Journal of the Society for Cardiovascular Angiography & Interventions 3 (2024) 101212

JSCAI

The official journal of the Society for Cardiovascular Angiography & Interventions

Original Research

Sex Disparities in the Management, Outcomes, and Transfer of Patients Hospitalized for Cardiogenic Shock

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ABSTRACT

Background: Previous studies have shown that women have worse outcomes for cardiogenic shock (CS) than men. Patients who receive care in CS "hubs" have also been shown to have improved outcomes when compared to those treated at "spokes." This study aimed to examine the presence of sex disparities in the outcomes of CS in relation to hospital type.

Methods: Hospitalizations of adults with a diagnosis of CS were identified using data from the 2016-2019 Nationwide Readmissions Database. CS "hubs" were defined as any centers receiving at least 1 interhospital transfer with CS, while those without such transfers were classified as "spokes." Data were combined across years and multivariable logistic regression modeling was used to evaluate the association of sex with in-hospital mortality, invasive procedures, and transfer to hubs.

Results: There were a total of 618,411 CS hospitalizations (62.2% men) with CS related to acute myocardial infarction comprising 15.3 to 17.3% of women hospitalizations and 17.8 to 20.3% of men hospitalizations. In-hospital mortality was lower at hubs (34.5% for direct admissions, 31.6% for transfers) than at spokes (40.3%, all $P < .01$). Women underwent fewer invasive procedures (right heart catheterization, percutaneous coronary intervention, mechanical circulatory support) and had higher mortality than men. Female sex was independently associated with decreased transfers to hubs (odds ratio, 0.93; 95% CI, 0.89-0.96) and increased mortality (odds ratio, 1.09; 95% CI, 1.05-1.12).

Conclusions: Women with CS were less likely to be treated at a hub or transferred to a hub, had higher in-hospital mortality, and had a lower likelihood of receiving CS-related procedures than men. Further research is needed to understand sex-specific gaps in CS outcomes.

Introduction

Cardiogenic shock (CS) is a state of severely diminished myocardial function leading to low cardiac output and end-organ hypoperfusion, with the leading cause being acute myocardial infarction (AMI).[1] While in-hospital mortality due to CS has decreased in recent years, multiple studies still report mortality rates over 30%.[2–6]

Sex disparities in CS outcomes have been well-documented. Specifically, women with AMI-CS have higher in-hospital mortality compared to men.[7–9] Such disparities may in part be explained by sex differences in treatment patterns. Women undergo fewer percutaneous coronary interventions (PCI), coronary angiography, invasive hemodynamic monitoring, and mechanical circulatory support (MCS) than men.[7–9] A study from the Ontario Myocardial Infarction Database

Abbreviations: AKI, acute kidney injury; AMI, acute myocardial infarction; CABG, coronary artery bypass graft; CS, cardiogenic shock; MCS, mechanical circulatory support; PCI, percutaneous coronary intervention; RHC, right heart catheterization.

Keywords: cardiogenic shock; hub; sex disparities; spoke; transfer.

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https://doi.org/10.1016/j.jscai.2023.101212

Received 23 July 2023; Received in revised form 3 October 2023; Accepted 4 October 2023

Available online 10 November 2023

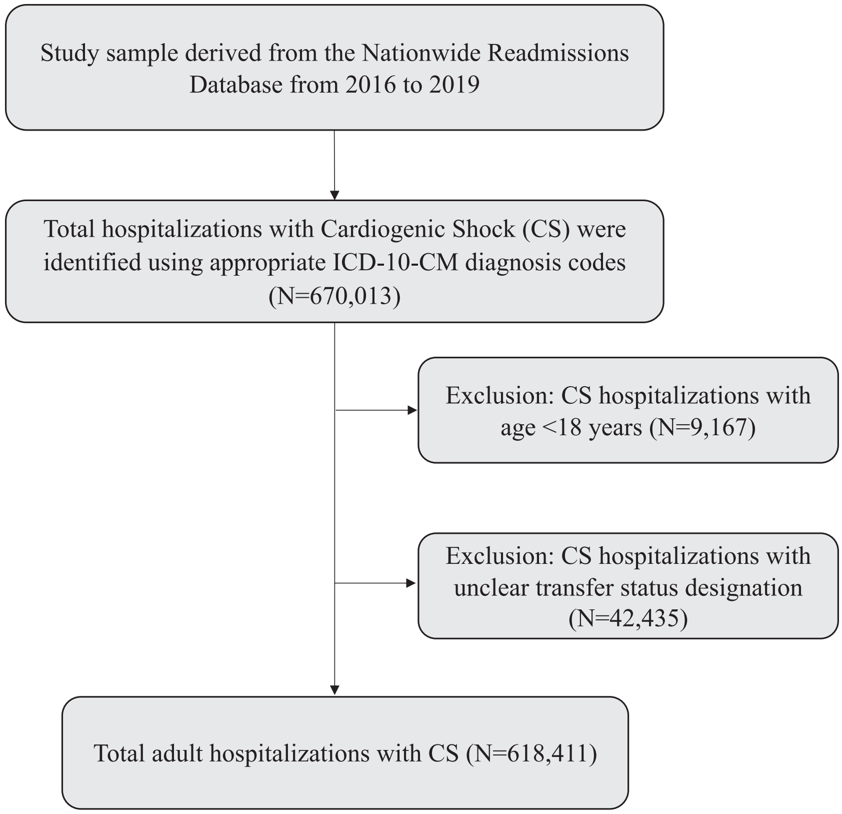


Figure 1.
Flowchart of the analytic sample. ICD, International Classification of Diseases.

demonstrated that women with AMI-CS were less likely to be revascularized, partly because they were less likely to present to revascularization-capable hospitals and less likely to be transferred to such hospitals when compared to men.[10]

The reasons behind these sex disparities are still unclear. One potential explanation may be the difference in access to high-level centers in which men and women obtain CS care. Our group previously found that patients hospitalized at CS hubs, whether through direct admission or transfer, had lower in-hospital mortality and were more likely to undergo invasive procedures than patients admitted to spoke hospitals.[5] This analysis, however, did not stratify the type of hospital admission (CS hubs vs spoke) or outcomes based on sex. To our knowledge, there is no contemporary large-scale analysis of the observed sex disparities in CS management and outcomes. Therefore, the aim of our study is to examine the impact of patient sex on outcomes of CS hospitalizations at a national level and to explore its relationship to hospital type (ie, CS hubs vs spoke) and transfer patterns.

Methods

Data source

This cross-sectional study sample was derived using data from the Nationwide Readmissions Database (NRD) from 2016 to 2019. The NRD is drawn from the Healthcare Cost and Utilization Project State Inpatient Databases and contains verified patient linkage numbers used to track patients across hospitals within states.[11] The NRD contains data from approximately 18 million discharges each year (35 million total weighted discharges) across 30 states. These data include information on demographics, primary and secondary diagnosis/procedure codes based on the International Classification of Diseases, Tenth Revision–Clinical Modification (ICD-10-CM) codes, length of stay (LOS), discharge disposition, death, admission cost-to-charge ratio, and hospital-level variables. Because data are deidentified, institutional review board approval and informed consent were not required.

Study population and variables

All hospitalizations of adults 18 years or older associated with CS were identified using ICD-10-CM codes R57.0 and T81.11XA. Patient sociodemographic characteristics from the NRD included age, sex, insurance status, and median household income based on the patient's ZIP code. Race and ethnicity are not available in the NRD. Patient comorbidities were obtained from a combination of Elixhauser comorbidities and ICD-10 codes (Supplemental Table S1). Complications during hospitalization were also analyzed and included acute kidney injury (AKI), AKI requiring dialysis, stroke, mechanical ventilation, and cardiac arrest.

To distinguish interhospital transfers from readmissions, the NRD combines records from both hospitals involved in the transfer into a single record.[12,13] The combined transfer records include the patient characteristics from the initial admission, hospital identifiers and characteristics of the latter admission, and combined measures such as LOS and diagnostic/procedure ICD-10-CM codes.[13] The variable "samedayevent" was used to identify transfers while the variable "rehabtransfer" was used to exclude transfers to rehabilitation centers. Only hospitalizations with a clear designation of transfer status were included in this study. Centers that received any transfers with CS in a given year were classified as CS transfer "hubs" while those without transfers with CS were classified as "spokes," as per previous work.[5]

Table 1. Comparison of hospitalization characteristics stratified by hospital type, transfer status, and sex.

Variable	Direct admission to spoke hospital (Cohort A) n = 161,121			Direct admission to hub hospital (Cohort B) n = 410,320			Transfer to hub hospital (Cohort C) n = 46,970		
	Men	Women	P value	Men	Women	P value	Men	Women	P value
N	96,330 (59.8%)	64,791 (40.2%)		258,031 (62.9%)	152,289 (37.1%)		30,245 (64.4%)	16,725 (35.6%)	
Demographics									
Age, y	68 (59-78)	72 (62-81)	<.01[a]	66 (57-75)	69 (59-79)	<.01[a]	65 (56-73)	67 (57-75)	<.01[a]
Insurance status			<.01[a]			<.01[a]			<.01[a]
Medicare	64.8%	74.0%		59.8%	69.3%		57.7%	65.1%	
Medicaid	11.6%	9.8%		11.9%	10.8%		11.9%	12.1%	
Private insurance	16.7%	12.3%		20.8%	16.1%		24.2%	18.3%	
Self-pay	3.2%	2.1%		3.3%	2.2%		3.3%	2.5%	
Median household income			.01[a]			<.01[a]			<.01[a]
Quartile 1 (lowest)	31.0%	32.2%		29.5%	31.3%		24.6%	26.8%	
Quartile 2	27.6%	27.4%		27.1%	27.5%		28.0%	28.8%	
Quartile 3	22.8%	22.9%		23.7%	23.3%		25.1%	24.2%	
Quartile 4 highest)	17.0%	16.3%		18.2%	16.7%		21.0%	18.9%	
Comorbidities									
Hypertension	64.3%	66.9%	<.01[a]	62.5%	64.0%	<.01[a]	73.7%	74.3%	.29
Atrial fibrillation	45.5%	43.1%	<.01[a]	47.4%	44.5%	<.01[a]	56.5%	49.6%	<.01[a]
Diabetes	39.1%	39.1%	.99	39.1%	38.7%	.14	45.9%	45.4%	.50
Coronary artery disease	74.5%	65.7%	<.01[a]	73.3%	62.9%	<.01[a]	81.1%	73.2%	<.01[a]
Heart failure	68.5%	66.1%	<.01[a]	72.3%	70.4%	<.01[a]	86.0%	83.0%	<.01[a]
Prior MI	13.7%	10.0%	<.01[a]	13.6%	9.4%	<.01[a]	19.9%	13.8%	<.01[a]
Peripheral vascular disease	11.8%	10.6%	<.01[a]	13.6%	12.7%	<.01[a]	20.2%	18.7%	.01[a]
Obesity	16.2%	20.0%	<.01[a]	17.5%	21.5%	<.01[a]	24.8%	29.5%	<.01[a]
Anemia	38.3%	41.5%	<.01[a]	46.4%	49.3%	<.01[a]	57.9%	62.7%	<.01 [a]
Smoking	41.9%	31.0%	<.01[a]	39.4%	29.9%	<.01[a]	52.7%	41.2%	<.01[a]
Dyslipidemia	45.6%	43.2%	<.01[a]	46.6%	43.1%	<.01[a]	59.3%	56.0%	<.01[a]
STEMI	20.3%	17.3%	<.01[a]	17.8%	15.3%	<.01[a]	18.5%	15.6%	<.01[a]
Valvular disease	22.3%	25.4%	<.01[a]	28.6%	32.7%	<.01[a]	42.4%	45.9%	<.01[a]
Chronic lung disease	27.8%	30.4%	<.01[a]	24.3%	27.3%	<.01[a]	29.7%	35.4%	<.01[a]
Liver disease	11.0%	8.1%	<.01[a]	11.2%	9.1%	<.01[a]	17.0%	15.0%	<.01[a]
CKD/ESRD	44.4%	39.2%	<.01[a]	44.9%	39.5%	<.01[a]	52.3%	43.7%	<.01[a]
Hypothyroidism	9.2%	19.4%	<.01[a]	9.0%	19.3%	<.01[a]	11.6%	23.0%	<.01[a]
Depression	6.8%	11.7%	<.01[a]	7.3%	12.5%	<.01[a]	10.4%	18.0%	<.01[a]
Drug use disorder	5.6%	3.3%	<.01[a]	5.0%	3.3%	<.01[a]	6.0%	5.0%	<.01[a]
Alcohol use disorder	8.1%	2.7%	<.01[a]	6.8%	2.4%	<.01[a]	9.5%	3.3%	<.01[a]

Values are median (Q1, Q3) or %. *P* values denote comparisons between men and women in each cohort.
CKD, chronic kidney disease; ESRD, end-stage renal disease; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction.
[a] Statistically significant values.

Study outcomes

The primary outcome was in-hospital mortality and secondary outcomes included procedural use, such as right heart catheterization (RHC), PCI, coronary artery bypass graft (CABG), and MCS, as well as LOS and total charges. MCS included extracorporeal membrane oxygenation, percutaneous ventricular assist device, and intraaortic balloon pump. The ICD-10-CM codes used for these outcomes are listed in Supplemental Table S1.

Statistical analyses

Analyses were performed using SAS version 9.4 (SAS Institute). Hospitalizations were stratified by sex and separated into 3 cohorts: (A) direct admission to a spoke hospital without transfer, (B) direct admission to a CS hub without transfer, and (C) interhospital transfer to a CS hub. Categorical variables were summarized as percentages and continuous variables were reported as medians and interquartile ranges, stratified by hospital type, transfer status, and sex. Categorical variables were analyzed with the χ^2 test and continuous variables were evaluated using the nonparametric Wilcoxon rank-sum test given significant data skew.

Multivariable logistic regression modeling was used to evaluate the association between sex and the above study outcomes. The models were adjusted for patient sociodemographic factors and comorbidities. Analyses accounted for the complex NRD survey design, which weighs admissions based on the stratification of hospitals by census region, ownership, location, and bed size. All statistical tests were 2-sided, with $P \leq .01$ indicating statistical significance.

Results

Patient characteristics

There were a total of 618,411 weighted adult hospitalizations for CS (Figure 1), of which 161,121 (26.1%) were directly admitted to a spoke hospital (Cohort A), 410,320 (66.4%) were directly admitted to a hub hospital (Cohort B), and 46,970 (7.6%) were transferred to a hub hospital (Cohort C). The majority of admitted patients were men (62.2%), regardless of hospital type, with a median age of 67.9 years. Table 1 compares the hospitalizations by hospital type, transfer status, and sex. In general, women were older than men irrespective of hospital type and transfer status. Women were significantly more likely to have Medicare and lower rates of private insurance than their men counterparts. More women were in the lowest income quartile, and fewer women were part of the highest income quartile compared to men (all *P* values <.01).

Women generally had fewer comorbidities than men (Table 1). Specifically, women had lower rates of atrial fibrillation, coronary artery disease (CAD), heart failure, prior MI, PVD, smoking, dyslipidemia, liver disease, chronic kidney disease/end-stage renal disease, drug use disorder, and alcohol use disorder (all $P < .01$). However, women had

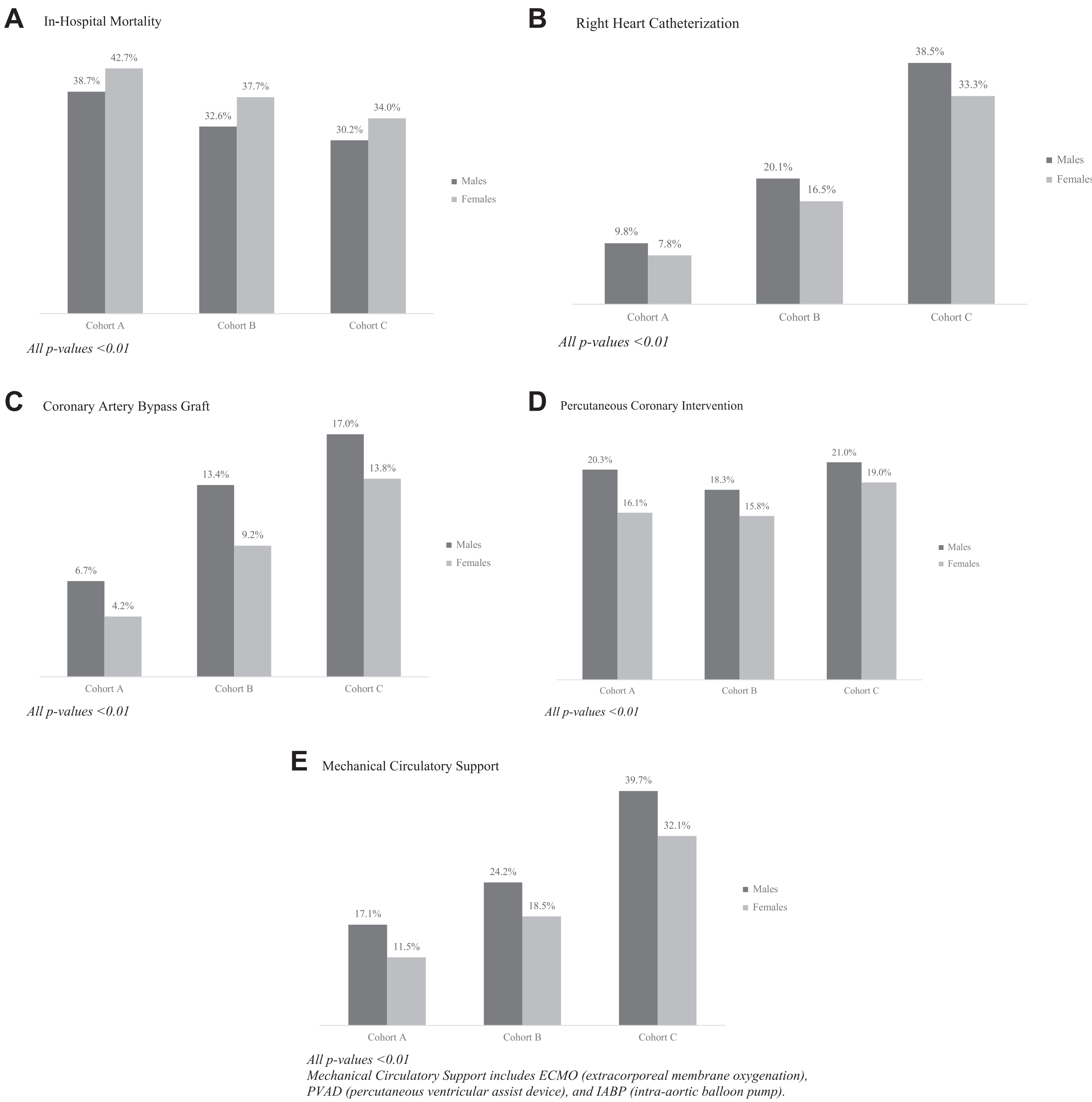


Figure 2.
Sex-based comparison of outcomes during hospitalization stratified by hospital type and transfer status.

higher rates of obesity, valvular disease, chronic lung disease, hypothyroidism, anemia, and depression (all $P < .01$). Among the 3 cohorts, the proportion of patients with AMI-CS ranged between 15.3% and 17.3% in women and 17.8% and 20.3% in men.

CS management and outcomes

Overall, in-hospital mortality for CS remained high, ranging from 30.2% to 42.7% (Figure 2A) among the 3 cohorts. While mortality was lower in hub hospitals for both women and men (Cohorts B and C), women had higher in-hospital mortality than men among all cohorts ($P < .01$).

Rates of procedures were higher in hub hospitals, especially among patients who were transferred. While women who were admitted or transferred to a hub hospital underwent more invasive procedures (ie, RHC, CABG, MCS) than those admitted to spoke hospitals (Figure 2, Table 2), women still underwent less invasive procedures than men regardless of hospitalization type or transfer status (all $P < .01$). Furthermore, on multivariable analysis, female sex was associated with a lower likelihood of undergoing RHC, PCI, CABG, and MCS and was associated with a higher likelihood of in-hospital mortality even after adjusting for patient characteristics and comorbidities (Figure 3, Table 3, Supplemental Tables S2-S5).

In general, patients in Cohorts B and C had higher rates of complications including stroke, AKI, and AKI requiring dialysis than those in Cohort A (Table 2). Among all 3 cohorts, women had higher rates of stroke but lower rates of AKI and AKI requiring dialysis when compared to men. Women in Cohorts B and C had higher rates of mechanical ventilation than men (all $P < .01$). There was no statistically significant difference in the rates of cardiac arrest between men and women in all 3 cohorts.

Table 2. Comparison of hospitalization complications and outcomes stratified by hospital type, transfer status, and sex.

Variable	Direct admission to spoke hospital (Cohort A) n = 161,121			Direct admission to hub hospital (Cohort B) n = 410,320			Transfer to hub hospital (Cohort C) n = 46,970		
	Men	Women	*P* value	Men	Women	*P* value	Men	Women	*P* value
N	96,330 (59.8%)	64,791 (40.2%)		258,031 (62.9%)	152,289 (37.1%)		30,245 (64.4%)	16,725 (35.6%)	
Complications									
Stroke	3.6%	4.1%	<.01[a]	5.0%	5.8%	<.01[a]	6.9%	7.6%	.04
AKI	62.2%	57.2%	<.01[a]	63.2%	57.7%	<.01[a]	74.1%	67.0%	<.01[a]
AKI requiring dialysis	7.3%	6.1%	<.01[a]	9.3%	8.4%	<.01[a]	14.7%	13.6%	.02
Mechanical ventilation	48.9%	48.7%	.68	44.2%	46.4%	<.01[a]	49.7%	53.2%	<.01[a]
Cardiac arrest	13.3%	12.9%	.10	11.3%	11.5%	.21	11.3%	11.5%	.75
Outcomes									
Length of stay, d	5.8 (2.2-11.3)	5.3 (1.8-10.6)	<.01[a]	7.9 (3.6-15.0)	7.4 (3.0-14.2)	<.01[a]	13.7 (7.9-22.8)	13.0 (7.2-21.6)	<.01[a]
Total charges, dollars	108,643 (51,508-220,917)	91,017 (43,833-185,564)	<.01[a]	167,109 (80,829-335,075)	146,474 (69,701-297,096)	<.01[a]	269,808 (144,163-510,596)	245,325 (130,786-451,216)	<.01[a]

Values are median (Q1, Q3) or %. *P* values denote comparisons between women and men in each cohort.
AKI, acute kidney injury.
[a] Statistically significant values.

The median LOS and total charges were higher in Cohort C than in the other cohorts. Notably, women had a shorter median LOS and lower median total charges than men in all cohorts (all $P < .01$).

Transfer status

In general, transferred patients were sicker with higher rates of comorbidities than patients in Cohorts A and B, despite being younger. Notably, a higher proportion of transferred patients were within the highest geographical quartile of household income while a lower proportion were within the lowest quartile when compared to Cohorts A and B. A lower proportion of women were admitted (6.5% women, 6.7% men; $P < .01$) or transferred to hubs (7.2% women, 7.9% men; $P < .01$) (Central Illustration). Patients who were older, women, and had Medicaid were less likely to be transferred while those with private insurance and living in higher geographical income quartiles were more likely to be transferred (Supplemental Table S6).

Discussion

The results of the present study have a number of important findings and vital implications in understanding the persistent sex disparities in the management and outcomes of patients with CS. We redemonstrate in this contemporary data set that, while in-hospital mortality from CS remains high, patients who received care at CS hub hospitals, whether through direct admission or transfers, had lower mortality than those treated at spoke hospitals, consistent with a previous publication.[5] Despite improved outcomes in CS hubs, women were less likely to be treated at or transferred to CS hubs compared to men. Women also had higher mortality and a lower likelihood of receiving reperfusion therapy, invasive hemodynamic monitoring, and MCS compared to men even when admitted to CS hubs.

Sex disparities in CS have often been attributed to differences in patient risk profiles. Previous studies have reported that women with CS have a significantly heightened cardiovascular risk profile, including older age, higher rates of hypertension, metabolic syndrome, and

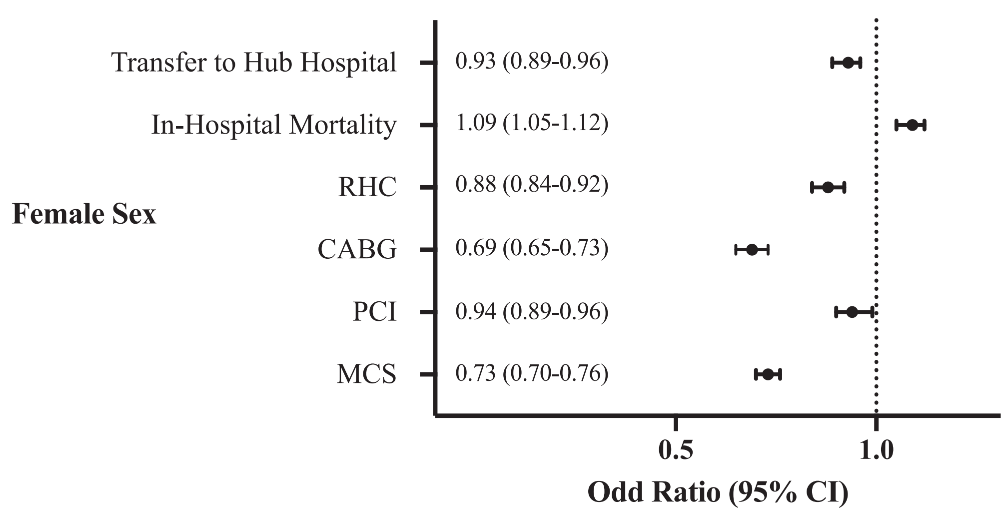


Figure 3.
Multivariable analysis of the association of sex withcardiogenic shock management and outcomes. CABG, coronary artery bypass graft; MCS, mechanical circulatory support; PCI, percutaneous coronary intervention; RHC, right heart catheterization.

Table 3. Multivariable analysis for predictors of mechanical circulatory support.

Variable	Odds ratio	95% CIs	*P* value
Demographics			
Age[a]	0.98	0.98-0.98	<.01[b]
Female sex	0.73	0.70-0.76	<.01[b]
Transfer status	3.32	3.09-3.58	<.01[b]
Insurance status			
Medicare	1 (Reference)		
Medicaid	0.93	0.87-1.00	.05
Private insurance	1.25	1.18-1.32	<.01[b]
Self-pay	1.15	1.02-1.29	.02
Median household income			
Quartile 1 (lowest)	1 (Reference)		
Quartile 2	1.07	1.01-1.13	.03
Quartile 3	1.11	1.03-1.18	<.01[b]
Quartile 4 (highest)	1.10	1.02-1.18	.02
Comorbidities			
Heart failure	1.42	1.34-1.50	<.01[b]
Valvular disease	1.15	1.10-1.21	<.01[b]
Peripheral vascular disease	1.08	1.02-1.14	.01[b]
Liver disease	0.69	0.65-0.74	<.01[b]
Hypertension	1.15	1.10-1.20	<.01[b]
Dyslipidemia	1.20	1.15-1.26	<.01[b]
Atrial fibrillation	0.84	0.81-0.88	<.01[b]
Coronary artery disease	2.79	2.56-3.04	<.01[b]
Depression	0.81	0.76-0.86	<.01[b]
Smoking	1.00	0.96-1.05	1.00
Obesity	1.07	1.02-1.13	.01[b]
Anemia	1.65	1.57-1.72	<.01[b]
Hypothyroidism	0.85	0.80-0.90	<.01[b]
Prior MI	0.88	0.83-0.93	<.01[b]
Diabetes	1.00	0.96-1.04	.92
STEMI	4.79	4.56-5.04	<.01[b]
CKD/ESRD	0.66	0.64-0.69	<.01[b]
Alcohol use disorder	0.72	0.66-0.78	<.01[b]
Chronic lung disease	0.72	0.69-0.76	<.01[b]
Drug use disorder	0.61	0.56-0.67	<.01[b]

CKD, chronic kidney disease; ESRD, end-stage renal disease; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction.

[a] Age was analyzed as a continuous variable; for every year increase, there is a 2% decrease in odds of undergoing mechanical circulatory support. [b] Statistically significant values.

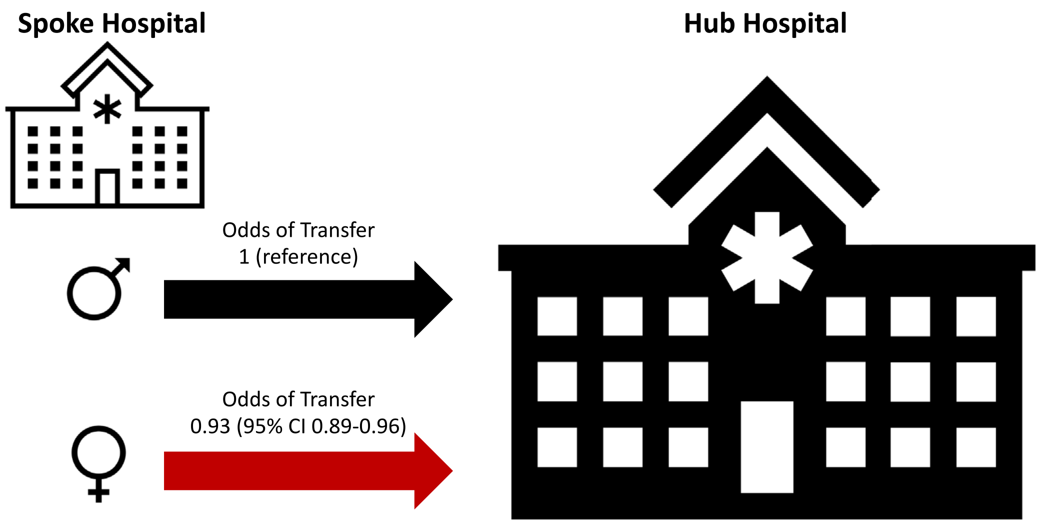
diabetes.[14,15] However, our study showed a different pattern with men having more features consistent with classic metabolic syndrome, including higher rates of CAD, heart failure, prior MI, dyslipidemia, atrial fibrillation, smoking, and chronic kidney disease/end-stage renal disease. Such conditions lead to men having higher rates of ST-elevation myocardial infarction, which could potentially be a reversible cause of CS. In contrast, women had higher rates of other conditions, such as obesity, hypertension, valvular disease, and hypothyroidism. These differences in risk profiles between men and women can potentially explain the differing pathophysiologic mechanisms at play and their contribution to the sex disparities in CS, given that having a lower cardiovascular risk profile has been associated with nonischemic CS.[16,17]

We postulate that the disparity in mortality rates between men and women is further related to discrepancies in access to invasive procedures commonly used in CS. As in other studies, we found that women undergo significantly fewer diagnostic and therapeutic CS-related procedures.[7–9] Some studies have suggested that this variance in management may be due to differences in CS presentation. For example, in patients with AMI, women are more likely to have high-risk presentation, delayed presentation, nonclassic chest pain, and angina-equivalent symptoms such as dyspnea, indigestion, and fatigue.[18,19] Such differences in presentation may lead to misdiagnosis, delayed revascularization, and therefore increased mortality in women.[18] Another plausible explanation is the higher rates of complications with MCS in women which may affect physician decision-making. Previous studies have found that women had worse complications after intraaortic balloon pump placement, possibly due to the smaller size of femoral vessels, lower body surface area, and higher rates of bleeding.[20–22] Similarly, in patients with percutaneous ventricular assist device, 1 study showed that women required more frequent blood transfusions than men, possibly due to higher rates of anemia and a more procoagulant profile predisposing women to develop hemolysis at higher rates than men.[23] A study evaluating patients with acute coronary syndrome who underwent PCI found that women had more bleeding and vascular complications than men, mostly due to access site complications (retroperitoneal bleed, pseudoaneurysm, and bleeding at the entry site).[24] These complications may also explain differences in the medical management of women, including decreased use of antiplatelet therapies both during admission and at the time of discharge despite guideline recommendations.[24] Fortunately, more recent studies have shown that improved operator experience with MCS and improved devices have decreased rates of major bleeding and vascular complications for both men and women.[25]

This study suggests that another potential explanation for the sex disparities in CS may be access to high-level centers where patients receive care. To our knowledge, this is the first contemporary US study to evaluate sex disparities in CS based on treatment facilities using a large nationally representative sample. One reason why women are admitted or transferred less to hub hospitals may be that they have less AMI-CS compared to men, consistent with other studies.[16] It is also plausible that patients may be transferred with a specific procedure or intervention in mind, and women generally undergo fewer of these procedures. Even when women do have AMI-CS, urgent management may be delayed due to the more common atypical symptoms seen in women. It is also possible that there are patient-level differences in preference, such as greater advocacy by men patients and their families to be treated at more specialized centers[10] or family dynamics and responsibility burden in women that decrease women' desire for transfer. Furthermore, previous work has shown that some women with nonclassic angina are more likely to underreport their symptoms and express a fear of appearing hypochondriacal.[26]

It is additionally crucial to ensure that cases of nonischemic CS are recognized promptly and managed as urgently as AMI-CS based on the Society for Cardiovascular Angiography & Interventions Classification of CS,[27] particularly as standardization of approach may help decrease the sex disparities in outcomes. Etiologies of nonischemic CS include decompensated heart failure, myocarditis, stress cardiomyopathy, valvular disease, and arrhythmias among others,[28] which may be more prevalent in women in our study given lower rates of AMI and CAD. Notably, treatment patterns differ between AMI-CS and nonischemic CS. Namely, patients with nonischemic CS are more likely to be treated with catecholamines and less likely to receive MCS.[16,29] Furthermore, patients with nonischemic CS have been found to have a higher mortality risk than those with AMI-CS,[16] possibly also contributing to the mortality difference between men and women in our study. Further work should focus on assessing sex differences in admissions and transfers to CS hubs based on the etiology of CS.

This study should be interpreted in the context of certain limitations. First, we identified diagnoses and procedures using ICD-10-CM codes, which portends a risk of misclassification. The use of ICD-10-CM codes also does not allow for obtaining important clinical characteristics such as hemodynamics, severity or stage of shock, end-organ function, medication use, and time elapsed for reperfusion therapies, which may limit our ability to assess sex differences in these factors. Second, the NRD does not provide the reason for transfer or timing between the development of shock and subsequent transfer, limiting our understanding of peritransfer decision-



Central Illustration.
Odds of being transferred to a hub hospital stratified by sex.

making. Third, the NRD does not include data on race and ethnicity which may play an additional role given the important intersection between race and sex. Multiple studies have shown disparities in cardiovascular care and outcomes among Black, Hispanic, and Native Americans.[18,30–32] It is also well-documented that Black women are referred less to coronary angiography and reperfusion when compared to White women and Black men[33–35] and women from all ethnic backgrounds are less likely to undergo PCI and CABG compared to their men counterparts.[36] Fourth, while the NRD is a nationally representative database, it is derived from state inpatient databases, leading to a small percentage of transfers being unaccounted for (eg, federal hospitals, across state lines). Fifth, this data set does not differentiate between sex, gender, and gender identity. Finally, another limitation to working with retrospective databases such as the NRD is that long-term outcomes following CS admission cannot be assessed.

Conclusion

To our knowledge, this is the first US study using a nationally representative sample to evaluate sex disparities in the treatment and outcomes of CS, as they relate to hospital type. We found that patients who receive care at CS hub hospitals have lower mortality than those treated at spoke hospitals. However, a lower proportion of women are treated in CS hubs and women are less likely to be transferred to CS hubs than men. Women with CS have higher in-hospital mortality than men and a lower likelihood of receiving reperfusion therapy, invasive hemodynamic monitoring, and MCS compared to men even if admitted to a CS hub. An understanding of the driving forces that underly these disparities at the health care system level can help inform medical guidelines and hospital policies. Future research should include prospective, qualitative, and patient-level studies to help close sex-specific gaps in patient outcomes.

Declaration of competing interest

Jim Cheung has received consulting fees from Abbott, Boston Scientific, and Biotronik, and has received fellowship grant support from Abbott, Biotronik, Boston Scientific, and Medtronic. All other authors have nothing to disclose.

Funding sources

This work was supported by grants from the Michael Wolk Heart Foundation (New York, New York), the New York Cardiac Center, Inc (New York, New York), and the NewYork Weill Cornell Medical Center Alumni Council (New York, New York). The Michael Wolk Heart Foundation, the New York Cardiac Center, Inc, and the NewYork Weill Cornell Medical Center Alumni Council had no role in the design and conduct of the study, in the collection, analysis, and interpretation of the data, or in the preparation, review, or approval of the manuscript.

Ethics statement and patient consent

An ethical publication statement is not required because all data collection was derived from a deidentified administrative database.

Supplementary material

To access the supplementary material accompanying this article, visit the online version of the *Journal of the Society for Cardiovascular Angiography & Interventions* at 10.1016/j.jscai.2023.101212.

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