73%)	2.04 [1.18-3.55]	0.011

The following variables were not related to in-hospital mortality in multivariable analysis: Diabetes mellitus, liver disease, paralysis, alcohol use disorder, chronic pulmonary disease, depression, anemia, psychosis, neurological disorders, solid tumor without metastases, HIV/AIDS, rheumatological disease, and peptic ulcer disease.

Table 6. Independent predictors of in-hospital mortality after TAVI in HFpEF patients

	In Hospital Death			
Variables	**Yes (n=136)**	**No (n=4,154)**	**Adjusted OR [95% CI]**	**Adjusted P value**
Hypertension	93 (68.38%)	3,380 (81.4%)	0.50[0.34-0.73]	<0.001
Age (years)	80.7 ± 10.5	80.1 ± 10.8	1.03 [1.00-1.06]	0.02
Depression	2 (1.5%)	320 (7.7%)	0.20 [0.05-0.81]	0.03
Liver disease	7 (5.2%)	107 (2.6%)	2.85 [1.23-6.57]	0.01
Chronic kidney disease	60 (44.1%)	1,512 (36.4%)	1.52 [1.06-2.18]	0.02
Anemia	24 (17.7%)	1,073 (25.8%)	0.52 [0.33-0.82]	0.005
Electrolyte abnormalities	64 (47.1%)	993 (23.9%)	2.63 [1.85-3.74]	<0.001
Coronary artery disease	94 (69.12%)	2,980 (71.74%)	0.92 [0.62-1.36]	0.69
Percutaneous coronary intervention	45 (33.09%)	1,479 (35.60%)	0.90 [0.61-1.32]	0.59
Coronary artery bypass grafting	3 (2.21%)	107 (2.58%)	0.85 [0.26-2.77]	0.79
Permanent pacemaker	20 (14.71%)	771 (18.56%)	0.80 [0.49-1.30]	0.36

The following variables were not related to in-hospital mortality in multivariable analysis: Diabetes mellitus, paralysis, alcohol use disorder, chronic pulmonary disease, psychosis, neurological disorders, solid tumor without metastases, HIV/AIDS, rheumatological disease, non-aortic valvular heart disease, and peptic ulcer disease.

Figure 1. In-hospital mortality in all patients undergoing TAVI during the study period, stratified according to the presence and type of heart failure. Odds ratios (OR) and 95% confidence intervals (CI) have been adjusted for differences in baseline characteristics.