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Epidemiology and Outcomes of Aortic Stenosis in Acute Decompensated Heart Failure: The ARIC Study

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Abstract

Background: Few studies characterize the epidemiology and outcomes of aortic stenosis (AS) in acute decompensated heart failure (ADHF). This study investigates the significance of AS in contemporary patients who have experienced an ADHF hospitalization.

Methods: The ARIC Community Surveillance Study surveilled ADHF hospitalizations for residents ≥55 years of age in four US communities. ADHF cases were stratified by left ventricular ejection fraction (LVEF). Demographic differences in AS burden, and the association of varying AS severities with mortality were estimated using multivariable logistic regression.

Results: From 2005–2014, there were 3,597 (weighted n=16,692) ADHF hospitalizations of which 48.6% had an LVEF <50% and 51.4% an LVEF ≥50%. AS prevalence was 12.1% and 18.7% in those with an LVEF <50% and ≥50%, respectively. AS was less likely in Black than White patients regardless of LVEF: LVEF <50%, odds ratio (OR): 0.34 [95% confidence interval (CI): 0.28, 0.42]; LVEF ≥50%, OR: 0.51 [95% CI: 0.44, 0.59]. Higher AS severity was independently associated with 1-year mortality in both LVEF subgroups: LVEF <50%, OR: 1.16 (95% CI: 1.04, 1.28); LVEF ≥50%, OR: 1.40 (95% CI: 1.28, 1.54). Sensitivity analyses excluding

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severe AS patients detected that mild/moderate AS was independently associated with 1-year mortality in both LVEF subgroups: LVEF <50%, OR: 1.23 (95% CI: 1.02, 1.47); LVEF ≥50%, OR 1.31 (95% CI: 1.14, 1.51).

Conclusions: Among patients who have experienced an ADHF hospitalization, AS is prevalent and portends poor mortality outcomes. Notably, mild/moderate AS is independently associated with 1-year mortality in this high-risk population.

Introduction:

Acute decompensated heart failure (ADHF) is the leading cause of hospitalization among patients ≥65 years of age in the United States (US). [1] Consequently, identifying pathologies which contribute to poor outcomes in patients who have experienced ADHF is necessary to develop evidence-based management strategies. [2] Aortic stenosis (AS) produces a high afterload state which complicates the multifactorial pathogenesis of acute heart failure (HF). [3] Thus, ADHF patients with AS constitute a high-risk population posing diagnostic and therapeutic challenges.

The prevalence of AS in the ADHF population is estimated to be ~18%. [4] Currently, the epidemiology and prognostic significance of AS in ADHF patients stratified by left ventricular ejection fraction (LVEF) has not been described. [4–8] Furthermore, variation in AS burden by sex remains unclear. [9] Novel trials targeting severe AS have demonstrated marked improvements in both mortality and patient health status after aortic valve replacement (AVR). [10,11] Lesser degrees of AS are also of contemporary interest, with the TAVR UNLOAD trial currently evaluating the role of transcatheter AVR (TAVR) as a treatment modality for chronic HF patients with moderate AS. [12] In this setting, determining the independent prognostic role of AS in patients who have experienced an acute HF hospitalization is necessary to guide clinical decision making.

The Atherosclerosis Risk in Communities (ARIC) Study is a biracial, population-based analysis that conducted community-wide surveillance of ADHF admissions in four US communities. In the present analysis, we examined ADHF hospitalizations in the ARIC Study to identify the prevalence of AS, as well as demographic differences in AS burden. We also explored the association between varying degrees of AS severity and mortality in ADHF patients stratified by LVEF.

Methods:

The data that support the findings of this study are available from the corresponding author upon request.

Study Design and Population:

The ARIC HF Community Surveillance Study performed continuous surveillance of HF hospitalizations from 2005 to 2014. The surveillance target population included residents ≥55 years of age in four geographically defined US communities: Forsyth County, North Carolina; Jackson, Mississippi; Minneapolis, Minnesota, suburbs; and Washington County, Maryland. Institutional review boards approved the ARIC Study protocol at all participating

hospitals, and no informed consent was required. Details of the ARIC HF Community Surveillance Study have been previously described. [13] For context, a stratified random sample of all eligible HF hospitalizations from 2005 to 2014 (unweighted n=23,410) was selected based on three criteria: International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) discharge diagnosis codes for HF or HF-related conditions (398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 415.0, 416.9, 425.4, 428.x, 518.4, 786.0x) in any position; ≥55 years of age at the time of hospital discharge; and home address within the boundaries of the ARIC communities. Computer algorithm [13] or one to two physicians of the ARIC Mortality and Morbidity Classification Committee then independently classified cases into one of five categories: definite ADHF; probable ADHF; chronic stable HF; HF unlikely; or unclassifiable. A board-certified HF specialist serving as the chair of the Mortality and Morbidity Classification Committee adjudicated any disagreements.

Inclusion and Exclusion Criteria:

In addition to being associated with an accelerated progression of aortic valve calcification, [14] end-stage renal disease is also known to aggravate diagnostic challenges in the HF population. [15] The present analysis thus excluded patients with any history of hemodialysis. To eliminate confounding of mortality analyses by aortic valve interventions (both invasive and minimally invasive), those with any history of heart valve surgery or intervention were excluded. For the purpose of this report, definite or probable ADHF hospitalizations (unweighted n=9,139) were eligible for inclusion (Figure 1). Of these, those without echocardiogram data available from their abstracted hospitalization (unweighted n=4,702), those with any history of hemodialysis (unweighted n=265), those with any history of heart valve surgery or intervention (unweighted n=349), those with missing LVEF data (unweighted n=164), and those with missing AS categorization data (unweighted n=62) were excluded. The final study sample included 3,597 (weighted n=16,692) validated ADHF hospitalizations.

Covariates and Definitions:

Data utilized in the present analysis were derived from patient charts by trained ARIC HF Community Surveillance Study abstractors. Although hyperlipidemia and left ventricular hypertrophy (by diagnosis code only, as quantitative measurements were not available) were considered for analysis, both were excluded due to large numbers of missing data in the final study sample - 67% and 31% missing data for hyperlipidemia and left ventricular hypertrophy, respectively. Demographics and covariates included in the present analysis were age, sex, race, diabetes mellitus, hypertension, tobacco smoking, atrial fibrillation, coronary artery disease, transient ischemic attack (TIA) / stroke, hemoglobin value (g/dl), worst in-hospital blood urea nitrogen, and admission systolic blood pressure. Atrial fibrillation was abstracted based on three criteria: past medical history; electrocardiogram reading obtained during hospitalization; or ICD-9-CM discharge diagnosis code 427.3. Anemia was defined as a hemoglobin <12 g/dl for females and <13 g/dl for males. Qualitative interpretation (mild, moderate, or severe) of AS severity was abstracted from available echocardiogram reports per ARIC HF Community Surveillance Study criteria. [16] ADHF cases were stratified into two groups based on LVEF recorded during their abstracted

hospitalization; LVEF <50% and LVEF ≥50%. All-cause 28-day and 1-year mortality outcomes after ADHF hospitalization were available for all included hospitalizations through National Death Index linkage data.

Statistical Analysis:

As previously described, [2,13] hospitalizations in the ARIC HF Community Surveillance Study were randomly sampled within five pre-specified strata: sex; race; center; discharge code group; and date of discharge. As a result of this stratified sampling design, selection probability varied across categories and each hospitalization could not be treated as having an equal weight for a population-level analysis. The present study therefore utilized sampling weights for unbiased estimates across the four sampled ARIC communities, as is standard for any analysis of the ARIC HF Community Surveillance Study. [2,13] All statistical models accounted for the stratified sampling design and were weighted by the inverse of the sampling probability. [17] Analyses were conducted using SAS Survey Procedures software version 9.4 (SAS Institute; Cary, NC).

Included patients were stratified by LVEF (LVEF <50% and ≥50%); both groups were then further stratified by AS severity into three categories: none, mild/moderate, and severe. Of note, our investigation relied on subjective AS classification data abstracted from echocardiogram reports. Thus, as has been previously done, [18] our primary analyses investigated mild/moderate AS as a single distinct entity to mitigate any potential diagnostic challenges in the differentiation between mild and moderate AS in the ADHF population. Baseline characteristics of the study population were described for each subgroup. The prevalence of any AS severity in four age categories (≥55 to 65, ≥65 to 75, ≥75 to 85, and ≥85 years of age) was also described, stratified by LVEF.

Multivariable logistic regression was used to examine the association of sex and race with the presence of AS. Females were compared to males in sex comparisons, and Black to White patients in race comparisons. Any AS (vs. no AS) was modeled as the outcome variable. Sex and race were individually modeled as predictor variables to estimate each of their associations with any AS in ADHF hospitalizations stratified by LVEF. These models were adjusted for age, sex (omitted in sex comparisons), race (omitted in race comparisons), diabetes mellitus, hypertension, tobacco smoking, coronary artery disease, and TIA/stroke.

Mortality analyses were also performed using logistic regression. All-cause 28-day and 1-year mortality were independently modeled as outcome variables. Increasing AS severity (including none, mild/moderate, and severe AS) was modeled as a continuous predictor variable to estimate the association between higher AS severity and all-cause mortality in ADHF hospitalizations stratified by LVEF. In sensitivity analyses excluding severe AS, all-cause 28-day and 1-year mortality were again independently modeled as outcome variables. Here, mild/moderate AS was compared to no AS as a categorical predictor variable to estimate the association between mild/moderate AS and all-cause mortality in ADHF patients stratified by LVEF. In further sensitivity analyses provided in Table S1, mild AS and moderate AS were individually compared to no AS as categorical predictor variables to estimate the association between these individual degrees of AS severity and all-cause mortality in ADHF patients stratified by LVEF. All mortality analysis models adjusted for

age, sex, race, diabetes mellitus, hypertension, tobacco smoking, atrial fibrillation, coronary artery disease, TIA/stroke, anemia, worst in-hospital blood urea nitrogen, admission systolic blood pressure, and LVEF (omitted in LVEF ≥50% models).

Results:

Patient Characteristics:

Overall, 3,597 (weighted n=16,692) ADHF hospitalizations occurred from 2005 to 2014 in those ≥55 years of age. Of all ADHF patients, 48.6% had an LVEF <50% (45.3% female, 33.8% Black) and 51.4% had an LVEF ≥50% (66.4% female, 25.9% Black) (Table 1). Table 1 describes the baseline characteristics of patients in the three analyzed AS severity categories (none, mild/moderate, and severe AS) stratified by LVEF. Any degree of AS was present in 12.1% of those with an LVEF <50% and 18.7% of those with an LVEF ≥50%. In patients with an LVEF <50% (Figure 2A) and ≥50% (Figure 2B), the prevalence of AS progressively increased with age category (≥55 to 65, ≥65 to 75, ≥75 to 85, and ≥85 years of age).

Sex and Race Analyses:

Sex and race analyses estimated the adjusted odds of any AS in ADHF patients with varying sex and race, stratified by LVEF. In sex analyses, females were less likely than males to have AS among those with an LVEF <50% (odds ratio [OR]: 0.84 [95% confidence interval (CI): 0.73, 0.97], p=0.02). No differences in odds of AS were detected between females and males in those with an LVEF ≥50% (OR: 1.04 [95% CI: 0.92, 1.17], p=0.6). In race analyses, Black patients were less likely to have AS than their White counterparts in both LVEF subgroups: LVEF <50%, OR: 0.34 [95% CI: 0.28, 0.42], p<0.0001; LVEF ≥50%, OR: 0.51 [95% CI: 0.44, 0.59], p<0.0001.

Mortality Analyses:

Table 2 summarizes all-cause 28-day and 1-year mortality in ADHF patients stratified by LVEF with none, mild/moderate, or severe AS. All-cause 28-day mortality after ADHF hospitalization was observed in 10.8% of all patients with an LVEF <50% and 8.88% of those with an LVEF ≥50%. In those affected by any degree of AS, 28-day mortality was observed in 13.4% of those with an LVEF <50%, and 10.6% of those with an LVEF ≥50%. All-cause 1-year mortality after ADHF hospitalization was observed in 31.5% of all patients with an LVEF <50% and 27.8% of those with an LVEF ≥50%. In those affected by any degree of AS, 1-year mortality was observed in 38.7% of those with an LVEF <50%, and 35.5% of those with an LVEF ≥50%.

Figure 3 displays the models for odds of all-cause 28-day mortality after ADHF hospitalization in patients with varying degrees of AS severity. All-cause 28-day mortality was more likely in patients with higher AS severity in those with an LVEF <50% (OR: 1.21 [95% CI: 1.04, 1.40], p=0.01), but not in those with an LVEF ≥50% (OR: 1.15 [95% CI: 0.99, 1.32], p=0.06). In sensitivity analyses excluding severe AS patients, no differences in 28-day mortality were detected between those with mild/moderate AS and no AS in either

LVEF subgroup: LVEF <50%, OR: 0.97 [95% CI: 0.73, 1.27], p=0.8; LVEF ≥50%, OR: 0.83 [95% CI: 0.66, 1.05], p=0.1.

Figure 4 displays the models for odds of all-cause 1-year mortality after ADHF hospitalization in patients with varying degrees of AS severity. All-cause 1-year mortality was more likely in patients with higher AS severity in both LVEF subgroups: LVEF <50%, OR: 1.16 [95% CI: 1.04, 1.28], p=0.007; LVEF ≥50%, OR: 1.40 [95% CI: 1.28, 1.54], p<0.0001. In sensitivity analyses excluding severe AS patients, 1-year mortality was more likely in patients with mild/moderate AS compared to no AS in both LVEF subgroups: LVEF <50%, OR: 1.23 [95% CI: 1.02, 1.47], p=0.03; LVEF ≥50%, OR: 1.31 [95% CI: 1.14, 1.51], p<0.001.

Discussion:

We detected several important findings in this ARIC HF Community Surveillance Study investigating ADHF hospitalizations in patients ≥55 years of age. (Figure 4) First, ADHF patients have a considerable prevalence of AS in both LVEF subgroups (LVEF <50% and ≥50%). Second, males are more likely than females to have AS among those with an LVEF <50%; White ADHF patients of both LVEF subgroups are more likely to have AS than their Black counterparts. Third, higher AS severity is associated with 28-day mortality in those with an LVEF <50%, and with 1-year mortality in both LVEF subgroups. Finally, our sensitivity analyses excluding severe AS patients reveal that mild/moderate AS, when compared to no AS, is associated with 1-year mortality in all ADHF patients, regardless of LVEF.

Epidemiologic data describing AS in ADHF is lacking. To our knowledge, of the major trials and registries describing ADHF populations, [4–8] only the EuroHeart Failure Survey II (EHFS II) has reported AS prevalence data. The EHFS II analyzed patients hospitalized for ADHF in 133 centers across 30 European countries and reported an AS prevalence of ~18%. [4] We report a similar prevalence of AS among the ADHF population (12.1% in those with an LVEF <50% and 18.7% in those with an LVEF ≥50%), but further the literature with stratification by LVEF. Additionally, the ARIC HF Community Surveillance Study included ADHF admissions in a biracial population across 4 US communities. Thus, our findings describe a uniquely heterogeneous population compared to that of previous studies.

Whether or not there is a sex related difference in AS severity remains unclear. Historically, male sex has been regarded as a risk factor for AS. [19] However, studies from the past decade have presented conflicting results. [9] For instance, while an analysis of the US Nationwide Inpatient Sample found that AS was more likely in males, [20] data from the Japanese CURRENT AS registry detected a higher AS burden in females. [21] Notably, our analyses reveal that males are more likely than females to have AS among ADHF patients with an LVEF <50%. However, there are no sex differences in the odds of AS among hospitalized acute HF patients with an LVEF ≥50%. With respect to race, previous analyses have described a significantly higher risk of AS in White compared to Black patients. [20,22] We add to the literature on this topic by reporting that in ADHF, AS is more likely in White than Black patients in both LVEF subgroups.

Currently, over 1 million patients are hospitalized annually in the US with HF as a primary diagnosis. [23] In this setting, understanding the individual contributions of specific pathologies to mortality in the ADHF population is necessary to improve outcomes. [2] Although AS is a known primary etiology of ADHF, it can also be one of many precipitating factors contributing to decompensation in HF patients. [1] Consequently, our study evaluating the independent contribution of varying AS severities to mortality in ADHF is of critical importance. We report that higher AS severity is independently associated with 28-day mortality in those with an LVEF <50%. Among those with an LVEF ≥50%, higher AS severity is not statistically associated with 28-day mortality, although we observe a confidence interval which approaches significance (OR 1.15, 95% CI [0.99–1.32]). Higher AS severity is associated with 1-year mortality in all ADHF patients. Given the well-established dismal outcomes associated with severe symptomatic AS, [24] we also conducted sensitivity analyses excluding severe AS patients. Here, we sought to determine if mild/moderate AS, compared to no AS, has independent prognostic implications in the ADHF population. In these sensitivity analyses, no differences in 28-day mortality were detected between the mild/moderate AS and no AS populations in both LVEF subgroups. Notably however, our analyses reveal that 1-year mortality after hospitalization is significantly more likely in ADHF patients with mild/moderate AS in both LVEF subgroups. This is a novel finding that has not been previously demonstrated in a population-level analysis of ADHF patients. A rapid progression from lesser AS degrees to severe AS is not uncommon, [18] and may contribute to the increased risk of 1-year mortality in ADHF patients with mild/moderate AS. Our findings highlight that any AS, even mild/moderate, in those who have been hospitalized for ADHF has unfavorable mortality implications.

There is no evidence for the role of pharmaceutical therapy in the prevention or reversal of AS. [10] Per the 2020 ACC/AHA valvular heart disease guidelines, [25] surgical and transcatheter AVR are the only Class 1 recommendations for definitive AS management. Indications for AVR, especially TAVR, are rapidly expanding with time. TAVR is now considered to be an appropriate intervention for severe AS patients with high, intermediate, or low surgical risk. [11,26–28] Lesser degrees of AS have also become a target of interest, [29] with a randomized control trial currently evaluating the safety and efficacy of TAVR in chronic HF patients with moderate AS. [12] This is in the setting of recent literature making it increasingly more apparent that lower degrees of AS, such as moderate AS, are associated with mortality in patients with HF. [30] Our study emphasizes that any AS severity in ADHF has important mortality implications for affected patients. Specifically, those with any degree of AS who have experienced an ADHF hospitalization have an increased risk of 1-year mortality compared to their counterparts with no AS.

Limitations:

The ARIC HF Community Surveillance Study is a biracial analysis which does not sample other racial and ethnic demographics. We sought to determine AS prevalence differences in ADHF patients stratified by race and sex - future analyses should seek to determine if prognostic differences exist between these demographic subgroups. Etiologic data to distinguish causes of AS (calcific, congenital, infective, or rheumatic) were not available. Clinically-relevant data such as readmissions or previous ADHF hospitalizations were not

recorded for the entire surveillance population in the ARIC HF Community Surveillance Study, and were therefore not analyzed in the present report. Due to the absence of a core echocardiography laboratory, there was potential for interobserver variation in AS classification (none, mild, moderate, and severe). Mild and moderate AS were analyzed as an aggregated variable to help mitigate effects stemming from potential imprecision in the distinction between these AS categories. Further sensitivity data detailing the results of analyses comparing short- and long-term mortality outcomes in mild AS vs. no AS and moderate AS vs. no AS are provided in Table S1. Classical low-flow, low-gradient severe AS and paradoxical low-flow, low-gradient severe AS are well known to pose diagnostic challenges in AS classification. [31] Thus, ADHF patients in the present analysis with severe AS may have been mislabeled to have lesser AS severity at the time of their echocardiogram due to discordance in their LVEF, mean transvalvular gradient, and aortic valve area. Unfortunately, key objective echocardiographic parameters in the assessment of AS were not available for investigation in this retrospective analysis. Interestingly however, our observation that 28-day mortality was more likely in patients with higher AS severity (including severe AS) among those with an LVEF <50% was not replicated in sensitivity analyses excluding patients with severe AS. If the mild/moderate AS dataset was significantly confounded by misclassified severe AS patients, we would not have expected this finding. Finally, information regarding the timing of echocardiogram imaging within each hospitalization (admission vs. discharge) was not available for analysis.

Conclusions:

In this investigation of the ARIC HF Community Surveillance Study, we report a considerable prevalence of AS in ADHF that varies with sex and race. Higher AS severity in ADHF is independently associated with 1-year mortality. Importantly, compared to no AS, mild/moderate AS is independently associated with 1-year mortality in both LVEF subgroups (<50% and ≥50%) of the ADHF population. Thus, any AS severity in ADHF predicts unfavorable mortality outcomes. In this setting, we advocate for non-randomized investigations which may corroborate our work, and randomized trials evaluating the appropriateness of therapeutically targeting AS in patients who have experienced a decompensated HF hospitalization.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Non-standard Abbreviations and Acronyms:

ARIC	Atherosclerosis Risk in Communities
AS	aortic stenosis
HF	heart failure
ADHF	acute decompensated heart failure
LVEF	left ventricular ejection fraction
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
EHFS II	EuroHeart Failure Survey II
AVR	aortic valve replacement
TAVR	transcatheter aortic valve replacement
TIA	transient ischemic attack

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Clinical Perspective:

What is new?

This novel study describes the prevalence and prognostic significance of aortic stenosis (AS) in acute decompensated heart failure (ADHF) patients stratified by left ventricular ejection fraction (LVEF). We highlight the following important findings:

- AS prevalence by subgroup was: LVEF <50%, 12.1%; LVEF ≥50%, 18.7%. The prevalence of AS increased with age and varied by sex and race.
- Higher AS severity was associated with 1-year mortality in both LVEF subgroups.
- Sensitivity analyses excluding severe AS were investigated. Here, mild/moderate AS, compared to no AS, was independently associated with 1-year mortality in all ADHF patients, regardless of LVEF.

What are the clinical implications?

Our study shows that AS is prevalent in ADHF patients, with variation by sex and race. Among those who have experienced a hospitalization for decompensated heart failure, higher AS severity is associated with increased mortality at 1-year after admission. Importantly, we highlight that even mild/moderate AS, compared to no AS, is independently associated with 1-year mortality in this high-risk population.

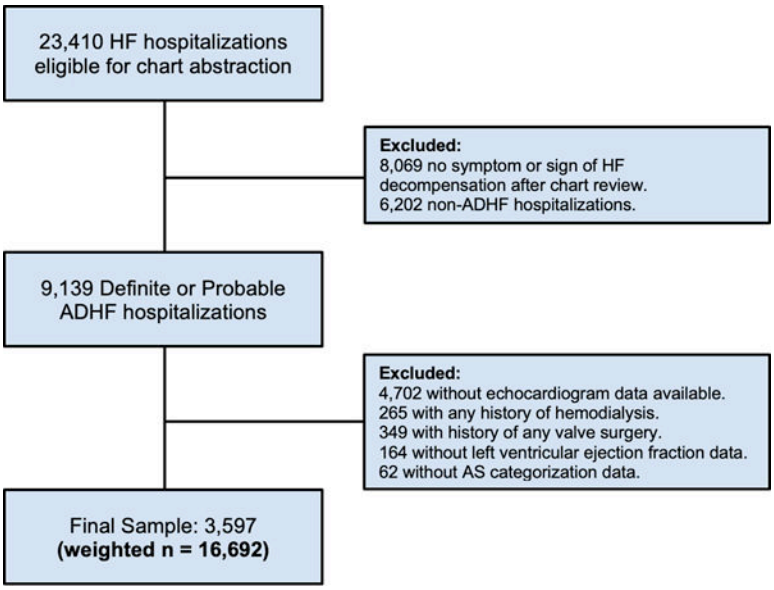

Figure 1: Flow Diagram of Eligible Hospitalizations and the Final Study Sample

A total of 23,410 HF hospitalizations were eligible for chart abstraction in the ARIC HF Community Surveillance Study. Of these, 9,139 were abstracted as definite or probable ADHF hospitalizations. For the purpose of this study, data from 3,497 (weighted n=16,692) of these hospitalizations was investigated after exclusion criteria were applied. All values are unweighted unless otherwise indicated.

ADHF = acute decompensated heart failure; ARIC = Atherosclerosis Risk in Communities; AS = aortic stenosis; HF = heart failure.

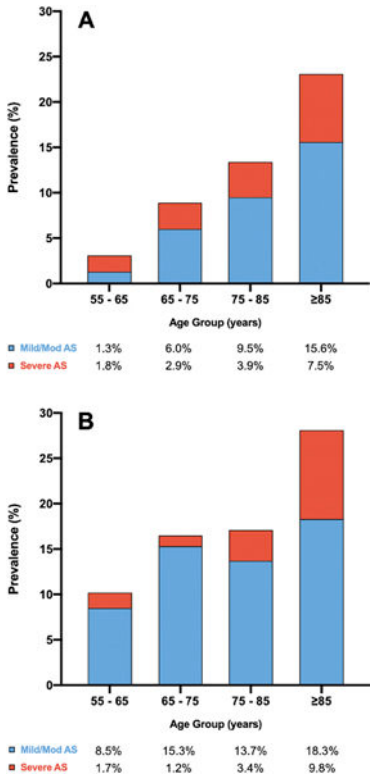

Figure 2: Prevalence of Aortic Stenosis in Patients Admitted for Heart Failure

Figure 2 (A) depicts ADHF patients with an LVEF <50%, and Figure 2 (B) ADHF patients with LVEF ≥50%. The prevalence of AS progressively increased with age, and was highest in those ≥85 years in both LVEF subgroups.

ADHF = acute decompensated heart failure; AS = aortic stenosis; LVEF = left ventricular ejection fraction.

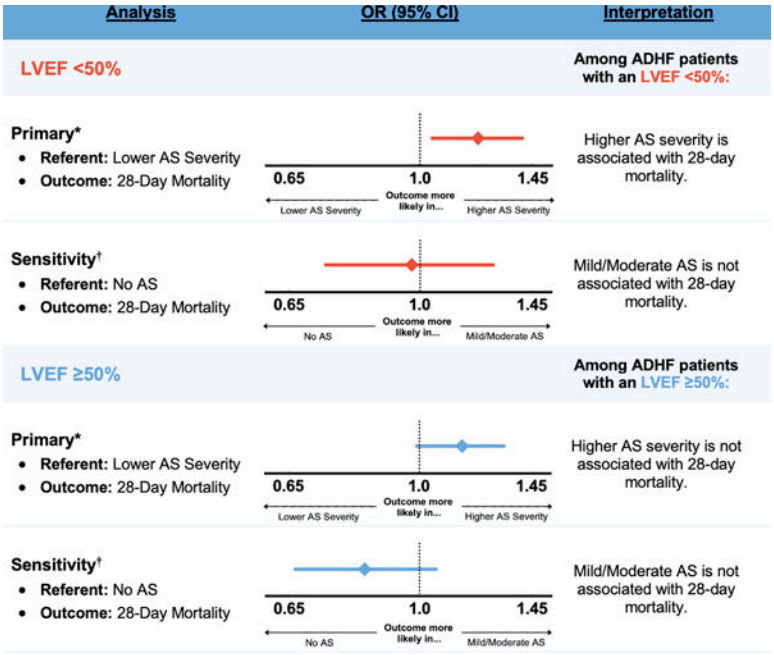

Figure 3: 28-Day Mortality in Acute Heart Failure Patients with Aortic Stenosis

Models were stratified by LVEF (<50% and ≥50%) and adjusted for age, sex, race, diabetes mellitus, hypertension, tobacco smoking, atrial fibrillation, coronary artery disease, TIA/stroke, anemia, worst in-hospital blood urea nitrogen, admission systolic blood pressure, and LVEF (omitted in LVEF ≥50% models).

*Primary analyses investigated the association between higher AS severity and all-cause 28-day mortality. Higher AS severity was only associated with 28-day mortality in those with an LVEF <50%.

†Sensitivity analyses excluded severe AS patients to investigate the association between mild/moderate AS (vs. no AS) and 28-day mortality. Mild/moderate AS was not associated with 28-day mortality in either LVEF subgroup.

ADHF = acute decompensated heart failure; AS = aortic stenosis; CI = confidence interval; LVEF = left ventricular ejection fraction; OR = odds ratio; TIA = transient ischemic attack.

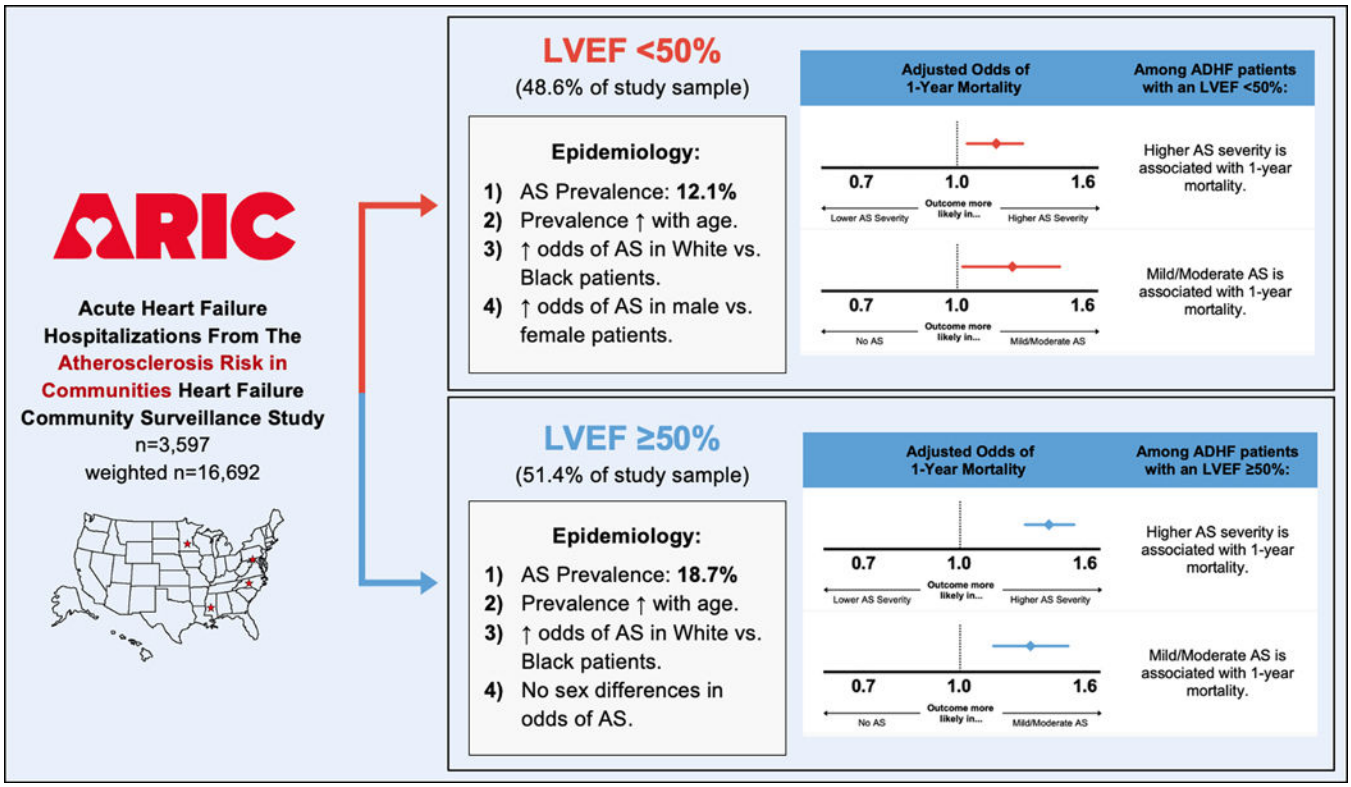

Figure 4: Epidemiology and 1-Year Mortality in Acute Heart Failure Patients with Aortic Stenosis

Models were stratified by LVEF (<550% and ≥50%) and adjusted for age, sex, race, diabetes mellitus, hypertension, tobacco smoking, atrial fibrillation, coronary artery disease, TIA/stroke, anemia, worst in-hospital blood urea nitrogen, admission systolic blood pressure, and LVEF (omitted in LVEF ≥50% models). Primary analyses investigated the association between higher AS severity and all-cause 1-year mortality. Higher AS severity was associated with 1-year mortality in both LVEF subgroups. Sensitivity analyses excluded severe AS patients to investigate the association between mild/moderate AS (vs. no AS) and 1-year mortality. Mild/moderate AS was associated with 1-year mortality in both LVEF subgroups.

ADHF = acute decompensated heart failure; AS = aortic stenosis; LVEF = left ventricular ejection fraction; TIA = transient ischemic attack.

Table 1.

Demographics and Clinical Characteristics of Patients Hospitalized for Acute Decompensated Heart Failure

	LVEF <50% (weighted n = 8113)			LVEF ≥50% (weighted n = 8579)		
	No AS (n = 7136)	**Mild / Moderate AS (n = 657)**	**Severe AS (n = 320)**	**No AS (n = 6978)**	**Mild / Moderate AS (n = 1237)**	**Severe AS (n = 364)**
Demographics						
Age, years	73.5 ± 11.0	80.5 ± 9.0	80.5 ± 10.3	75.4 ± 10.7	79.2 ± 10.2	83.7 ± 9.8
Female	3253 (45.6%)	277 (42.2%)	142 (44.5%)	4604 (66.0%)	820 (66.3%)	273 (75.1%)
Black	2528 (36.8%)	80 (12.4%)	41 (13.1%)	1902 (28.5%)	208 (17.0%)	29 (8.0%)
Medical History						
Diabetes mellitus	3294 (46.2%)	314 (47.9%)	125 (38.9%)	3301 (47.4%)	603 (48.7%)	112 (30.7%)
Hypertension	6016 (84.3%)	580 (88.4%)	260 (81.2%)	6040 (86.6%)	1138 (92.0%)	318 (87.4%)
Atrial fibrillation	3175 (44.5%)	345 (52.5%)	158 (49.5%)	3486 (50.0%)	567 (45.8%)	199 (54.7%)
Coronary artery disease	4573 (64.1%)	514 (78.3%)	225 (70.2%)	3565 (51.1%)	637 (51.5%)	210 (57.7%)
Tobacco smoking	1194 (16.7%)	82 (12.5%)	33 (10.2%)	788 (11.3%)	130 (10.5%)	34 (9.3%)
Anemia	113 (1.6%)	13 (1.9%)	0 (0.0%)	106 (1.5%)	8 (0.6%)	5 (1.3%)
TIA/Stroke	1313 (18.4%)	128 (19.5%)	100 (31.4%)	1341 (19.2%)	239 (19.3%)	60 (16.6%)
Labs and Vitals						
Worst in-hospital blood urea nitrogen, mg/dl	41.0 ± 25.7	43.7 ± 24.6	43.4 ± 22.5	39.7 ± 23.6	40.5 ± 24.3	35.7 ± 18.0
Systolic blood pressure on admission, mm Hg	142.4 ± 34.4	140.8 ± 31.3	131.2 ± 27.8	148.1 ± 33.7	148.8 ± 33.6	138.2 ± 31.1

Values are n (%) or mean ± SD.

AS = aortic stenosis; LVEF = left ventricular ejection fraction; SD = standard deviation; TIA = transient ischemic attack.

Table 2.

28-Day and 1-Year All-Cause Mortality in Patients Hospitalized for Acute Decompensated Heart Failure

	LVEF <50% (weighted n = 8113)			LVEF ≥50% (weighted n = 8579)		
AS Severity	**No AS (n = 7136)**	**Mild / Moderate AS (n = 657)**	**Severe AS (n = 320)**	**No AS (n = 6978)**	**Mild / Moderate AS (n = 1237)**	**Severe AS (n = 364)**
28-Day Mortality	745 (10.4%)	75 (11.4%)	56 (17.5%)	593 (8.5%)	113 (9.2%)	56 (15.3%)
1-Year Mortality	2177 (30.5%)	252 (38.4%)	126 (39.4%)	1814 (26.0%)	409 (33.1%)	159 (43.7%)

AS = aortic stenosis; LVEF = left ventricular ejection fraction.