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Characterization of Patients with Type 2 Diabetes Admitted for Acute Heart Failure During the COVID-19 Pandemic

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ABSTRACT

Background: Cardiomyopathy (CMP) and heart failure (HF) are serious health conditions that impact millions of Americans, including people with Type 2 Diabetes (T2DM). The COVID-19 pandemic presented disruptions, yet it is unclear how it affected those living with T2DM and HF. This study aimed to describe the demographic and clinical characteristics of patients with T2DM and CMP who were hospitalized with acute heart failure (aHF) during the COVID-19 pandemic.

Methods: Retrospective study of 288 adults with aHF between May 2020 to June 2021. Descriptive statistics were used to summarize the characteristics of adults hospitalized at a non-profit community hospital in Miami, Florida.

Results: Fifty-two percent ($n = 150$) of the patients had T2DM, 98% were admitted via the Emergency Department, the average age was 73.4 (± 14.5) years, 56% were male, 65% were White Hispanic, 20% were White, and 14% were non-Hispanic Black. Ischemic CMP (38%) and diastolic HF (26%) were prevalent in this sample. Patients with T2DM were more likely to be discharged home with home health care (45%) compared to those without T2DM (35%). The home medications reported by the patients included: diuretics (73%), beta-blockers (71%), statins or other agents (65%), Angiotensin-II Receptor Blockers (41%), antiglycemics (39%), calcium channel blockers (27%), and ACE inhibitors (13.7%).

Conclusion: This study sheds light on the demographic factors in adults living with CMP, HF, and T2DM during the COVID-19 Pandemic. The prevalence of T2DM, ischemic CMP, and diastolic HF, especially among Hispanics, warrants further research to guide interventions to improve the treatment of these conditions in ethnic minorities.

Keywords: Cardiomyopathy, Heart Failure, Hispanics, Type 2 Diabetes, Acute Heart Failure, COVID-19

INTRODUCTION

Acute heart failure (aHF) remains a serious public health problem, detrimental to the health and lifestyle of adults. It is caused by the inability of the heart to pump effectively because of cardiomyopathy (CMP) or weakening and stiffness of the heart muscle (Nair,

2020). Approximately 6.5 million adults in the United States suffer from heart failure (HF), and its prevalence continues to rise (Nair, 2020). One in eight die from HF-related complications in the U.S. (Tsao et al., 2022). In response to these high statistics, it has become a national goal to reduce HF hospitalizations in adults

through better prevention and treatment as part of the Healthy People 2030 initiative (U.S. Department of Health and Human Services, 2023).

The pathophysiology of aHF is complex, resulting in pulmonary congestion, systemic congestion, and organ dysfunction (Arrigo et al., 2020). Patients tend to report to the Emergency Department (ED) when they are in aHF. Common symptoms include hypotension, hypoxemia, hyponatremia, elevated brain natriuretic peptide, and increased troponin and creatinine levels (Rider et al., 2021). Patients with aHF report high mortality and hospital readmission rates. National estimates indicate there are 676,000 ED visits and one million hospitalizations for aHF syndrome, with an estimated direct cost of \$31 billion annually (Hasegawa et al., 2014). Current treatment for aHF targets symptom management, and the goal is to achieve optimal hemodynamic status for these patients (Yancy et al., 2013). Results from controlled trials have demonstrated the effectiveness of diuretic drugs in increasing urinary sodium excretion, decreasing signs of fluid retention, and improving symptoms and exercise tolerance in patients with HF (Yancy et al., 2013). However, the utilization of these drug regimens remains understudied in ethnic minorities.

There are ethnic disparities in the prevalence of CMP and HF. Recent statistics show increasing rates of cardiovascular disease and T2DM among Hispanics. From 2015 to 2018, Hispanic men (52%) and women (43%) aged 20 years and older had cardiovascular disease (American Heart Association, 2021). Hispanics represent the largest minority in the United States, with higher rates of T2DM (80%) than non-Hispanic Whites and Blacks (Aguayo-Mazzucato et al., 2019). About 4.9 million African American adults in the United States who are 20 years of age or older have diagnosed or undiagnosed diabetes (Chow et al., 2012). Hispanics and Blacks with T2DM

face long-term consequences, including albuminuria, retinopathy, HF, and worse glycemic control compared to non-Hispanic Whites (Haw et al., 2021). Moreover, it is predicted that one in three U.S. residents will be Hispanic by the year 2050, accounting for 16.3% (50.5 million) of the total U.S. population (Iglesias-Rios & Parascandola, 2013). Hence, there is a need to address the impact of these conditions, especially on Hispanics, who experience growing disparities in access to care and use of healthcare services compared to other racial and ethnic groups (Chin et al., 2011).

Despite these findings, there is a paucity of large-scale HF studies that include diagnosis, risk factors, and management in ethnic minority groups (Piña & Ventura, 2014). The research is especially lacking relative to Hispanic populations according to their region of residence. Those residing in the southern United States may present with different symptoms and health care needs than those in other regions. There is also conflicting information on the incidence of HF. Data suggests that the incidence of HF is mostly flat or declining. However, the burden of mortality and hospitalization remains unabated despite ongoing efforts to treat and manage HF (Roger, 2021). A knowledge gap exists among Black patients, resulting in a lack of awareness of screening services for comorbidities, including HF and CMP (Piette et al., 2006).

From 2019 through 2021, the U.S. healthcare system was strained by the effects of the COVID-19 pandemic. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic was declared in March 2020 and affected more than 220 countries worldwide by August 2021. Patients hospitalized with COVID-19 were older, Black males diagnosed with T2DM, elevated body mass index, and elevated inflammatory markers correlated with critical illness (Hehar et al., 2022). Blacks, Hispanics, and Native Americans were at increased

odds of inpatient mortality from diabetes, chronic kidney disease, HF, arrhythmias, obesity, and coagulopathy because of the COVID-19 infection (Isath et al., 2023).

Knowledge remains lacking in the presentation and characteristics of patients who sought care for aHF, especially in ethnically diverse populations during the pandemic. Understanding the medication regimen for these patients before hospitalization for aHF is necessary. There are gaps in understanding these factors in patients with and without T2DM. To address these research gaps, this study aimed to explore characteristics and demographic factors in patients with T2DM and CMP hospitalized with aHF in a community hospital in Miami, Florida. We also aimed to study the differences in characteristics between T2DM and non-T2DM adults with HF and CMP. Findings from this study will help guide the development of specific strategies to support patients with CMP and T2DM, particularly those presenting with aHF in hospital settings.

METHODS

Design, Sample, and Setting

The design was a single-center, retrospective record review. A random sample of 300 charts was chosen from the electronic medical records of patients hospitalized at a large acute care community hospital in Miami, Florida, from May 2020 to June 2021. After applying the exclusion criteria, 288 records were included in the study. The inclusion criteria were: (a) patients aged 18 years or older, (b) admitted to the hospital with a diagnosis of aHF or CMP, and (c) T2DM. Cases were identified and classified according to the International Classification of Diseases tenth revision (ICD-10) code. The exclusion criteria included (a) women who were pregnant, (b) prisoners, or (c) incapacitated adults. The study was reviewed and determined to have exempt status by the hospital's Institutional Review Board.

Data Collection Procedures

Data were queried from the electronic health record. The data files included patient demographics (age, gender, ethnicity, length of stay in days, mode of admission, and discharge disposition—whether “home” or “home with home health”). We also collected information on home medication use from the admission and medication reconciliation history. These medications were then classified into diuretics, beta-blockers, anticoagulants, antiglycemics, Angiotensin-II Receptor Blockers (ARBs), calcium channel blockers, Angiotensin-Converting Enzyme (ACE) inhibitors, aspirin, and statins or other cholesterol agents. Other medical diagnoses were collected from the problem list: hyperlipidemia, T2DM, CMP type, hypertension, atrial fibrillation, coronary artery disease (CAD), and suspected exposure to COVID-19. Data were de-identified before analysis.

Data Analysis

Descriptive statistics were used to summarize the sample demographic and characteristics. Chi-square tests were used to analyze the differences between patients with and without T2DM for the categorical variables (gender, ethnicity, concomitant disease states, and home medication therapies). *T*-test analyses were performed for continuous variables (length of stay and age). The level of statistical significance was defined as $p < .05$. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N. Y., USA).

RESULTS

Sample Characteristics

The demographic characteristics of this sample are presented in Table 1. Most of the patients were male (56%), with a mean age of 73 years (range: 28-101 years). The majority of the sample were Hispanic Whites (65%), followed by Whites (20%) and non-Hispanic Blacks (14%). Most of the patients were admit-

Table 1

Demographic Characteristics of Heart Failure Sample by Type 2 Diabetic Status

Characteristics	Total (n = 288) n (%)	T2DM (n = 150, 52%) n (%)	Non-T2DM (n = 138, 48%) n (%)	p value
Age				
Mean, SD	73.4 (14.5)	72.7 (12.1)	74.2 (16.8)	.39
Min, Max	28, 101			
Gender				
Female	125 (44)	66 (44)	59 (43)	.90
Male	163 (56)	84 (56)	79 (57)	
Race				
White Hispanic	186 (65)	102 (68)	84 (61)	.06
White	57 (20)	22 (15)	35 (25)	
Non-Hispanic Black	41 (14)	25 (17)	16 (12)	
Other Race	4 (1)	1 (1)	3 (2)	
Hospital Days				
Mean (SD)	10.3 (12.6)	10.8 (11.8)	9.3 (10.1)	.58
Range in days	1-124	1-77	1-36	
Hospital Service				
ED	284 (98)	150 (100)	134 (97)	.036
Discharge Disposition				
Home	121 (42)	68 (45)	53 (38)	.005
Home with home health	115 (40)	67 (45)	48 (35)	
Other	41 (14)	15 (10)	26 (19)	
Expired	11 (4)	0 (0)	11 (8)	

Note. n = number of participants; T2DM = Type 2 Diabetes Mellitus

ted via the ED (98%). Patients were discharged home (45%) and home with home health (45%) after these admissions. The remaining 10% of the sample were discharged to skilled nursing facilities or rehabilitation hospitals. Fifty-two percent of the patients had T2DM. Patients spent an average of 10.3 days in the hospital (SD = 12.6).

Table 2 provides a summary of common comorbidities in this sample. Ischemic CMP was prevalent in this sample (38%), followed by acute on chronic diastolic HF (26%). Concurrent comorbidities included hyperlipidemia (72%), CAD (68%), hypertension (51%), and atrial fibrillation (31%). Sixty-two percent of the sample had suspected exposure to COVID-19 and a diagnosis of respiratory

Table 2*Common Comorbidities by Type 2 Diabetic Status*

Diagnosis Description	Total (n = 288) n (%)	T2DM (n = 150, 52%) n (%)	Non-T2DM (n = 138, 48%) n (%)	p value
Heart Failure Types				.005
Acute on chronic diastolic	75 (26)	49 (33)	26 (19)	
Acute on chronic systolic	22 (8)	7 (5)	15 (11)	
Unspecified	47 (17)	15 (10)	32 (23)	
Cardiomyopathy Types				
Ischemic	108 (38)	64 (43)	44 (32)	
Other	36 (13)	15 (10)	21 (15)	
Comorbid diagnoses				
Atrial fibrillation	88 (31)	49 (33)	39 (29)	
CAD	193 (68)	112 (76)	81 (60)	
Neurological	37 (13)	17 (12)	20 (15)	
Hyperlipidemia	203 (72)	117 (79)	86 (63)	
Hypertension	144 (51)	68 (46)	76 (56)	
Kidney failure	46 (16)	27 (18)	19 (14)	
Respiratory failure	77 (27)	42 (29)	35 (12)	
COVID-19	175 (62)	91 (62)	84 (62)	

Note. n = number of participants; T2DM = Type 2 Diabetes Mellitus; COVID-19 = Coronavirus disease 2019

failure (27%). The home medications reported by the patients included: diuretics (73%), beta-blockers (71%), statins or other agents (65%), ARB agents (41%), antiglycemics (39%), calcium channel blockers (27%), and ACE inhibitors (13.7%). These are presented in Table 3.

There were interesting differences related to gender and ethnicity in this sample. Female patients spent more days in the hospital (1-117 days) than male patients (1-97 days). Patients with suspected exposure to COVID-19 spent 1 to 117 days in the hospital, contrary to those with no exposure to COVID-19 (range: 1-56 days). Furthermore, there were differences in the length of hospital

stay for the non-Hispanic Blacks (2-117 days) compared to their other counterparts. White patients spent 1 to 97 days in the hospital, and White Hispanic patients spent 1 to 51 days there. While not statistically significant, these results were clinically concerning and merit further exploration. There were significant differences in discharge disposition related to ethnicity. Non-Hispanic Black patients were discharged with home health the least (26.8%, $p = .04$). Figure 1 displays the sample distribution by CMP and HF according to ethnicity. Ischemic CMP and acute on chronic diastolic HF were prevalent in the three ethnic groups (White Hispanic, non-Hispanic Black, and White).

Table 3

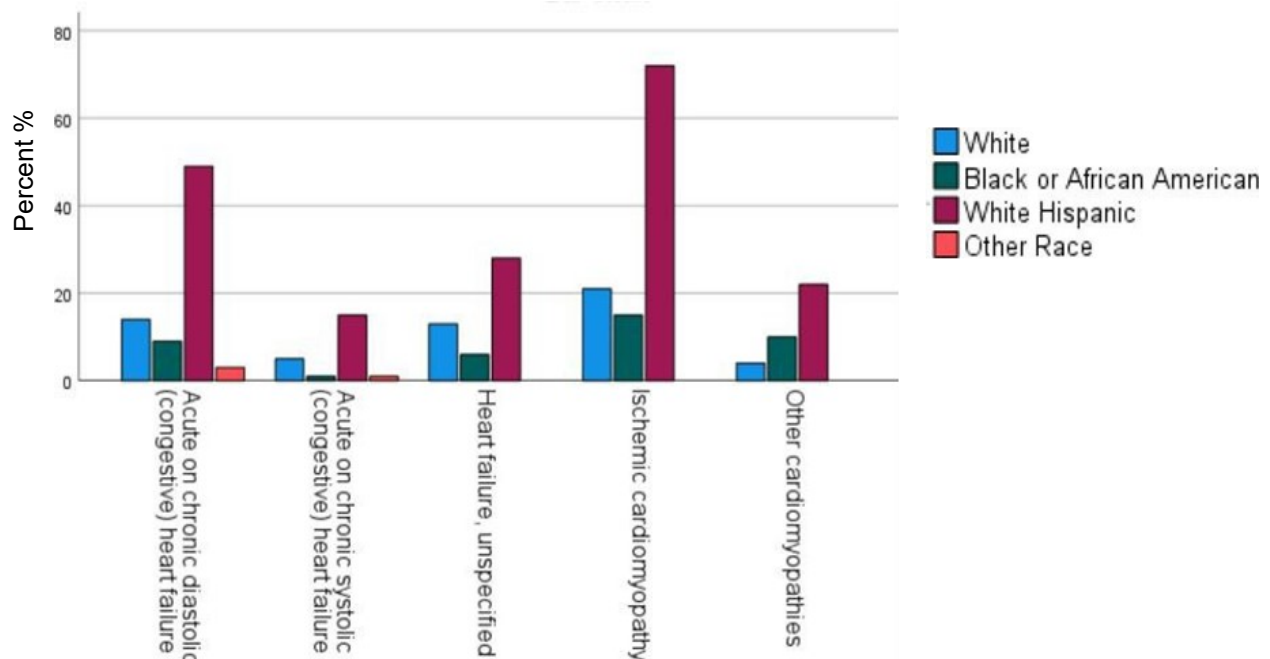
Home Medications Prior to ED Admission by Type 2 Diabetic Status

Medication Classification	Total (n = 284) n (%)	T2DM (n = 148) n (%)	Non-T2DM (n = 136) n (%)	p value
Classification				.005
ACEIs	39 (2.3)	27 (18)	12 (9)	
ARBs	115 (6.8)	61 (41)	54 (40)	
Aspirin	80 (4.7)	47 (32)	33 (24)	
Antiglycemics	112 (39.4)	89 (60)	0 (0)	
Antiarrhythmics	31 (1.8)	15 (10)	16 (12)	
Beta-blockers	202 (11.9)	125 (84)	84 (62)	
Calcium channel blockers	77 (4.6)	52 (35)	25 (18)	
Digoxin	15 (12.2)	10 (7)	5 (4)	
Diuretics	207 (12.2)	118 (80)	89 (65)	
Nitrates	40 (2.4)	29 (2.8)	11 (8)	
Statins or other agents	185 (11)	113 (76)	72 (53)	

Note. n = number of participants; T2DM = Type 2 Diabetes Mellitus; ACEIs = Angiotensin-Converting Enzyme Inhibitors; ARBs = Angiotensin receptor blockers

Figure 1

Distribution of Sample by CMP and HF According to Ethnicity



Characteristics of Patients with Diabetes

The prevalence of T2DM was the highest in Hispanics (68%), followed by non-Hispanic Blacks (17%) and Whites (15%) in this sample. The mean average age of patients with T2DM was 72 years old ($SD = 12.1$). Patients with T2DM experienced longer length of stay compared to those without T2DM. Their length of stay in the hospital ranged from 1 to 77 days compared to those without T2DM (1-36 days). However, this was not significant. Results are presented in Table 1. Ischemic CMP (43%) and diastolic HF (32%) were prevalent in the diabetic group. Gender differences were noted related to ischemic CMP. Ischemic CMP was prevalent in diabetic males (68%) and non-diabetic females (63%). Non-diabetic females and diabetic males had an average number of 9.7 hospital days ($SD = 12.9$). In the non-diabetic group, the prevalence of ischemic CMP was 32%, and diastolic HF was 19%. Results are presented in Table 2. Other comorbidities such as CAD (76%), hyperlipidemia (79%), exposure to COVID

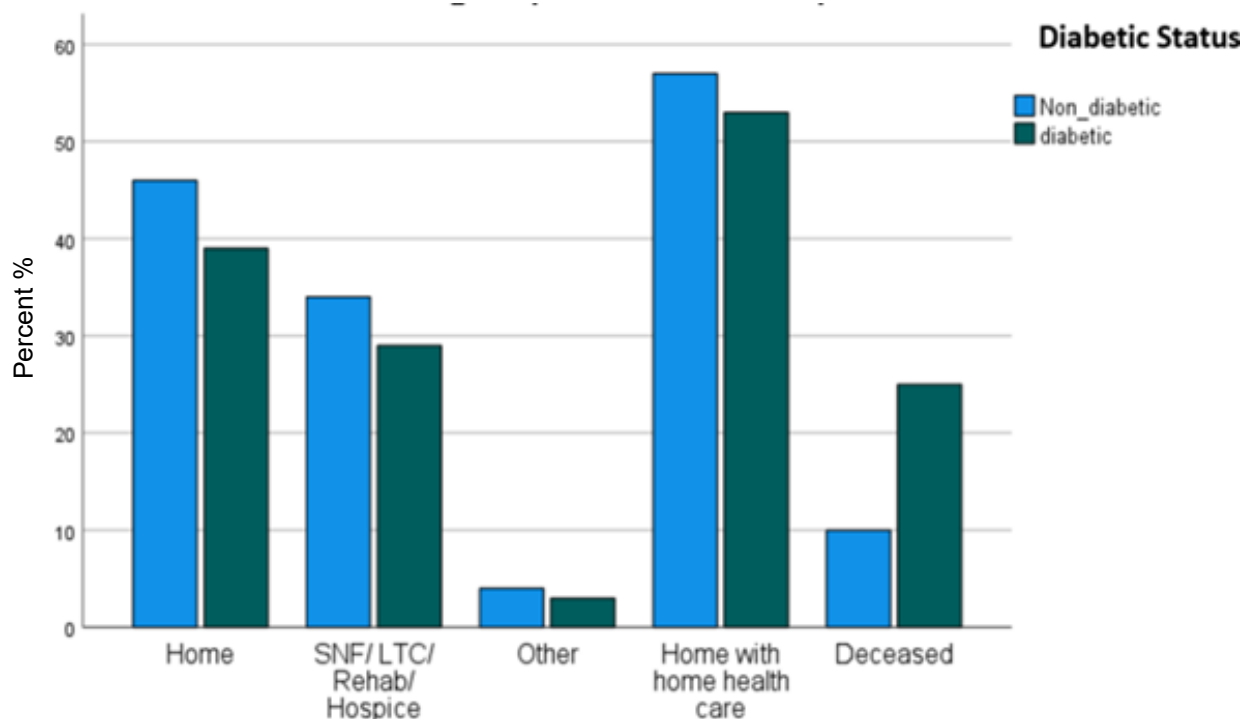
-19 (62%), and hypertension (46%) were also prevalent in the T2DM group. Approximately 50% of these patients were discharged home independently or with home health care regardless of having a T2DM diagnosis (Figure 2). For the T2DM patients, their home medication regimen included beta-blockers (84%), diuretics (80%), statins or others (76%), antiglycemics (60%), and ARB agents (41%). The antiglycemic agents represented a combination of oral agents ($n = 54$) and insulin ($n = 35$) in the diabetic group.

DISCUSSION

The results of our study indicate that there are important characteristics of patients admitted with aHF who require emergent care. The patients in this sample were over 70 years of age and had concomitant diagnoses, including hyperlipidemia, hypertension, CAD, and T2DM. These findings complement the existing literature on older patients experiencing the burden of multiple comorbidities. As

Figure 2

Distribution of Sample Discharge Disposition According to Type 2 Diabetic Status



patients with HF age, they are more likely to seek care through the ED (Long et al., 2019). Consistent with the literature, CMP, HF, and T2DM were prevalent in Hispanics and non-Hispanic Blacks in this sample. However, we would like to emphasize that the patients in this sample were Hispanic, representing the changing population in South Florida. Cardiomyopathy and HF were prevalent in over half of this sample. These findings are essential, mainly because the literature is limited on HF in Hispanics living in the United States (Piña et al., 2021).

Interestingly, females had higher rates of ischemic CMP and spent more days in the hospital. Future studies must explore factors associated with CMP and HF in women, especially among Hispanics. Another critical factor in this study was the period the data was queried. The SARS-CoV-2 infection was declared a pandemic in March 2020 and affected more than 220 countries worldwide by August 2021. Some reports suggest a link between the SARS-CoV-2 infection and an increased incidence of new-onset heart disease and diabetes with the new delta variant wave (Hebbard et al., 2021). This is concerning because patients with pre-existing HF diagnosed with COVID-19 face a two-fold increased mortality rate when compared to COVID-19 patients without prior HF history (Standl & Schnell, 2021). Moreover, based on biomarker and imaging findings, a widespread endothelial and cardiac injury may be present in many patients presenting with COVID-19, which may have been associated with adverse outcomes, including new-onset HF (Standl & Schnell, 2021).

In our study, patients with T2DM presented with diagnoses of CAD and hyperlipidemia. These findings raise concerns because ischemic CMP and CAD are leading factors associated with high mortality in T2DM patients. The high prevalence of ischemic heart disease and cardiovascular risk factors are likely to contribute to the development of CMP

and HF in patients with diabetes (Oktaç et al., 2023). This information is relevant, as the sample studied showed that ischemic CMP was prevalent in nearly half of the sample (43%). The patients in this sample also presented with acute on chronic diastolic (congestive) HF diagnoses. These findings align with reports in the literature of patients with T2DM presenting with impaired diastolic cardiac function and preserved systolic function, known as HF with preserved Ejection Fraction (HFpEF) (Jia et al., 2018). Patients with HFpEF have significant mortality rates due to the lack of effective, validated therapies and the limited research on this condition (Ma et al., 2020).

Another interesting finding was the mean age and age range in this sample. The younger age in this sample highlights the need for aggressive measures and interventions with the younger population diagnosed with CMP and aHF, especially in T2DM patients. The findings regarding age in this sample also warrant investigating the factors contributing to longevity for those living with these comorbidities. The T2DM patients in this sample had a longer length of stay in the hospital when compared to those without T2DM. Future studies are needed to guide interventions aimed at decreasing the length of stay for T2DM patients with CMP and HF. Patients with T2DM are likely to experience more comorbidities, which places them at greater risk for complications during hospitalization.

The home medication regimens of the patients in this sample included diuretics, beta-blockers, ARB agents, and statins or other anti-lipid agents. While these agents may be standard care for aHF, more recent national guidelines recommend the utilization of four medication classes that include sodium-glucose cotransporter-2 inhibitors (SGLT2i), in addition to beta-blockers, ARB agents, and ACE inhibitors (McMurray et al., 2019). The use of SGLT2 inhibitors has recently been advocated due to their associated reduction in hospitalization risk, cardio-

vascular death, and all-cause mortality for patients with HF (McMurray et al., 2019). Patients with advanced HF should also be referred to a team specializing in HF for management, suitability for advanced HF therapies, and use of palliative care (Heidenreich et al., 2022).

Sixty percent of the T2DM patients in this sample were on antiglycemics, whether oral agents, insulin, or a combination of both. This finding presents concerns about the remaining forty percent who did not report agents to medically manage their T2DM. This also brings into question whether these patients may be presenting with advanced-stage T2DM. These factors should be explored in future studies. Limited health literacy remains prevalent in the United States and is strongly associated with patient morbidity, mortality, healthcare use, and costs (Magnani et al., 2018). Health literacy should be explored in future studies, especially since medication non-adherence is thought to be a leading cause of CHF exacerbation (Zhang et al., 2022). Management of T2DM requires medication compliance as prescribed and lifestyle modifications, including appropriate dieting, exercise, and cardiology recommendations.

Moreover, most of the patients in the current study were discharged home independently. Patients with T2DM were discharged home independently and with home health care services. Hispanics in this study were discharged with home health services. These findings bridge the existing gap in research on ethnic minorities with HF and their disposition for being discharged with home health services (Rao et al., 2022). In our study, there was overrepresentation of Hispanics; it is difficult to compare our findings to the literature as Hispanics remain underrepresented in research. Alternately, our findings align with reports about racial disparities; Blacks experience longer hospital stay and are discharged with home health less frequently (Patlolla et al., 2022). In our study, non-Hispanic Blacks were dis-

charged with home healthcare services the least. Nurse-led interventions, including post-discharge nurse-led visits in HF patients' homes, have been reported to be effective, as they offer the greatest reduction in mortality and readmission compared to usual care (Sterling et al., 2018). Beyond the benefits of single healthcare professionals, multidisciplinary team-based interventions in HF patient homes that include advanced HF nurses, pharmacists, dieticians, physical therapists, social workers, primary care providers, and cardiologists effectively reduce hospitalization and readmission rates (Sterling et al., 2018). These findings align with the existing literature on healthcare disparities experienced by ethnic minorities. Due to the cross-sectional nature of this study and the limited data on discharge disposition, it is difficult to determine the underlying causes for these disparities. Thus, they merit further investigation.

The strengths of this retrospective study included that the investigators were able to explore the characteristics of individuals with CMP, HF, and T2DM during the COVID-19 pandemic. Hispanics as an ethnic minority remain understudied in the literature, yet they are increasingly affected by CMP and HF. The findings of this study warrant future investigation on interventions towards the prevention of aHF in adults, patients with T2DM, and ethnic minorities. The limitations of this study included the retrospective design. It is impossible to establish causality due to the cross-sectional nature of this study. Another limitation was the selection of records based on ICD-10 coding, which may not always include the diagnoses of interest. We also encountered missing data, which may have affected our overall results. It is also not possible to generalize the findings of this study to other Hispanic groups due to the overrepresentation of White Hispanics in this sample. Future studies should include representation of Hispanics from various ethnic backgrounds.

RECOMMENDATIONS FOR PRACTICE

The implementation of multidisciplinary approaches to address major contributors to the persisting burden of HF is recommended, especially for ethnic minorities with comorbidities like T2DM and CMP (Roger, 2021). A team specializing in HF and T2DM is vital for the proper management and evaluation of advanced therapies for these types of patients. Education is a crucial component in improving medication compliance. Practitioners should consider developing an educational plan specific to the patient's diagnosis, teaching patients to take ownership in the management of their disease. Lifestyle modifications (including diet changes to reduce sodium and high saturated fat foods in daily meals), providing a nutrition consult, and having a nutritionist follow up with the patient upon discharge are essential. It is also important to assess the patient's understanding and receptiveness for compliance during hospitalization. Home health services may be beneficial for patients recently diagnosed with HF or T2DM and those who may present to the ED for aHF and do not meet the criteria for hospitalization.

CONCLUSION

This study sheds light on the demographic features, prevalence, and discharge needs of patients residing in South Florida with HF, CMP, and T2DM. Our findings highlight the need to pursue interventions to prevent aHF, as most of these patients sought emergency care during an aHF exacerbation. Additionally, the high prevalence of ischemic CMP in this sample highlights the need for more aggressive interventions targeting lifestyle measures to prevent complications and improve the quality of life for these patients, especially among minority groups.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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