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Research Paper

Non-acute myocardial infarction-associated cardiogenic shock in Hispanic patients: An analysis from the National Inpatient Sample Database

Nismat Javed [a], Preeti Jadhav [a,b], Sridhar Chilimuri [a,b], Johanna Contreras [b], Jacqueline Tamis-Holland [c], Jonathan N. Bella [a,b,*]

[a] BronxCare Health System, Bronx, NY, USA
[b] Icahn School of Medicine at Mount Sinai, New York, NY, USA
[c] Cleveland Clinic Foundation, Cleveland, OH, USA

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ABSTRACT

Background: Current knowledge about non-acute myocardial infarction-associated cardiogenic shock (nAMI-CS) by ethnicity is limited. This study compares clinical features and outcomes of nAMI-CS in Hispanic versus non-Hispanic patients in the U.S.

Methods: Hospitalizations with nAMI-CS from 2018 to 2020 were identified using the National Inpatient Sample (NIS) database. Patients were classified by ethnicity (Hispanic vs. non-Hispanic). Statistical analysis, including Chi-square and *t*-tests, was conducted using STATA version 18.

Results: Out of 8607 nAMI-CS hospitalizations, 832 (9.6 %) were Hispanic. Hispanic patients were younger (62.3 ± 15.2 vs. 66.2 ± 15.3 years) and had higher incidences of smoking (2.4 % vs. 2.1 %), coronary artery disease (45.4 % vs. 44.1 %), myocardial infarction (2.9 % vs. 1.9 %), heart failure (10.1 % vs. 9.2 %), and diabetes mellitus (18.9 % vs. 18.1 %). They had lower incidences of hypertension (32.9 % vs. 34.3 %), valve disease (1.9 % vs. 2.1 %), and cerebrovascular disease (6.5 % vs. 8.5 %, all $p < 0.005$). Hispanic patients had slightly higher in-hospital mortality rates (18.6 % vs. 17 %, $p < 0.001$), with an adjusted odds ratio (aOR) of 1.20 (95 % CI: 1.01–1.50, $p = 0.01$). Their hospital stays were longer (17.7 ± 1.87 vs. 13.2 ± 0.31 days, $p = 0.03$) and costlier ($409,280 ± 591,582 vs. $291,298 ± 461,920, $p = 0.03$).

Conclusion: Hispanic nAMI-CS patients are younger, have more co-morbid conditions, longer hospital stays, higher costs, and higher in-hospital mortality rates than non-Hispanic patients. Further research is needed to understand the mechanisms behind these disparities.

1. Introduction

Cardiogenic shock is a cause of significant morbidity and mortality worldwide. Approximately 80 % of individuals experiencing cardiogenic shock (CS) are attributed to acute myocardial infarction (AMI), typically presenting with left ventricular failure [1]. In recent years, there has been greater emphasis on understanding the characteristics and outcomes of other forms of CS unrelated to an AMI (nAMI-CS), including pulmonary embolism, pericardial tamponade, myocarditis, arrhythmia, valvular disease, decompensated congestive heart failure or other cardiomyopathies [1,2]. Considering this spectrum, the incidence and prevalence estimates of nAMI-CS have also been observed to vary across different patient subgroups. A recent study conducted in the US identified heart failure as the second most common cause of nAMI-CS, followed by arrhythmia, specifically atrial fibrillation [3]. In a study involving 1767 individuals diagnosed with nAMI-CS secondary to heart failure, a significant proportion had denovo heart failure (19.8 %) and were likely to present in advanced SCAI stages as well as lead to high rates of mortality and complications (63 %) compared to AMI-CS [4,5]. Furthermore, higher rates have been observed with nAMI-CS ranging from 68 per 100,000 hospitalizations in 2004 to 258 per 100,000 hospitalizations in 2018 compared to AMI-CS [6]. Patients with nAMI-CS are generally younger than patients with AMI-CS and, exhibit a lower prevalence of comorbidities and have a higher hospital mortality rate [7]. However, the impact of race and ethnicity on presenting characteristics and outcomes in nAMI-CS is not well understood, except in some studies with AMI-CS [8]. In one US-based registry focused on percutaneous coronary interventions in CS, substantial disparities in the

* Corresponding author at: BronxCare Health System, Bronx, NY, USA.
E-mail address: jbella@bronxcare.org (J.N. Bella).

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treatment and in-hospital mortality of Hispanic patients with cardiogenic shock, particularly in their reduced likelihood of undergoing percutaneous coronary intervention, were highlighted [9]. The existing knowledge regarding the clinical features and outcomes of non-AMI-CS in Hispanic populations remains limited. Accordingly, we sought to compare the clinical features and outcomes of non-AMI-CS in the Hispanic population with those of the non-Hispanic population in the United States.

2. Materials and methods

2.1. Data source and study cohort

The analysis utilized data from the National Inpatient Sample (NIS) database from January 2018 to December 2020. The National Inpatient Sample (NIS) is an openly accessible administrative dataset established as part of the Healthcare Cost and Utilization Project (HCUP), funded by the Agency for Healthcare Research and Quality (AHRQ). Covering 98 % of the U.S. population across 44 states, the NIS compiles data from approximately 7 million hospitalizations annually, representing all discharges from 1050 hospitals—a sample roughly mirrors 20 % of the entire U.S. hospital landscape. Utilizing the 'discharge weight' variable, the weighted estimate of yearly hospitalizations amounts to around 35 million. Each entry in the database includes a primary diagnosis, in-hospital procedures, and up to 24 secondary discharge diagnoses [10]. Diseases and procedures can be tracked using the International Classification of Diseases (ICD) codes [11]. Noteworthy data like cost, length of stay, and discharge disposition are available, although pharmacological data and lab results are not recorded [10]. Due to the de-identified nature of the database and its public accessibility, the study did not require Institutional Review Board approval or informed consent. The analysis employed the ICD-10-CM for data interpretation, excluding encounters involving individuals under 18. Initially, encounters with cardiogenic shock were identified using ICD-10-R57.0, R57.9. ICD-10-R57.0 is defined by the International Classification of Diseases (ICD) as shock resulting from diminution of cardiac output in heart disease, shock resulting from primary failure of the heart in its pumping function, as in myocardial infarction, severe cardiomyopathy, or mechanical obstruction or compression of the heart, or shock resulting from the failure of the heart to maintain adequate output. ICD-10-R57.9 is defined as an unspecified shock per the International Classification of Diseases (ICD). Subsequently, these encounters were categorized into cardiogenic shock associated with non-acute myocardial infarction-based encounters after excluding ICD-10-I21.1. ICD-10-I21.0 is defined as acute myocardial infarction or cardiac infarction or infarction of the heart, myocardium, or ventricle or myocardial infarction specified as acute or with a stated duration of 4 weeks (28 days) or less from onset.

For this study, race was classified as Hispanic (from here on referred to as Hispanic) and non-Hispanic (white, black, Asian, Pacific Islander, Native American, and others). In the NIS, 'race' and 'ethnicity' are coded using a single data element known as "RACE." When both 'race' and 'ethnicity' information is accessible, preference is given to ethnicity over race when establishing the HCUP value for 'RACE.' We included demographic characteristics, admission type and day, insurance status, hospital characteristics, mortality, complications, length of stay, and resource utilization. Hospitalizations with missing race/ethnicity data were excluded from the study. Hospitalizations related to COVID-19 admissions were also excluded from the study.

2.2. Outcomes

The study focused on the rate of inpatient mortality. Secondary outcomes encompass complications, utilization of mechanical circulatory support, and resource assessment involving the length of hospitalization and the average stay costs.

2.3. Data analysis

Baseline characteristics were analyzed through statistical tests, employing a Pearson chi-square test, Fisher's exact test for categorical variables, and an independent samples *t*-test for continuous variables. Categorical variables were presented using frequencies and percentages, while continuous variables were described with means and standard deviations. Unadjusted odds ratios (OR) with 95 % confidence intervals (CI) were calculated for crude binary data. A multivariate logistic regression model (LRM) was utilized to assess in-hospital outcomes and account for potential confounders. The multivariable LRM was adjusted for age, gender, hospital characteristics (including hospital size, type of hospital, and location), and baseline comorbidities to calculate adjusted odds ratios (aOR). A significance level of 0.05 (two-sided) was considered for all analyses conducted using STATA version 18.

3. Results

3.1. Cases extracted for analysis

A total of 277,638 hospitalizations were identified for CS, and 269,031 hospitalizations were excluded from the study owing to AMI and CS secondary to non-cardiopulmonary causes, for example, sepsis, respiratory failure, or trauma. There were no hospitalizations with missing data. There was a total of 8607 hospitalizations identified from January 2018 to December 2020 for nAMI-CS, of which 832 (9.6 %) patients were Hispanics and 7775 (90.4 %) patients were non-Hispanics.

3.2. Baseline characteristics

As seen in Table 1, Hispanic nAMI-CS patients were, on average, four years younger than non-Hispanic nAMI-CS patients and more likely to be female. Both groups exhibited similar rates of non-elective hospitalizations. A more significant proportion of Hispanic nAMI-CS patients were admitted to rural centers and were more frequently admitted to hospitals in the Northeast and the West Coast. Hispanic nAMI-CS patients were more likely than non-Hispanic AMI-CS to have Medicaid or no insurance coverage.

Among the underlying co-morbid conditions, Hispanic nAMI-CS patients had slightly but statistically significantly higher smoking, CAD, CHF, MI, CHF, and DM but lower AF, hypertension, valve disease, and cerebrovascular disease (Table 1). Fig. 1 and Table 2 detail the underlying etiologies of non-AMI CS in Hispanic and non-Hispanic patients. Most of the Hispanic patients developed shock secondary to heart failure (66.3 %).

3.3. In-hospital mortality, morbidity, and resource utilization

As seen in Tables 3 and 4, Hispanic nAMI-CS patients had slightly but statistically significantly higher in-hospital mortality rates compared to non-Hispanic nAMI-CS patients.

Cases of stroke, tracheostomy, PEG placement, and use of advanced circulatory support were slightly lower in Hispanic nAMI-CS patients compared to non-Hispanic nAMI-CS patients. Still, after adjusting for differences in baseline variables, the likelihood of stroke, PEG placement, and use of advanced circulatory support was higher in Hispanic nAMI-CS patients. The probability of in-hospital death was 1.20-fold higher in Hispanic nAMI-CS patients even after adjusting for age, gender, hospital characteristics such as bed size, and baseline comorbidities including hypertension, type 2 diabetes mellitus, coronary artery disease, COPD, history of prior myocardial infarction, end-stage renal disease, and history of prior percutaneous intervention (OR = 1.20 [95 % CI: 1.01–1.50], p 0.01). Length of stay was, on average, four days longer. Costs of hospitalization over $117,000 and higher were observed in Hispanic nAMI-CS patients compared to non-Hispanic nAMI-CS patients (Table 3).

Table 1
Baseline characteristics.

Variable	Hispanics ($N = 832$)	Non-Hispanics ($N = 7775$)	*p*-value
Age (years)	62.3 ± 15.2	66.2 ± 15.3	0.02
Female	48.5 %	26.9 %	0.01
Type of admission			
Elective	7.8 %	7.1 %	0.312
Non-elective	92.2 %	92.9 %	
Admission day			
Weekday	93.0 %	92.4 %	0.901
Weekend	7.0 %	7.6 %	
Primary payer			<0.001
Medicare	31.7 %	44.9 %	
Medicaid	30.3 %	27.6 %	
Private insurance	5.2 %	8.2 %	
Self-pay	17.6 %	10.5 %	
No charge	0.1 %	0.2 %	
Other	15.1 %	8.6 %	
Hospital Characteristics			
Bed size			
Small	33.3 %	15.5 %	
Medium	16.7 %	25.8 %	0.111
Large	50.0 %	58.6 %	
Region			<0.001
Northeast	19.1 %	16.6 %	
Midwest	7.3 %	22.8 %	
South	37.8 %	40.9 %	
West	35.8 %	19.7 %	
Location			
Rural	3.5 %	0.8 %	<0.001
Urban nonteaching	13.8 %	13.9 %	
Urban teaching	82.7 %	85.3 %	
Comorbidities			
CAD	45.4 %	44.1 %	<0.001
Smoking	2.4 %	2.1 %	<0.001
PCI	5.4 %	5.0 %	<0.001
ESRD	5.5 %	5.9 %	<0.001
AF	6.9 %	7.9 %	<0.001
MI	2.9 %	1.9 %	<0.001
CHF	10.1 %	9.2 %	<0.001
COPD	6.0 %	5.5 %	<0.001
DM	18.9 %	18.1 %	<0.001
HTN	32.9 %	34.3 %	<0.001
Hypothyroidism	2.2 %	1.2 %	<0.001
Pulmonary hypertension	0.7 %	0.9 %	<0.001
Valvular heart disease	1.9 %	2.1 %	<0.001
CVD	6.5 %	8.5 %	<0.001

N-number of patients, CAD- Coronary Artery Disease, PCI-Percutaneous Intervention, ESRD-Endstage Renal Disease, AF- Atrial Fibrillation, MI-Myocardial Infarction, CHF-Congestive Heart Failure, COPD-Chronic Obstructive Pulmonary Disease, DM- Type 2 Diabetes Mellitus, HTN-Hypertension, CVD- Cerebrovascular Disease.

4. Discussion

In the current study, Hispanic nAMI-CS patients were younger than non-Hispanic patients and had higher in-hospital mortality and prolonged length of stay. We found that most Hispanic patients had either Medicaid or Medicare insurance. After adjusting for covariates, Hispanic nAMI-CS patients had a 1.23-fold higher risk of requiring mechanical circulatory support. They were more likely to utilize ECMO or IABP compared to non-Hispanic patients. To our knowledge, this is the first study to describe the clinical features and outcomes of nAMI-CS in Hispanic patients. Hispanics are disproportionately impacted by unfavorable daily living conditions, driven by structural and social factors such as macroeconomics, cultural norms, income, education, employment, and health service availability [12–14]. These factors, known as social determinants of health, can induce chronic stress through a mechanism called allostatic load, resulting in behavioral risk factors such as unhealthy diet, physical inactivity, and substance abuse, as well as biological responses like disrupted circadian rhythms, inflammatory reactions, and cytokine responses [14]. Therefore, it is essential to highlight disparities in this cohort.

Fig. 2 details the overall distribution of the Hispanic population in the US. As observed in the figure, most of the Hispanic population is based in the West (31 %) and South (19 %) regions of the US. This is consistent with the overall percentage of hospitalizations observed in our analysis, with the South and West Regions being the most common territories for the Hispanic population. Our study is representative of the distribution of the Hispanic population in the US, and therefore, healthcare resources can be well distributed accordingly.

In our study, higher mortality rates were observed for Hispanic nAMI-CS patients, and the cohort was relatively younger. This is possibly related to the increased cardiovascular risk highlighted in the literature. Hispanics have a high lifetime risk of developing type 2 diabetes mellitus. Estimates from the CDC survey in 2011 showed that the prevalence was higher, the prevalence of type 2 diabetes mellitus in Hispanics was 11.8 % compared to 7 % in non-Hispanics [15] but recent statistics from the Centers for Disease Control in adults (2019–2021) showed changes in age-adjusted data [16]. For both men and women, prevalence of diagnosed diabetes was highest among American Indian and Alaska Native adults (13.6 %), followed by non-Hispanic Black adults (12.1 %), adults of Hispanic origin (11.7 %), non-Hispanic Asian adults (9.1 %) and non-Hispanic White adults (6.9 %) [16]. The prevalence of diabetes mellitus in non-Hispanics may reflect the increased prevalence of diagnosed diabetes in other ethnicities [17]. Type 2 diabetes mellitus remodels the heart in a variety of ways that increase the chances of developing further comorbidities [18,19]. Increased left ventricular hypertrophy, increased relative wall thickness, and abnormal diastolic function are independently associated with diabetes mellitus [18,19]. The remodeling can be possibly accelerated by other comorbidities that were noted to be significantly higher in the younger Hispanic cohort, such as coronary artery disease, heart failure, and smoking. Total cardiovascular disease and heart failure mortality have also been noted to increase in young Hispanics [20]. Additionally, data from the National Health and Nutrition Examination Survey (2015–2016) revealed that young Hispanic adults had higher rates of obesity (46.9 % vs. 38.2 %) [21]. The recent Young-MI registry found that 18 % of young Hispanic adults had possible or definite familial hypercholesterolemia [22]. Furthermore, Behavioral Risk Factor Surveillance System data (2015–2018) showed that younger Hispanic adults had a higher prevalence of physical inactivity (31.7 % vs. 23.4 %) than non-Hispanic adults [23]. Childhood adiposity, obesity, and young-onset diabetes are also more prevalent in Hispanic individuals than in non-Hispanic individuals [24]. Additionally, smoking rates were higher among Hispanic youth (28 % vs. 23.8 %) compared to non-Hispanic youth [25]. Given the combination of these factors, the overall risk of the Hispanic population developing such diseases at a younger age, followed by complications and mortality, has significantly increased. This ultimately results in higher rates of mortality.

In our study, Hispanic nAMI-CS experienced a prolonged length of stay during in-hospital admission. The longer length of stay may have been due to the increased risk of complications after adjusting for covariates in this cohort, including stroke followed by PEG placement. As a result of increased length of stay and higher complication rate, the mean hospital charges were $117,982 higher in Hispanic nAMI-CS patients than non-Hispanic nAMI-CS patients.

We hypothesize a few explanations for these findings. Access to appropriate and timely healthcare for Hispanics may hindered by various financial and nonfinancial barriers [26]. First, acculturation level, language proficiency, and immigration status directly impact their healthcare access [26]. Second, recent immigrants face challenges due to isolation from mainstream U.S. society and unfamiliarity with the healthcare system, leading to potential delays in receiving necessary care [26]. Furthermore, undocumented immigrants face additional barriers due to fear of deportation. Third, two primary barriers to healthcare access for Hispanics are the lack of health insurance coverage and the absence of a usual source of care [26]. Lack of insurance makes

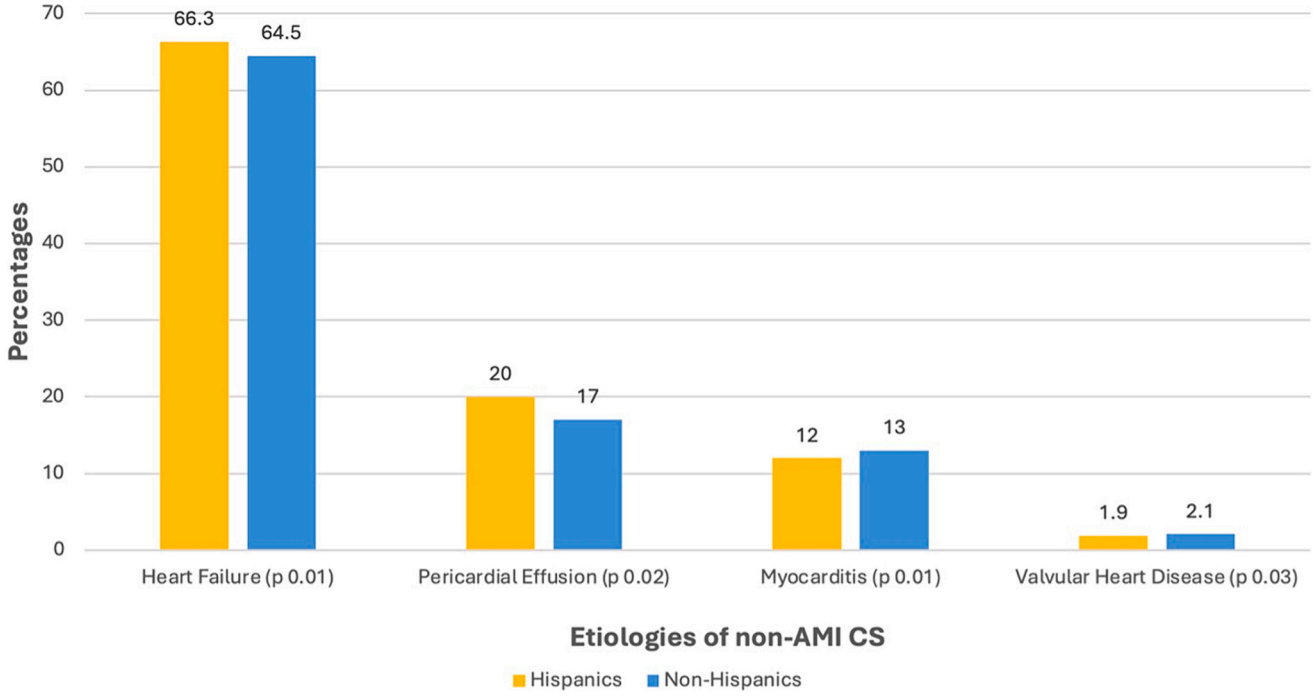

Fig. 1. Etiology of non-AMI cardiogenic shock. Bar Color: Yellow = Hispanics. Blue = Non-Hispanics. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 2
Logistic regression analysis of etiologies.

Etiologies	Hispanics	Non-Hispanics	Adjusted odds ratio	
	(N = 832)	(N = 7775)	aOR	p-value
Heart failure	552 (66.3 %)	5014 (64.5 %)	1.38 (1.13–1.44)	0.01
Pericardial effusion	106 (20.0 %)	1321 (17.0 %)	1.22 (1.03–1.55)	0.02
Myocarditis	100 (12.0 %)	1011 (13.0 %)	1.15 (1.02–1.38)	0.01
Valvular heart disease	16 (1.9 %)	163 (2.1 %)	1.11 (1.01–1.33)	0.03

healthcare unaffordable, and without a regular source of care, individuals may face difficulties in obtaining timely and necessary services [26]. Hispanics rank poorly on both these barriers, with historical disparities in health insurance coverage compared to non-Hispanic whites [26]. Differences in employer-provided insurance coverage and job characteristics contribute to these disparities. As a result of the vicious cycle of delayed care, many patients present at a very complicated stage of the disease, contributing to increased length of stay, higher inpatient mortality rate, complications, and cost of hospitalization.

The risk of mechanical circulatory support was 1.23-fold higher among Hispanic nAMI-CS patients in comparison to the non-Hispanic group after adjusting for covariates. Hispanic nAMI-CS patients were more likely to utilize ECMO or IABP. In comparing nAMI-CS (non-acute myocardial infarction cardiogenic shock) with AMI-CS (acute myocardial infarction cardiogenic shock), key differences arise from their distinct pathologies. While AMI-CS is primarily due to myocardial injury and hypoperfusion, nAMI-CS encompasses various causes like acute or chronic heart failure, fulminant myocarditis, and malignant arrhythmias [4,27,28]. Both conditions follow an "ischemic spiral" leading to multiorgan failure. Management strategies differ; nAMI-CS patients often tolerate relative hypotension better, and initial treatments may include diuresis, vasodilators, or inotropes. Persistent hypotension or worsening end-organ function necessitates mechanical circulatory support, chosen based on comprehensive clinical evaluations [28]. The use of IABP was explained by the initial presentation of Hispanic patients to rural centers

Table 3
In-hospital outcomes, MCS use, and resource utilization among Hispanics and other races.

Outcomes	Hispanics	Non-Hispanics	Unadjusted odds ratio		Adjusted odds ratio	
	(N = 832)	(N = 7775)	uOR	p-value	aOR	p-value
Mechanical Circulatory Support	49 (5.9 %)	715 (9.2 %)	1.27 (1.01–1.31)	<0.001	1.23 (1.05–1.41)	<0.001
Impella						
LVAD	15 (1.8 %)	220 (2.8 %)	0.89 (0.63–1.11)	0.30	0.79 (0.61–1.15)	0.32
ECMO	5 (0.6 %)	77 (1.0 %)	0.79 (0.51–1.33)	0.41	0.75 (0.44–1.23)	0.43
IABP	5 (0.6 %)	80 (1.0 %)	1.02 (0.85–1.13)	0.51	0.98 (0.80–1.11)	0.55
Resource utilization	24 (2.9 %)	338 (4.3 %)	1.09 (1.01–1.50)	<0.001	1.07 (1.02–1.22)	<0.001
Length of stay (days)						
Total charges ($)						
	17.7 ± 1.87	13.2 ± 0.31		0.03		
	409,280 ± 591,582	291,298 ± 461,920		0.03		

uOR- Unadjusted Odds Ratio, aOR- Adjusted Odds Ratio.

Table 4
Adverse outcomes.

Outcomes	Hispanics	Non-Hispanics	Unadjusted odds ratio		Adjusted odds ratio	
	(N = 832)	(N = 7775)	uOR	p-value	aOR	p-value
In-hospital mortality	155 (18.6 %)	1328 (17.0 %)	1.24 (1.05–1.61)	<0.001	1.20 (1.01–1.50)	0.01
Stroke						
Tracheostomy	54 (6.5 %)	645 (8.3 %)	1.45 (1.11–1.59)	0.01	1.33 (1.08–1.47)	0.03
PEG	43 (5.0 %)	443 (5.7 %)	0.99 (0.91–1.06)	0.06	1.04 (0.94–1.10)	0.06
	51 (6.1 %)	536 (6.9 %)	1.39 (1.23–1.45)	<0.001	1.29 (1.16–1.37)	<0.001

uOR- Unadjusted Odds Ratio, aOR- Adjusted Odds Ratio, PEG-Percutaneous Gastrostomy.

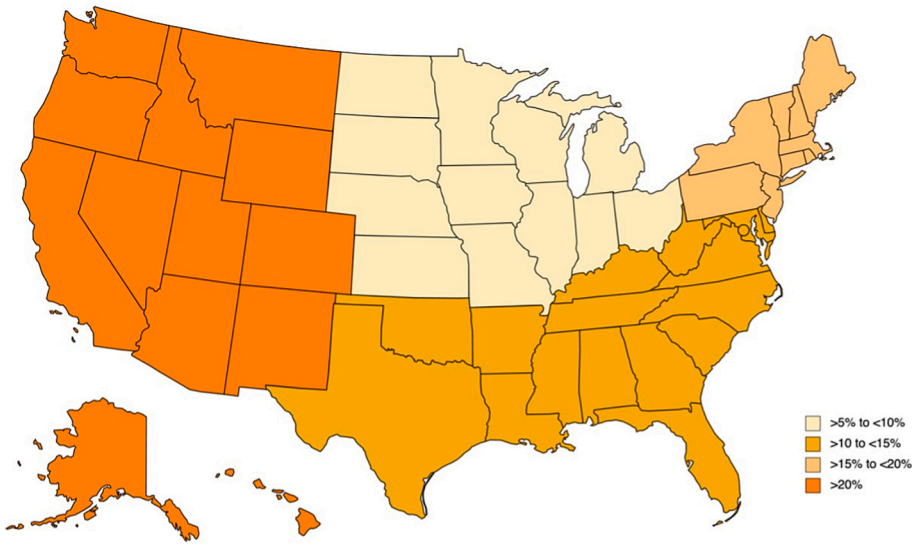

Fig. 2. Population distribution of Hispanics in the United States.

(3.5 % of the total hospitalizations), where it served as a temporary measure of definitive therapy. Unlike AMI-CS, risk prediction models for nAMI-CS are lacking, but IABP use is more common. Heart transplantation and LVAD remain primary treatments. However, due to delays in healthcare and presentation, restrictions in insurance, and immigration status, these patients are more likely to present as poor candidates for definitive therapy due to the risk of increased complications.

The underlying etiology of nAMI-CS could also explain the difference in increased use of IABP in Hispanic patients. Hispanic patients were 1.38 times more likely to have heart failure than non-Hispanic patients (p 0.01). In one retrospective study composed of patients with heart failure not related to acute myocardial infarction, IABP therapy significantly increased the cardiac index and reduced systemic vascular resistance ($P < 0.05$) [28]. Despite these improvements, 28 % of these patients either died (24 %) or required urgent escalation to mechanical circulatory support (MCS) (4 %). In this regard, baseline left ventricular cardiac power index and a history of ischemic cardiomyopathy were significantly associated with death or urgent MCS escalation [29]. However, evidence for IABP and ECMO for other etiologies, specifically pericardial effusion and myocarditis, is limited, with the patient population primarily being non-Hispanic. IABP is a common strategy considered for fulminant myocarditis complicated by effusion that ECMO follows in case of persistent lactic acidemia and low cardiac index [30].

Our observations align with previous research on minorities, particularly Asians and Blacks [8,9,31–34]. However, limited studies focus on the Hispanic population [31]. In a study focused on AMI-CS in Asians, Asians had a higher likelihood of in-hospital mortality (aOR 1.03, 95 % CI 1.01–1.05), and the use of IABP (aOR 1.15, 95 % CI 1.12–1.17) compared to non-Asians. The average in-hospital cost for CS hospitalization was significantly greater in the Asian population ($63,787 ± $80,261) than in non-Asians ($56,207 ± $76,120, $p < 0.001$). Asians also showed lower odds of receiving Impella (aOR 0.90, 95 % CI 0.86–0.95) and left ventricular assist devices (LVAD) (aOR 0.71, 95 % CI 0.65–0.77). At the same time, there was no difference in the use of extracorporeal membrane oxygenation (ECMO) compared to non-Asians [8]. In our study, nAMI-CS was evaluated in Hispanics. While a similar likelihood of requiring mechanical support was observed, the total hospitalization costs were found to be much higher as compared to hospitalization costs for Asians. The SHOCK trial revealed no statistically significant differences in race and mortality concerning AMI-CS [9]. However, in our study, Hispanics had higher and statistically significant mortality rates. While percutaneous interventions were not variable for outcome in our study, the SHOCK trial noted a decreased rate of interventions in the Hispanic population with nAMI-CS [9]. Another study also noted a statistically significant higher odds of inpatient mortality in Hispanic women [27]. In our study, gender differences were observed between the Hispanic and non-Hispanic populations but were not found to be statistically significant for inpatient mortality.

The strengths of our study include a specific focus on the Hispanic population, one of the most significant minorities in the US who are underrepresented in clinical studies, and the robust characteristics of the database, particularly its ability to provide nationwide estimates. Our study has some limitations that should be considered when interpreting the results. The reliability of the National Inpatient Sample (NIS) is contingent on the proficiency of coders, thereby introducing the possibility of coding and documentation errors. Additionally, changes in criteria for identifying and coding cardiogenic shock (CS) over time may impact accuracy. However, the validity of the ICD-10 codes has been thoroughly investigated and optimized for cardiogenic shock [35]. Additionally, the database identifies transfers in the following manner:

emergency department, another hospital, another healthcare facility including long-term care, and court/law enforcement. Therefore, the data regarding transfers from rural to urban hospitals is limited. However, it can be implied that advanced therapies were the primary reason when patients were transferred, as observed by the odds ratio for ECMO therapy. Unfortunately, the NIS lacks information on medications, CS severity, hemodynamics, cardiac biomarkers, left ventricular ejection fraction, coronary anatomical features, and lactate levels that form components of the SCAI Shock classification and, therefore, could not be included. Despite these limitations, the robust characteristics of the database, particularly its ability to provide nationwide estimates, enhance the credibility of our study's findings. Furthermore, the study emphasizes the need for prospective research to better understand clinical outcomes in cardiogenic shock within this population to address healthcare disparities. Increased awareness in both patients and clinicians alike regarding modifiable risk factors for cardiogenic shock (CS) may identify barriers to access to care and address racial disparities in healthcare.

5. Conclusion

In summary, Hispanic nAMI-CS patients tend to be younger with higher co-morbid conditions and have a longer length of stay, resulting in higher cost of hospitalization compared with non-Hispanic nAMI-CS patients. Hispanic nAMI-CS patients had higher in-hospital mortality rates compared to non-Hispanic nAMI-CS patients. Further investigations need to analyze these trends in underrepresented populations that might contribute to higher morbidity, mortality, and healthcare costs.

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Ethical statement

The project was executed using national data estimates that include de-identified data.

Therefore, consent was not required.

CRediT authorship contribution statement

Nismat Javed: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Preeti Jadhav:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Sridhar Chilimuri:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Johanna Contreras:** Writing – review & editing, Writing – original draft, Validation, Supervision, Conceptualization. **Jacqueline Tamis-Holland:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation. **Jonathan N. Bella:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] V.P. Harjola, J. Lassus, A. Sionis, et al., Clinical picture and risk prediction of short-term mortality in cardiogenic shock, Eur. J. Heart Fail. 17 (5) (2015 May) 501–509, https://doi.org/10.1002/ejhf.260.

[2] J.S. Hochman, C.E. Buller, L.A. Sleeper, et al., Cardiogenic shock complicating acute myocardial infarction—etiologies, management and outcome: a report from the SHOCK Trial Registry. Should we emergently revascularize occluded coronaries for cardiogenic shock? J. Am. Coll. Cardiol. 36 (3 Suppl A) (2000) 1063–1070, https://doi.org/10.1016/S0735-1097(00)00879-2.

[3] J.C. Jentzer, S. van Diepen, G.W. Barsness, et al., Cardiogenic shock classification to predict mortality in the cardiac intensive care unit, J. Am. Coll. Cardiol. 74 (17) (2019 Oct 29) 2117–2128, https://doi.org/10.1016/j.jacc.2019.07.077.

[4] J. Abraham, V. Blumer, D. Burkhoff, et al., Heart failure-related cardiogenic shock: pathophysiology, evaluation and management considerations: review of heart failure-related cardiogenic shock, J. Card. Fail. 27 (10) (2021 Oct) 1126–1140, https://doi.org/10.1016/j.cardfail.2021.08.010.

[5] J. Hernandez-Montfort, M. Kanwar, et al., Clinical presentation and in-hospital trajectory of heart failure and cardiogenic shock, JACC Heart Fail. 11 (2) (2023 Feb) 176–187, https://doi.org/10.1016/j.jchf.2022.10.002.

[6] M. Osman, M. Syed, S. Patibandla, et al., Fifteen-year trends in incidence of cardiogenic shock hospitalization and in-hospital mortality in the United States, J. Am. Heart Assoc. 10 (15) (2021 Aug 3) e021061, https://doi.org/10.1161/JAHA.121.021061.

[7] M. Shah, S. Patnaik, B. Patel, et al., Trends in mechanical circulatory support use and hospital mortality among patients with acute myocardial infarction and non-infarction related cardiogenic shock in the United States, Clin. Res. Cardiol. 107 (4) (2018 Apr) 287–303, https://doi.org/10.1007/s00392-017-1182-2.

[8] H. Sandhyavenu, W. Ullah, I. Badu, et al., Trends and outcomes of cardiogenic shock in Asian populations compared with non-Asian populations in the US: NIS analysis (2002-2019), Expert. Rev. Cardiovasc. Ther. 21 (1) (2023 Jan) 67–74, https://doi.org/10.1080/14779072.2023.2162040.

[9] S.T. Palmeri, A.M. Lowe, L.A. Sleeper, et al., Racial and ethnic differences in the treatment and outcome of cardiogenic shock following acute myocardial infarction, Am. J. Cardiol. 96 (8) (2005 Oct 15) 1042–1049, https://doi.org/10.1016/j.amjcard.2005.06.033.

[10] Agency for Healthcare Research and Quality, National (Nationwide) Inpatient Sample (NIS) Database Documentation. [Internet] [cited 2024 Jan 6]; Available from: https://hcup-us.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp, 2023.

[11] Centers for Medicare and Medicaid Services, ICD Code Lists. [Internet] [cited 2024 Jan 6]; Available from: https://www.cms.gov/medicare/coding-billing/icd-10-codes, 2023.

[12] United States Census Bureau, The Hispanic Population in the United States: 2020. [Internet] [cited 2024 Feb 12]; Available from: https://www.census.gov/data/tables/2020/demo/hispanic-origin/2020-cps.html, 2020.

[13] United States Census Bureau, The Hispanic Population in the United States: 2021. [Internet] [cited 2024 Feb 12]; Available from: https://www.census.gov/data/tables/2021/demo/hispanic-origin/2021-cps.html, 2021.

[14] E. Velasco-Mondragon, A. Jimenez, A.G. Palladino-Davis, et al., Hispanic health in the USA: a scoping review of the literature, Public Health Rev. 7 (37) (2016 Dec) 31, https://doi.org/10.1186/s40985-016-0043-2.

[15] K. Cusi, G.L. Ocampo, Unmet needs in Hispanic/Latino patients with type 2 diabetes mellitus, Am. J. Med. 124 (10 Suppl) (2011 Oct) S2–S9, https://doi.org/10.1016/j.amjmed.2011.07.017.

[16] Centers for Disease Control and Prevention, National Diabetes Statistics Report. [Internet] [cited 2024 Aug 28]. Available from: https://www.cdc.gov/diabetes/php/data-research/index.html#:~:text=Among%20U.S.%20adults%20aged%2018%20years%20or,which%20is%20an%20indicator%20of%20socioeconomic%20status, 2024.

[17] C. Aguayo-Mazzucato, P. Diaque, S. Hernandez, et al., Understanding the growing epidemic of type 2 diabetes in the Hispanic population living in the United States, Diabetes Metab. Res. Rev. 35 (2) (2019 Feb) e3097, https://doi.org/10.1002/dmrr.3097.

[18] V. Palmieri, J.N. Bella, D.K. Arnett, et al., Effect of type 2 diabetes mellitus on left ventricular geometry and systolic function in hypertensive subjects: Hypertension Genetic Epidemiology Network (HyperGEN) study, Circulation 103 (1) (2001 Jan 2) 102–107, https://doi.org/10.1161/01.cir.103.1.102.

[19] J.E. Liu, V. Palmieri, M.J. Roman, et al., The impact of diabetes on left ventricular filling pattern in normotensive and hypertensive adults: the Strong Heart Study, J. Am. Coll. Cardiol. 37 (7) (2001 Jun) 1943–1949, https://doi.org/10.1016/s0735-1097(01)01230-x.

[20] R. PéRez-Escamilla, P. Putnik, The role of acculturation in nutrition, lifestyle, and incidence of type 2 diabetes among Latinos, J. Nutr. 137 (2007) 860–870, https://doi.org/10.1093/jn/137.4.860.

[21] United States Department of Health and Human Services, NHANES - National Health and Nutrition Examination Survey. [Internet] [cited 2024 May 28]; Available from: https://health.gov/healthypeople/objectives-and-data/data-sources-and-methods/data-sources/national-health-and-nutrition-examination-survey-nhanes, 2024.

[22] A. Singh, A. Gupta, B.L. Collins, et al., Familial hypercholesterolemia among young adults with myocardial infarction, J. Am. Coll. Cardiol. 73 (2019) 2439–2450, https://doi.org/10.1016/j.jacc.2019.02.059.
[23] Centers for Disease Control and Prevention, The Behavioral Risk Factor Surveillance System (BRFSS) Prevalence and Trends Data. [Internet] [cited 2024 May 28]. Available from: https://www.cdc.gov/brfss/brfssprevalence/index.html, 2023.
[24] M.L. Daviglus, A. Pirzada, G.A. Talavera, Cardiovascular disease risk factors in the Hispanic/Latino population: lessons from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), Prog. Cardiovasc. Dis. 57 (2014) 230–236, https://doi.org/10.1016/j.pcad.2014.07.006.
[25] S.U. Khan, A.N. Lone, S.H. Yedlapati, et al., Cardiovascular disease mortality among Hispanic versus non-Hispanic white adults in the United States, 1999 to 2018, J. Am. Heart Assoc. 11 (7) (2022) e022857, https://doi.org/10.1161/JAHA.121.022857.
[26] J.J. Escarce, K. Kapur, Access to and quality of health care, in: National Research Council (US) Panel on Hispanics in the United States, M. Tienda, F. Mitchell (Eds.), Hispanics and the Future of America 10, National Academies Press (US), 2006. Available from: https://www.ncbi.nlm.nih.gov/books/NBK19910/.
[27] M.D. Samsky, D.A. Morrow, A.G. Proudfoot, et al., Cardiogenic shock after acute myocardial infarction: a review, JAMA 326 (18) (2021 Nov) 1840–1850, https://doi.org/10.1001/jama.2021.18323.
[28] C.F. Barnett, S.B. Brusca, T.C. Hanff, et al., Management of cardiogenic shock unrelated to acute myocardial infarction, Can. J. Cardiol. 39 (4) (2023 Apr) 406–419, https://doi.org/10.1016/j.cjca.2023.01.023.
[29] S. Hsu, S. Kambhampati, C.M. Sciortino, et al., Predictors of intra-aortic balloon pump hemodynamic failure in non-acute myocardial infarction cardiogenic shock, Am. Heart J. 199 (2018 May) 181–191, https://doi.org/10.1016/j.ahj.2017.11.016.
[30] T. Olanipekun, T. Abe, V. Effoe, et al., Racial and ethnic disparities in the trends and outcomes of cardiogenic shock complicating peripartum cardiomyopathy, JAMA Netw. Open 5 (7) (2022 Jul) e2220937, https://doi.org/10.1001/jamanetworkopen.2022.20937.
[31] H. Li, L. Li, Successful treatment of fulminant myocarditis with intra-aortic balloon pump counterpulsation combined with immunoglobulin and glucocorticoid in a young male adult, Front Cardiovasc Med. 22 (9) (2022 Jul) 905189, https://doi.org/10.3389/fcvm.2022.905189.
[32] L. Ya'qoub, A. Lemor, M. Dabbagh, et al., Racial, ethnic, and sex disparities in patients with STEMI and cardiogenic shock, JACC Cardiovasc. Interv. 14 (6) (2021 Mar) 653–660, https://doi.org/10.1016/j.jcin.2021.01.003.
[33] A.V. Subramaniam, S.H. Patlolla, W. Cheungpasitporn, et al., Racial and ethnic disparities in management and outcomes of cardiac arrest complicating acute myocardial infarction, J. Am. Heart Assoc. 10 (11) (2021) e019907, https://doi.org/10.1161/JAHA.120.019907.
[34] S.H. Patlolla, A. Shankar, P.R. Sundaragiri, et al., Racial and ethnic disparities in the management and outcomes of cardiogenic shock complicating acute myocardial infarction, Am. J. Emerg. Med. 51 (2022 Jan) 202–209, https://doi.org/10.1016/j.ajem.2021.10.051.
[35] M.D. Lauridsen, H. Gammelager, M. Schmidt, et al., Positive predictive value of International Classification of Diseases, 10th revision, diagnosis codes for cardiogenic, hypovolemic, and septic shock in the Danish National Patient Registry, BMC Med. Res. Methodol. 15 (2015 Mar) 23, https://doi.org/10.1186/s12874-015-0013-2.