

Incremental Burden of Type 2 Diabetes Mellitus in Patients Hospitalized for Heart Failure

Aditya D. Raju¹, Anna D. Coutinho¹, Weijia Wang², Sharash Shetty², Stephen D. Sander², Craig I. Coleman³
¹Xcenda, LLC, Palm Harbor, FL, USA; ²Boehringer Ingelheim Pharmaceuticals, Inc., Ridgefield, CT, USA; ³University of Connecticut, Storrs, CT, USA

BACKGROUND

- Heart failure (HF) is a cardiovascular disease (CVD) that affects an estimated 5.7 million adults aged ≥20 years and was the underlying cause of 65,120 deaths in the United States (US) in 2013.^{1,2}
- Type 2 diabetes mellitus (T2DM) is a known prognostic factor for HF and is associated with a 2-fold increased adjusted risk of an incident HF event, and a 25% increase in total lifetime costs for HF.^{3,4}
- The post-discharge morbidity and mortality burden of hospitalized HF patients can be substantial; hence, it is important to quantify the impact of T2DM on healthcare resource utilization (HCRU) and costs following discharge from a HF hospitalization.

STUDY OBJECTIVES

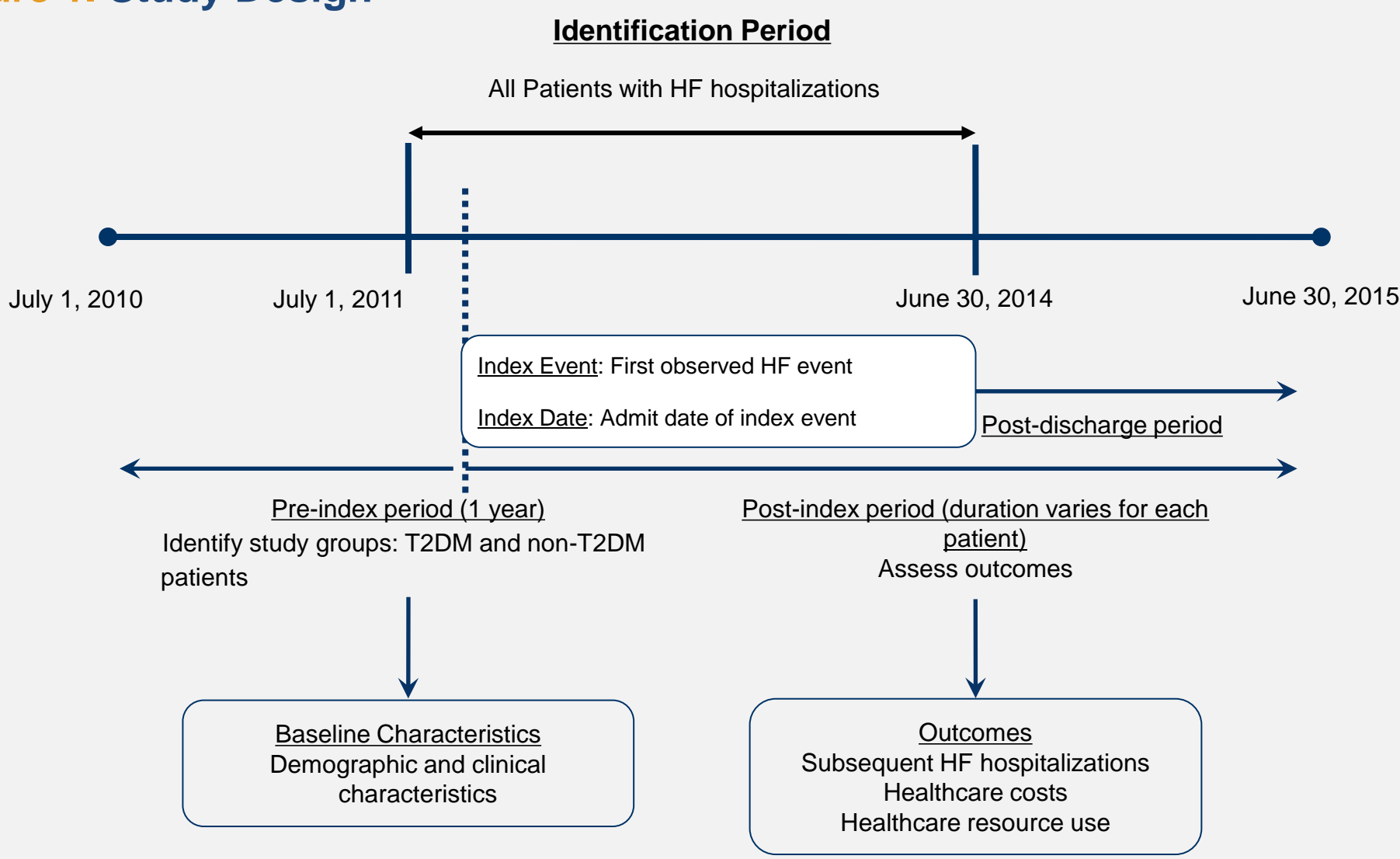
- To evaluate and compare the economic burden in patients hospitalized for HF between those with and without T2DM.

METHODS

Data Source and Study Design

- National commercial claims database (IMS LifeLink PharMetrics Plus™)
- Retrospective cohort study
- Index HF hospitalization: First observed HF event during the period of July 1, 2011–June 30, 2014. (Figure 1)

Figure 1. Study Design



Sample/Population Selection

- Target population: Patients with HF hospitalizations, defined as a hospitalization with a primary discharge diagnosis for HF (International Classification of Diseases [ICD]-9 codes: 428.xx, 402.x1, 404.x1, 404.x3)
- Inclusion:
 - ≥18 years of age at index date
 - Continuous health plan enrollment during the pre-index period
- Exclusion:
 - Diagnosis of pregnancy, gestational diabetes, secondary diabetes, or type 1 diabetes mellitus anytime during the pre-index or post-index period
 - Missing demographic information (eg, age, gender, geographic region)

Definition

- T2DM
 - ≥1 hospitalization with a diagnosis of T2DM in any diagnosis field OR
 - ≥2 medical claims at least 30 days apart within 12 months in the outpatient setting, except lab and radiology, with a diagnosis of T2DM in any diagnosis field OR
 - ≥1 pharmacy claim indicated for T2DM, including a) a non-insulin injectable, or b) an oral antidiabetic agent, except metformin, or c) metformin pharmacy claim without a diagnosis code for pre-diabetes or polycystic ovary syndrome⁵

Study Outcomes

- All patients were included for analysis of outcomes from the index HF hospitalization, but only those surviving the index HF hospitalization were analyzed for outcomes during the variable post-discharge period.
- Risk of subsequent HF hospitalizations
- HCRU
 - All-cause and HF-related length of stay per hospitalization, and bed-days per patient
 - Number of all-cause and HF-related visits by setting of care (reported per patient per month)
- Healthcare costs (medical and pharmacy) in 2015 United States dollars (USD)
 - Computed using paid amounts on claims
 - All-cause and HF-related costs (reported per patient per month)
- HF-related HCRU and costs were identified as medical claims with a primary diagnosis of HF, and prescription claims for HF-related drugs
- Due to variable follow-up for each patient, outcomes were reported per patient per month (where applicable) by summing them over each patient's duration of follow-up, dividing by their days of follow-up, and multiplying by 30.

METHODS (contd.)

Statistical Analysis

- Baseline characteristics were evaluated using t-tests for continuous variables and chi-square tests for categorical variables.
- Risk of subsequent HF hospitalizations was evaluated using Cox proportional hazards models.
- Costs and resource use were evaluated using generalized linear models with gamma and negative-binomial distributions, respectively.
- All outcomes were assessed for T2DM vs non-T2DM patients; and multivariable models for all outcomes controlled for the following covariates measured during the pre-index period: age; gender; geographic region; payer and plan type; index year; revascularization procedure; HF, myocardial infarction, or stroke events; type of CVD condition; Charlson comorbidity index; and other CVD risk factors.
- Statistical analyses were conducted using SAS® version 9.2 (SAS Institute; Cary, NC, USA).

RESULTS

Sample Characteristics

- 40,066 patients met study criteria, 35% of whom had T2DM.
- Mean age of the total sample was 68.5 ±13.1 years, and more than half (58%) were male. (Table 1)
- T2DM patients had higher comorbidity burden vs non-T2DM patients.
- T2DM patients had a higher number of CVD conditions; where, after HF, arrhythmia was the most prevalent condition.
- 1.6% of the patients died during the index HF hospitalization (the same proportion in both groups); hence, post-discharge outcomes were assessed among the remaining 39,441 patients.

Table 1. Pre-index Characteristics of Patients Experiencing HF Hospitalizations

Characteristics During the Pre-index Period	T2DM Patients N=13,966	Non-T2DM Patients N=26,100	P-value
Age at index (in years)			
Mean (SD)	68.9 (11.3)	68.2 (14.0)	<.0001
Male, n (%)	8,380 (60.0%)	14,653 (56.1%)	<.0001
Geographic region, n (%)			
Northeast	3,550 (25.4%)	7,031 (26.9%)	0.0052
Midwest	4,547 (32.6%)	8,330 (31.9%)	
South	4,516 (32.3%)	8,364 (32.0%)	
West	1,353 (9.7%)	2,375 (9.1%)	
Payer type, n (%)			
Commercial	6,342 (45.4%)	12,450 (47.7%)	<.0001
Medicaid/State Children's Health Insurance Program	2,059 (14.7%)	3,911 (15.0%)	
Medicare	231 (1.7%)	349 (1.3%)	
Self-insured	5,169 (37.0%)	9,131 (35.0%)	
Unknown/Other ^a	165 (1.2%)	259 (1.0%)	
Charlson comorbidity index, ^b mean (SD)	3.1 (2.3)	2.5 (2.3)	<.0001
Type of CVD, n (%)			
Angina (pectoris or unstable)	1,731 (12.4%)	2,149 (8.2%)	<.0001
Arrhythmias	7,384 (52.9%)	13,143 (50.4%)	<.0001
Arterial thrombosis and embolism	223 (1.6%)	306 (1.2%)	0.0004
Atherosclerosis and other ischemic heart disease	8,179 (58.6%)	11,362 (43.5%)	<.0001
Cardiac arrest	169 (1.2%)	249 (1.0%)	0.0162
Cardiomyopathy	3,804 (27.2%)	6,266 (24.0%)	<.0001
Conduction disorders	2,041 (14.6%)	3,394 (13.0%)	<.0001
Endocarditis, pericarditis, myocarditis	4,467 (32.0%)	8,302 (31.8%)	0.7181
Heart failure	8,941 (64.0%)	14,123 (54.1%)	<.0001
Myocardial infarction	3,790 (27.1%)	4,905 (18.8%)	<.0001
Other heart disease	3,000 (21.5%)	4,834 (18.5%)	<.0001
Peripheral vascular disease	2,193 (15.7%)	2,967 (11.4%)	<.0001
Rheumatic heart disease and fever	1,361 (9.7%)	2,782 (10.7%)	0.0042
Stroke	2,920 (20.9%)	4,237 (16.2%)	<.0001
Number of CVD conditions, mean (SD)	3.9 (2.8)	3.3 (2.7)	<.0001
Revascularization procedures, n (%)	3,318 (23.8%)	4,174 (16.0%)	<.0001
Presence of CVD risk factors, n (%)			
Dyslipidemia	12,157 (87.0%)	17,996 (69.0%)	<.0001
Hypertension	10,713 (76.7%)	13,005 (49.8%)	<.0001
Obesity	2,201 (15.8%)	1,915 (7.3%)	<.0001

Key: CVD – cardiovascular disease; HF – heart failure; SD – standard deviation; T2DM – type 2 diabetes mellitus.
^aSelf-insured, Unknown/Missing; ^bExcludes diagnoses of T2DM

Study Outcomes

Figure 2. Risk of Subsequent HF Hospitalization among Patients with and without T2DM

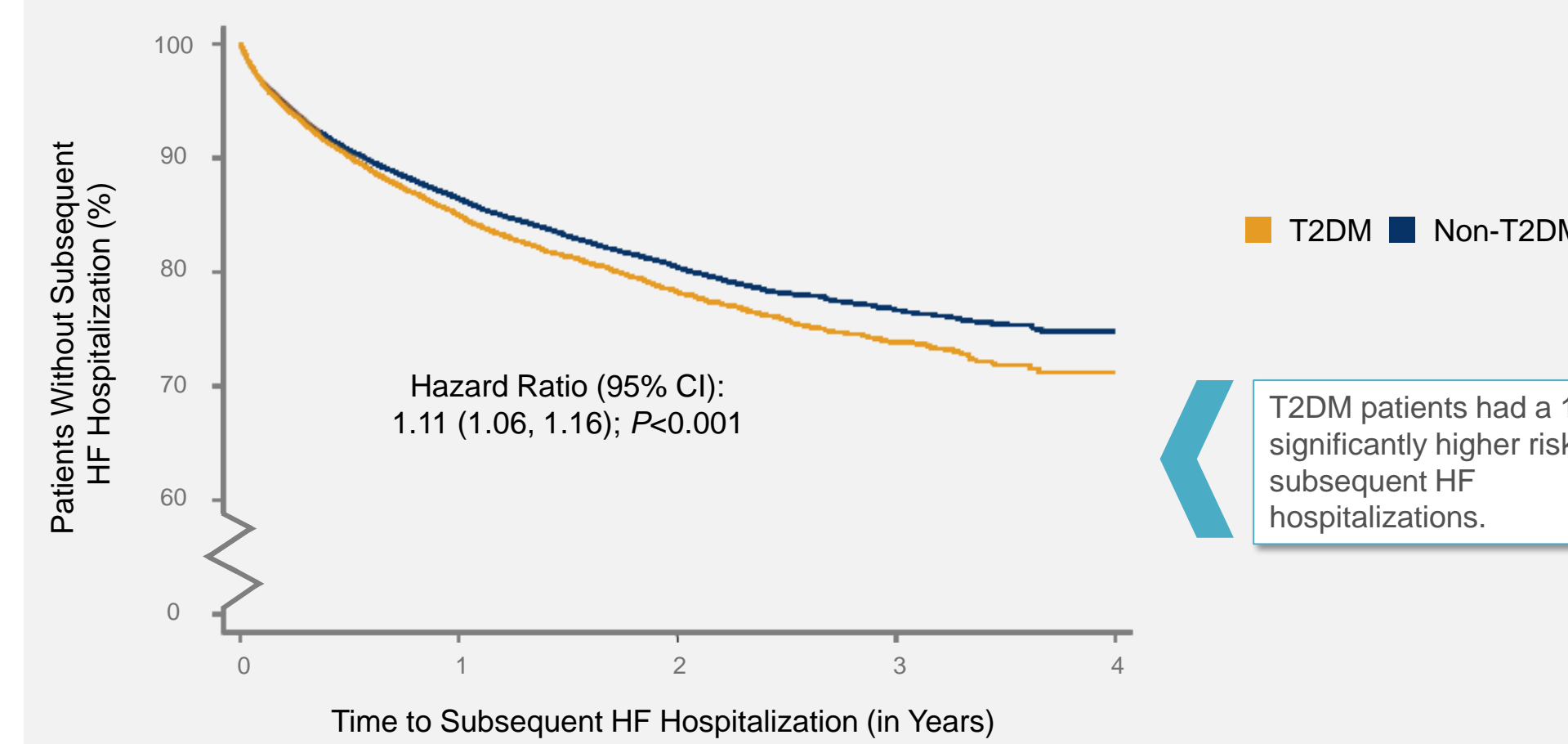
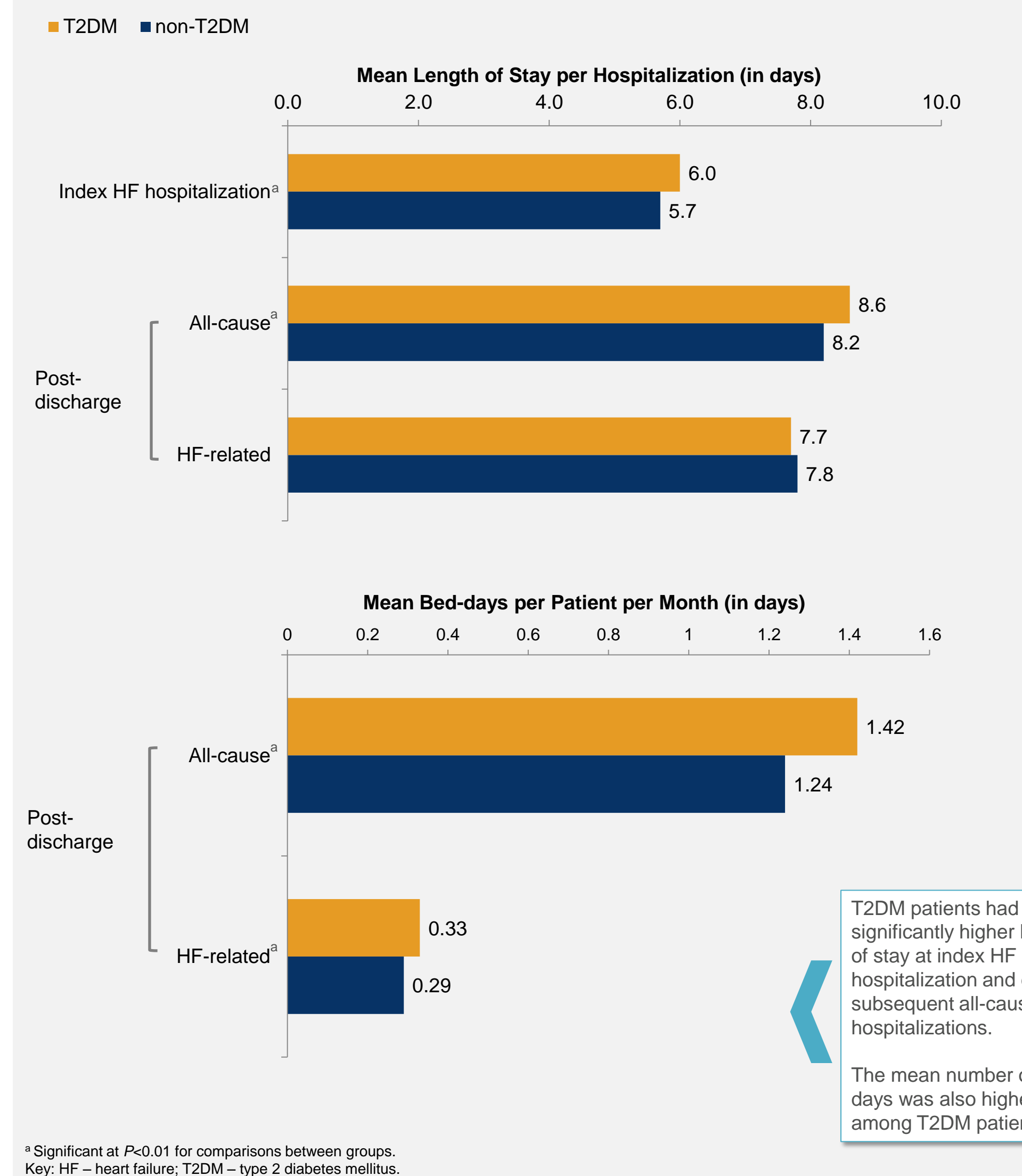
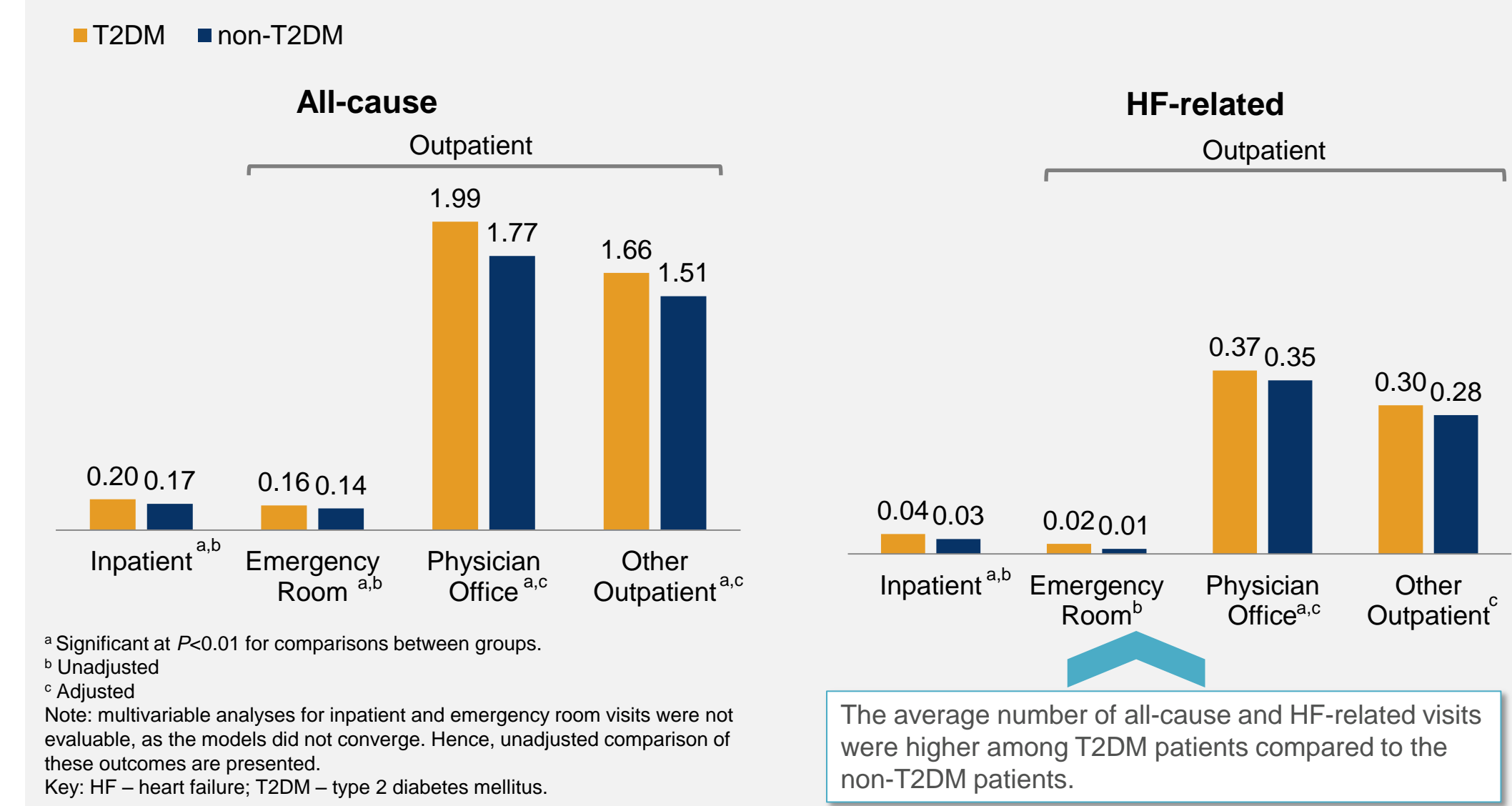


Figure 3. Adjusted Mean Length of Stay and Bed-days



^a Significant at P<0.01 for comparisons between groups.
 Key: HF – heart failure; T2DM – type 2 diabetes mellitus.

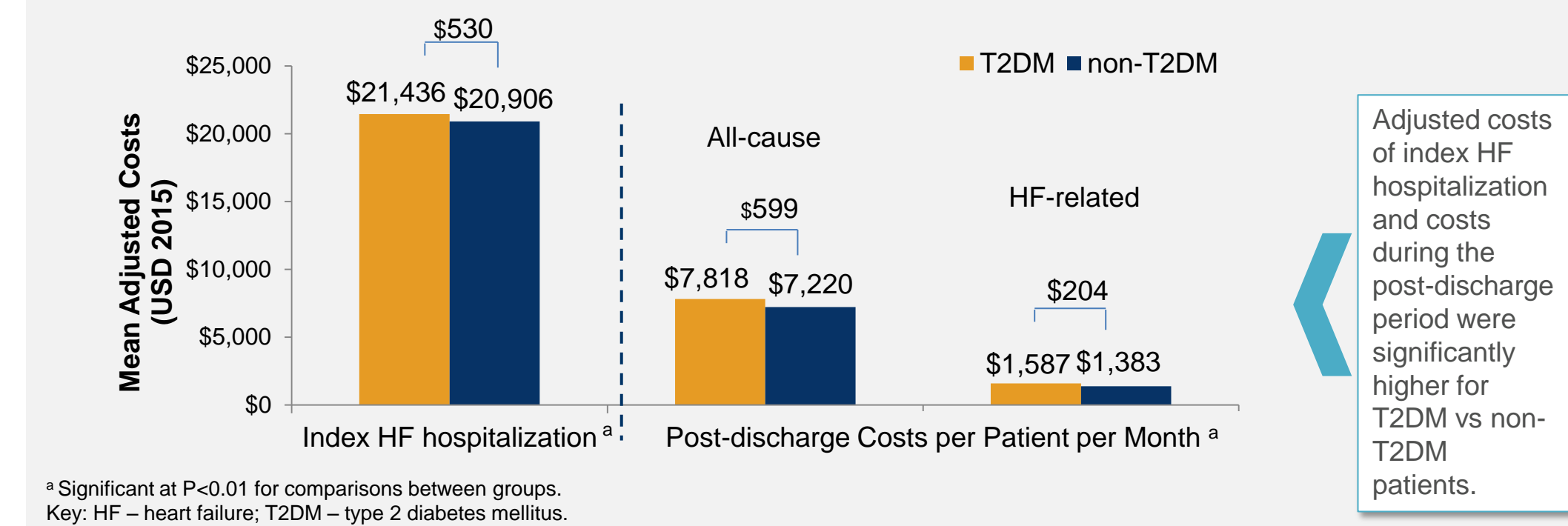
Figure 4. Number of Healthcare Visits, per Patient per Month by Setting of Care



^a Significant at P<0.01 for comparisons between groups.
^b Unadjusted
^c Adjusted
 Note: multivariable analyses for inpatient and emergency room visits were not evaluable, as the models did not converge. Hence, unadjusted comparison of these outcomes are presented.
 Key: HF – heart failure; T2DM – type 2 diabetes mellitus.

The average number of all-cause and HF-related visits were higher among T2DM patients compared to the non-T2DM patients.

Figure 5. Adjusted Healthcare Costs During the Index Hospitalization and Post-discharge Period



^a Significant at P<0.01 for comparisons between groups.
 Key: HF – heart failure; T2DM – type 2 diabetes mellitus.

Adjusted costs of index HF hospitalization and costs during the post-discharge period were significantly higher for T2DM vs non-T2DM patients.

LIMITATIONS

- Results may be confounded by missing some important HF risk factors, such as socioeconomic status, smoking status and obesity (likely under-coded in claims data).
- Since this study had variable follow-up time and censored patients in the event of death, disenrollment, or the end of available data, complete cost data was not available for all patients for estimating total healthcare resource utilization and costs between groups.
- Results of the analysis are primarily generalizable to a commercially insured population, which made up approximately 90% of the sample.

CONCLUSION

- Comorbid T2DM was associated with higher costs for a HF hospitalization, increased risk of subsequent HF hospitalizations, and higher post-discharge costs and healthcare resource use.

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