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Research Paper

Sex and race disparities in emergency department patients with chest pain and a detectable or mildly elevated troponin☆

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ABSTRACT

Background: Identifying and eliminating health disparities is a public health priority. The goal of this analysis is to determine whether cardiac testing or outcome disparities exist by race or sex in patients with detectable to mildly elevated serum troponin.

Methods: We conducted a secondary analysis of the CMR-IMPACT trial that randomized patients with symptoms suggestive of acute coronary syndrome and a detectable or mildly elevated troponin measure from 4 US hospitals to an early invasive angiography or cardiac MRI strategy. The primary endpoint was the composite of all-cause mortality, myocardial infarction, cardiac hospital readmission, and repeat cardiac ED. Secondary outcomes were components of the composite and revascularization.

Results: Participants (n = 312, mean age 61 ± 11 years) were 36.2 % non-white and 40.1 % female. The composite outcome occurred in 63.7 % of non-white vs. 49.8 % of white patients (aHR 1.50, 95 % CI 1.08–2.09) and 53.6 % of female vs. 55.6 % of male patients (aHR 0.93, 95 % CI 0.68–1.28). Non-white (aHR 0.57, 95 % CI 0.35–0.92) patients had lower rates of revascularization also less median stenosis ($p < 0.001$) and stenosis >70 % ($p < 0.001$) during index cardiac testing. Despite these findings, ACS after discharge was higher among non-white patients (aHR 1.84, 95 % CI 1.11–3.05). Females had lower rates of revascularization (aHR 0.52, 95 % CI 0.33–0.82), but no increase in ACS after discharge (aHR 0.90, 95 % CI 0.55–1.49).

Conclusion: Non-white patients had higher rates of ACS following discharge despite lower rates of obstructive CAD following standardization of index cardiac testing. Future disparity works should explore care following the index encounter.

Abbreviations: ED, Emergency department; US, United States; ACS, acute coronary syndrome; CMR, cardiac MRI; MI, myocardial infarction; MACE, major adverse cardiac events; aHR, adjusted hazard ratio; aOR, adjusted odds ratio; CI, confidence interval; CAD, coronary artery disease.

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1. Introduction

Heart disease is the leading cause of death in nearly all demographic populations, regardless of race or sex [1]. The advent of high-sensitivity troponins have greatly improved the detection of acute coronary syndrome (ACS) in patients presenting to the emergency department (ED) with chest pain [2–5]. However, despite these advancements, non-white and female patients continue to experience inequities in diagnostic testing and treatment during their initial presentation and follow-up care, potentially leading to poorer health outcomes for these populations [6–11].

Prior work on sex and race disparities have primarily focused on testing and treatment of patients with confirmed myocardial infarction (MI) or the risk stratification of lower risk patients [10–17]. These important works continue to illustrate the vulnerability of non-white and female populations, who have been shown to undergo less diagnostic testing, receive less treatment through revascularization, and have higher cardiac mortality. However, to our knowledge, no prior studies address the moderate- to high-risk ED patient populations or elucidate the underlying cause for health inequities in this population. Previous publications suggest that the creation of a standardized care pathway could alleviate these disparities at initial presentation [18,19], but no prior study has provided a system of randomization to confirm or deny this hypothesis. The CMR-IMPACT trial includes a unique population of patients with detectable to mildly elevated serum troponin near the time of ED triage [20]. Further, the CMR-IMPACT trial randomized the initial diagnostic testing to invasive angiography or non-invasive perfusion testing with cardiac magnetic resonance imaging. Analysis of disparities in the CMR-IMPACT cohort not only examines a novel patient population—it allows a unique mechanistic insight, as the randomization scheme largely determined the initial diagnostic testing approach. Therefore, if disparities relate to the index cardiovascular testing choice, those should be reduced in this analysis, allowing the assessment of other potential sources of disparities to be more apparent.

The goal of this analysis is to determine whether race or sex disparities in cardiac testing and outcomes exist in patients with detectable to mildly elevated serum troponin with possible ACS when their initial cardiac diagnostic testing is assigned by randomization. This will help inform whether future efforts to promote health equity should focus on early care standardization or downstream management.

2. Methods

2.1. Study design and setting

We conducted a secondary analysis of the Cardiac MRI versus Invasive-based Strategies in Patients with Chest Pain and Detectable to Mildly Elevated Serum Troponin: A Randomized Clinical Trial (CMR-IMPACT; ClinicalTrials.gov: NCT01931852) trial [20]. This study prospectively enrolled patients from four US academic referral centers with high-volume EDs (Corewell Health William Beaumont University Hospital, formerly Beaumont Hospital, Royal Oak, MI; University of Mississippi, Jackson; Ohio State University, Columbus, OH; Wake Forest University, Winston-Salem, NC) from September 2013 to July 2018. CMR stress and invasive angiography with revascularization capabilities were available at all participating institutions. Patients were randomized between CMR- and invasive-based treatment strategies. Participants assigned to the invasive-based care pathway were evaluated by the admitting or consulting Cardiology team, and if the patient met ACC/AHA guideline recommendations, underwent invasive angiography as the initial diagnostic modality [20]. CMR-based participants were similarly evaluated by the admitting or consulting Cardiology team, and if deemed appropriate, underwent initial CMR stress imaging. This investigation was approved by the institutional review board at each study site. All participants provided written informed consent to participate in the study.

2.2. Population

Adult patients ≥21 years old with symptoms suggestive of ACS and at least 1 serum troponin value above the lower limit of detection with no troponin results >1.0 ng/ml were considered. Troponin assays used by individual sites can be found in the supplemental material of the primary manuscript [20]. Study coordinators approached potentially eligible patients in the ED following clinical data review. Exclusion criteria included completion of index visit stress testing or coronary angiography prior to enrollment, ongoing symptoms requiring emergent cardiac catheterization, hemodynamic instability, new ST-segment elevation (≥1 mm) or depression (≥2 mm) at presentation, prior severe multi-vessel coronary artery disease determined to be inappropriate for mechanical intervention, revascularization in the past 6 months, life expectancy <6 months, prior solid organ transplant, creatinine clearance <30 ml/min or < 60 ml/min with concurrent hepato-renal syndrome or chronic liver disease, and any contraindications to CMR-stress testing.

2.3. Demographics

Sex and race were self-reported by patients during hospital registration and later abstracted from patient records by research staff. Sex was defined as either female or male. Race was defined as white, Native American, Asian, Pacific Islander, African American, and Other. The study cohort only included a few patients that identified as Native American, Asian, and Pacific Islander, and patients were ultimately categorized into white or non-white race groups due to statistical limitations. Ethnicity data was gathered in concurrence with other demographic data and treated separately from race but was not examined as part of this analysis.

2.4. Outcomes

The study's primary outcome was a composite of all-cause mortality, MI after randomization, cardiac hospital readmission, and repeat cardiac ED visits. Secondary outcomes were invasive angiography, recurrent cardiac testing (cardiac echocardiography, CMR, invasive angiography, nuclear imaging, and coronary CT angiography after discharge), and coronary revascularization. The safety endpoint was ACS following discharge, comprised of either cardiac death, MI, or emergent revascularization. Major adverse cardiac events (MACE; composite of death, MI, or revascularization) was also considered at 90-days and throughout follow-up. Outcome events were adjudicated based on the consensus of three cardiovascular experts. MI was defined based on the Fourth Universal Definition of MI: rise and fall of troponin (with at least one value >99th percentile URL) with symptoms of ischemia, electrocardiogram evidence of ischemia, or imaging evidence of new non-viable myocardium or a new regional wall motion abnormality [12].

2.5. Statistical analysis

The study population was described using counts, percentages, means, and standard deviations. Cox proportional hazards models were used to evaluate the association between sex or race and the outcomes of interest. The time to the composite outcome was defined as the minimum time to any of the component events. Similarly, component times and other secondary and safety outcome times were defined as time to the first event for the event of interest. Patients who were lost to follow-up were considered censored at their last contact. For the outcome of 90-day MACE, logistic regression models were used. Both unadjusted and adjusted models were performed for all outcomes. Multivariable models assessed the association between race or sex and the outcomes of interest while adjusting for other well-known variables associated with cardiovascular disease, including sex or race, age, prior coronary artery

disease, troponin, diabetes, hypertension, and hyperlipidemia [13]. Unadjusted or adjusted hazard ratios (aHR) were reported as appropriate for all Cox proportional hazards models and unadjusted or adjusted odds ratios (aOR) were reported for all logistic regression models, each with a corresponding 95 % confidence interval (CI). For patients undergoing cardiac catheterization or CT coronary angiogram at index, maximum stenosis was compared between white and non-white patients using a Wilcoxon rank-sum test and those with a maximum stenosis of at least 70 % were compared between white and non-white patients using a Fisher's exact test. For patients with a maximum stenosis of <70 % or a negative test at index, ACS after discharge was compared between white and non-white patients using a Fisher's exact test.

3. Results

During the study period, 312 patients with symptoms suggestive of possible ACS were enrolled and eligible for analysis (Fig. 1). The cohort was comprised of 36.2 % (113/312) non-white patients and 40.1 % (125/312) female patients with a mean age of 60.6 ± 11.3 years. Black or African American patients comprised the majority of the non-white population at 93.8 % (106/113). The primary composite outcome occurred in 54.8 % (171/312) of patients, with all-cause mortality occurring in 9.9 % (31/312), MI in 21.6 % (66/312), cardiac hospital readmission in 38.5 % (120/312), and repeat cardiac ED visit in 44.9 % (140/312). Table 1 summarizes additional characteristics of the CMR-IMPACT cohort overall and separately by the sex and race subgroups.

Race-based comparisons for health outcomes and testing rates can be found in Table 2. The primary composite outcome occurred in 63.7 % (72/113) of non-white vs. 49.8 % (99/199) of white patients (aHR 1.50, 95 % CI 1.08–2.09). The race-based difference in the composite outcome was driven by higher rates of MI (aHR 1.71, 95 % CI 1.01–2.88) and repeat cardiac ED visits (aHR 1.70, 95 % CI 1.18–2.45) in the non-white population. Non-white patients also had a higher likelihood of recurrent cardiac testing (aHR 1.43, 95 % CI 1.02–2.01), but lower rates of revascularization (aHR 0.57, 95 % CI 0.35–0.92). This subsequently led to an overall lower MACE rate at 90 days (aOR 0.54, 95 % CI 0.31–0.94) that was not significantly different through follow up (aHR, 0.81, 95 % CI 0.57–1.15).

Table 3 compares rates of stenosis during index testing by race, with a subsequent analysis of which patients suffered ACS following discharge in Fig. 2. Non-white patients had less median stenosis ($p < 0.001$) and less actionable stenosis (>70 % occlusion, $p < 0.001$) following index cardiac testing when compared to their white counterparts. Among those with <70 % stenosis or a negative test, 27.4 % (20/73) of non-white patients had ACS after discharge compared to 9.9 % (9/91) of white patients ($p = 0.004$).

Sex-based comparisons for health outcomes and testing rates can be found in Table 4. The primary composite outcome occurred in 53.6 % (67/125) of female vs. 55.6 % (104/187) of male patients (aHR 0.93, 95 % CI 0.68–1.28). Females, compared to males, had similar rates of death (aHR 0.67, 95 % CI 0.31–1.43) and MI (aHR 0.82, 95 % CI 0.49–1.39). Females also experienced a lower rate of revascularization (aHR 0.52, 95 % CI 0.33–0.82), which parallelled an overall lower rate of MACE at 90 days (aOR 0.54, 95 % CI 0.30–0.99) that persisted through follow up (aHR 0.61, 95 % CI 0.43–0.86). There was no detectable difference in recurrent cardiac testing (aHR0.91, 95 % CI 0.66–1.27) or ACS after discharge (aHR 0.90, 95 % CI 0.55–1.49).

4. Discussion

The results of this analysis demonstrate that non-white patients have a higher incidence of ACS in follow up despite having a lower burden of coronary disease or positive testing during the index encounter. We found a lower rate of revascularization during the index visit in both non-white patients and women in the context of a randomized clinical trial, in which the randomization scheme should have controlled for differences in cardiac testing. Prior publications have extensively documented worse cardiovascular outcomes among minorities compared to white patients in the US [21–26]. We now provide

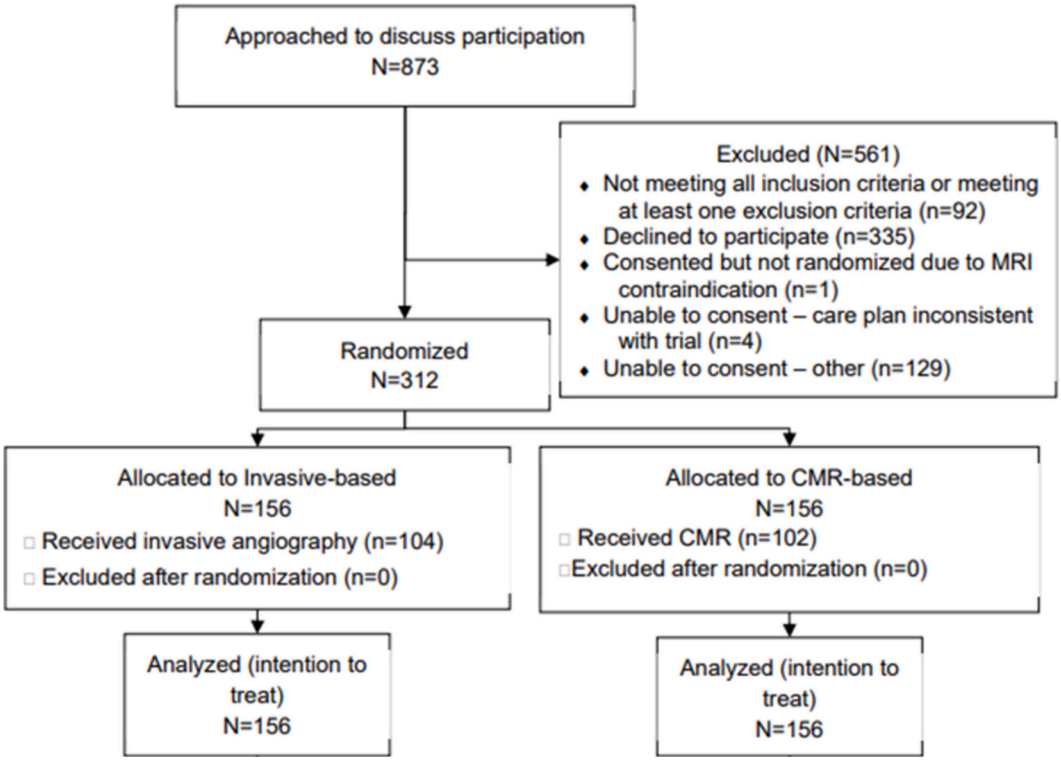

Fig. 1. Case flow diagram.

Table 1
CMR-IMPACT cohort patient characteristics.

Patient characteristics	Overall n (%) or mean (SD) (*n* = 312)	Female n (%) or mean (SD) (*n* = 125)	Male n (%) or mean (SD) (*n* = 187)	Non-White n (%) or mean (SD) (*n* = 113)	White n (%) or mean (SD) (*n* = 199)
Age, yrs	60.6 ± 11.3	60.2 ± 12.3	60.8 ± 10.6	56.7 ± 10.8	62.8 ± 10.9
Sex					
Female	125 (40.1)	125 (100)	0 (0)	54 (47.8)	71 (35.7)
Male	187 (59.9)	0 (0)	187 (100)	59 (52.2)	128 (64.3)
Race					
White	199 (63.8)	71 (56.8)	128 (68.4)	0 (0)	199 (100)
Non-white	113 (36.2)	54 (43.2)	59 (31.6)	113 (100)	0 (0)
Native American	1 (0.3)	1 (0.8)	0 (0)	1 (0.9)	
Asian	2 (0.6)	1 (0.8)	1 (0.5)	2 (1.8)	
Pacific Islander	1 (0.3)	1 (0.8)	0 (0)	1 (0.9)	
Black or African American	106 (34.0)	50 (40.0)	56 (29.9)	106 (93.8)	
Other[a]	3 (1.0)	1 (0.8)	2 (1.1)	3 (2.7)	
Ethnicity					
Hispanic or Latino	3 (1.0)	1 (0.8)	2 (1.1)	1 (0.9)	2 (1.0)
Not Hispanic or Latino	309 (99.0)	124 (99.2)	185 (98.9)	112 (99.1)	197 (99.0)
Risk factors					
Weight, lbs	199.5 ± 42.9	186.0 ± 43.1	208.5 ± 40.4	204.1 ± 46.6	196.9 ± 40.5
Height, inches	67.6 ± 4.2	64.0 ± 2.8	70.0 ± 3.1	67.4 ± 4.4	67.7 ± 4.1
Current or history of smoking[a]	197 (63.5)	76 (61.3)	121 (65.1)	70 (62.5)	127 (64.1)
Current or history of cocaine use[a]	33 (10.7)	10 (8.1)	23 (12.4)	17 (15.3)	16 (8.1)
Hypertension	238 (76.3)	102 (81.6)	136 (72.7)	94 (83.2)	144 (72.4)
Diabetes	112 (35.9)	47 (37.6)	65 (34.8)	47 (41.6)	65 (32.7)
Hyperlipidemia	186 (59.6)	64 (51.2)	122 (65.3)	61 (54.0)	125 (62.8)
Prior congestive heart failure	39 (12.5)	15 (12.0)	24 (12.8)	14 (12.4)	25 (12.6)
Prior coronary artery disease	128 (41.0)	45 (36.0)	83 (44.4)	42 (37.2)	86 (43.2)
Prior MI	83 (26.6)	31 (24.8)	52 (27.8)	24 (21.2)	59 (29.7)
Prior stent/PCI	87 (27.9)	30 (24.0)	57 (30.5)	27 (23.9)	60 (30.2)
Prior CABG	41 (13.1)	9 (7.2)	32 (17.1)	10 (8.9)	31 (15.6)
Prior coronary invasive angiography	130 (41.7)	42 (33.6)	88 (47.1)	37 (32.7)	93 (46.7)
Prior cerebral vascular accident	34 (10.9)	11 (8.8)	23 (12.3)	10 (8.9)	24 (12.1)
Prior peripheral vascular disease[a]	28 (9.0)	9 (7.2)	19 (10.3)	11 (9.8)	17 (8.6)
Family history of ACS[a]	142 (45.7)	61 (49.2)	81 (43.3)	47 (42.0)	95 (47.7)

Abbreviations: myocardial infarction (MI); percutaneous coronary intervention (PCI); coronary artery bypass graft (CABG); acute coronary syndrome (ACS).

[a] The one patient with missing race is considered to be other race for this analysis; 2 patients are missing smoking status, 3 patients are missing cocaine or amphetamine use, 2 patients are missing information on peripheral vascular disease, and 1 patient is missing information on family history of acute coronary syndrome.

Table 2
Health and treatment outcomes by race (comparing non-white to white).

Outcomes	Non-White (*N* = 113) n (%)	White (*N* = 199) n (%)	HR or OR (95 % CI)	aHR or aOR (95 % CI)
Primary outcome[a]				
Composite	72 (63.7)	99 (49.8)	**1.41 (1.04–1.91)**	**1.50 (1.08–2.09)**
Death[b]	13 (11.5)	18 (9.1)	1.29 (0.63–2.63)	1.46 (0.69–3.12)
Myocardial infarction	30 (26.6)	36 (18.1)	1.54 (0.95–2.50)	**1.71 (1.01–2.88)**
Cardiac hospital readmission	47 (41.6)	73 (36.7)	1.19 (0.82–1.71)	1.26 (0.85–1.87)
Cardiac emergency department visit	61 (54.0)	79 (39.7)	**1.54 (1.10–2.15)**	**1.70 (1.18–2.45)**
Secondary outcomes[a]				
Invasive angiography	65 (57.5)	131 (65.8)	0.82 (0.61–1.11)	0.79 (0.58–1.09)
Recurrent cardiac testing	66 (58.4)	94 (47.2)	1.29 (0.94–1.77)	**1.43 (1.02–2.01)**
Coronary revascularization	25 (22.1)	73 (36.7)	**0.56 (0.35–0.87)**	**0.57 (0.35–0.92)**
Major adverse cardiac events				
90 days[c]	26 (23.0)	75 (37.7)	**0.49 (0.29–0.83)**	**0.54 (0.30–0.99)**
End of follow-up[a]	53 (46.9)	104 (52.3)	0.79 (0.57–1.10)	0.81 (0.57–1.15)
Safety events[a]				
Acute coronary syndrome after discharge	33 (29.2)	37 (18.6)	**1.65 (1.03–2.63)**	**1.84 (1.11–3.05)**
Cardiac death	3 (2.7) *N* = 110	6 (3.1) *N* = 194	0.90 (0.22–3.59) 0.88	NA

Models adjusted for: age, sex, strata (prior CAD and troponin), hyperlipidemia, hypertension, diabetes.
Bold status denotes clinical significance.
[a] Cox proportional hazards regression.
[b] 9 cardiac deaths, 14 non-cardiac deaths and 8 unknown type deaths; only adjusted for age and sex.
[c] Logistic regression.

Table 3
Rates of maximum stenosis by race (comparing non-white to white).

Maximum stenosis	Non-White (*n* = 58)	White (*n* = 124)	*p*-Value
Median (IQR)	50 (0–90)	90 (50–100)	<0.001
70 % n (%)	23 (39.7 %)	85 (68.5 %)	<0.001

additional insight from the CMR-IMPACT trial that these events are primarily due to myocardial infarction, which occurred more frequently among patients with stenosis <70 %. In contrast, white patients with ACS after discharge most commonly occurred among those with stenosis >70 %. This suggests that the disparity in health outcomes for non-white patients does not reside with the decision to undergo revascularization, but instead with downstream factors. Despite lower rates of actionable stenosis on catheterization, non-white patients continue to face higher rates of ACS after discharge.

Non-white patients had lower rates of revascularization. This is consistent with prior race disparity works that have not only identified disparities in revascularization but further associated them with higher mortality rates, which was attributed to socioeconomic status, rates of follow up, and provider bias [6,7,11,14,15,27]. This study suggests that the perceived disparity in revascularization rates may represent

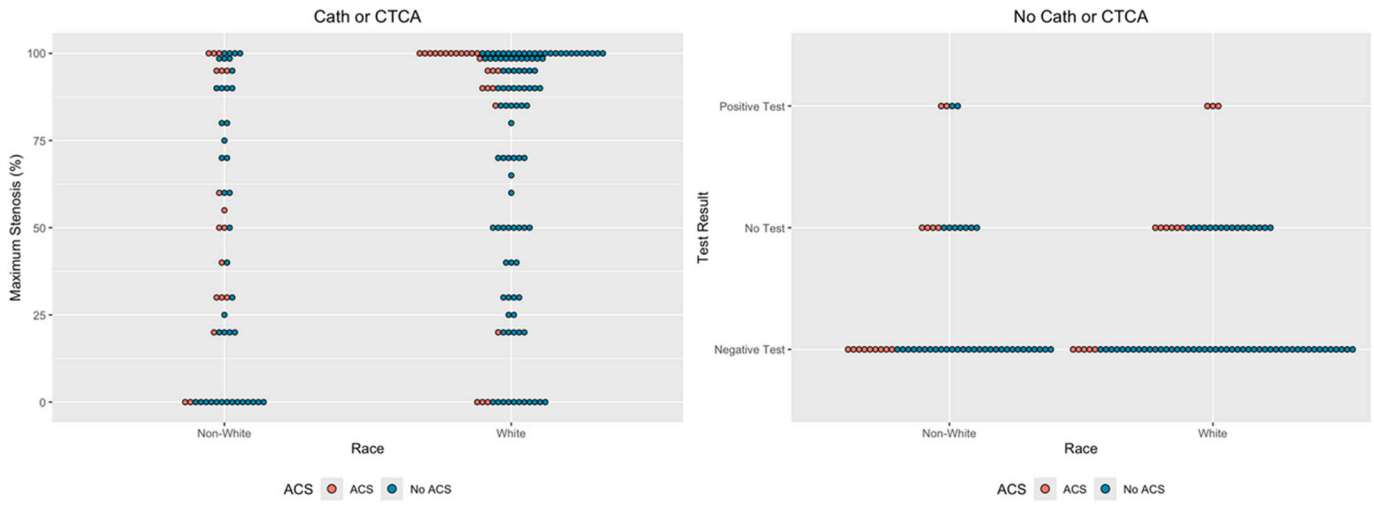

Fig. 2. ACS after discharge by percent maximum stenosis and stress test result.
Includes results for patients with a stress echo, stress MRI or stress nuclear without catheterization or CTCA at index. The no testing category includes 1 patient with an unknown stress nuclear result.

Table 4
Health and treatment outcomes by sex (comparing female to male).

Outcomes	Female (N = 125) n (%)	Male (N = 187) n (%)	HR or OR (95 % CI)	aHR or aOR (95 % CI)
Primary outcome[a]				
Composite	67 (53.6)	104 (55.6)	0.97 (0.72–1.32)	0.93 (0.68–1.28)
Death[b]	10 (8.0)	21 (11.2)	0.70 (0.33–1.48)	0.67 (0.31–1.43)
Myocardial infarction	24 (19.2)	42 (22.5)	0.83 (0.50–1.37)	0.82 (0.49–1.39)
Cardiac hospital readmission	46 (36.8)	74 (39.6)	0.92 (0.64–1.33)	0.94 (0.64–1.37)
Cardiac emergency department visit	57 (45.6)	83 (44.4)	1.05 (0.75–1.47)	1.04 (0.74–148)
Secondary outcomes[a]				
Invasive angiography	72 (57.6)	124 (66.3)	0.81 (0.61–1.09)	0.84 (0.62–1.14)
Recurrent cardiac testing	63 (50.4)	97 (51.9)	0.95 (0.69–1.31)	0.91 (0.66–1.27)
Coronary revascularization	26 (20.8)	72 (38.5)	**0.48 (0.31–0.76)**	**0.52 (0.33–0.82)**
Major adverse cardiac events				
90 days[c]	30 (24.0)	71 (38.0)	**0.52 (0.31–0.86)**	**0.54 (0.31–0.94)**
End of follow-up[a]	50 (40.0)	107 (57.2)	**0.60 (0.43–0.85)**	**0.61 (0.43–0.86)**
Safety events[a]				
Acute coronary syndrome after discharge	27 (21.6)	43 (23.0)	0.91 (0.56–1.48) 0.71	0.90 (0.55–1.49) 0.69
Cardiac death	4 (3.3) *N* = 123	5 (2.8) *N* = 181	1.17 (0.31–4.36)	NA

Models adjusted for: age, race, strata (prior CAD and troponin), hyperlipidemia, hypertension, diabetes.
Bold status denotes clinical significance.
[a] Cox proportional hazards regression.
[b] 9 cardiac deaths, 14 non-cardiac deaths and 8 unknown type deaths; only adjusted for age and race.
[c] Logistic regression.

appropriate care. Following standardization of cardiac testing, non-white patients had a lower burden of coronary artery disease (CAD) when compared to their white counterparts, with less median stenosis and lower actionable stenosis of >70 % occlusion. However, despite lower rates of CAD on index testing, non-white patients suffer higher rates of ACS after discharge. Due to unclear social or environmental forces, mortality rates persist beyond care provided during the index visit. To further characterize this affected population, non-white patients presenting with ACS after discharge were often without obstructive CAD on their index visit, while most subsequent white patients were found to have obstruction. These findings offer a unique vantage point into how we might begin to address these continued disparities in mortality—not through index testing decisions—but rather by addressing factors downstream of the index visit.

Prior disparity works have identified links between socioeconomic status and health outcomes for a diverse population with chest pain. Financial instability has been associated with decreased rates of hospital follow up due to employment time restrictions and lack of insurance [16,17]. The financial burden of outpatient management is also an important consideration, with health insurance, copay, and medication costs adding another barrier to access. Regional access to primary care and cardiac specialty providers are also an important healthcare access consideration. In our study, non-white patients showed a higher utilization of the ED after their index visit, which may indicate a difficulty in access to specialty cardiac care or could simply reflect their higher frequency of acute illness after discharge. While these factors may contribute to our findings, our work did not explicitly explore these social drivers of health and cannot clarify this relationship.

Women had similarly reduced rates of revascularization yet did not experience the increase in ACS after discharge seen among non-white patients. Other studies with similar findings as ours have proposed theories to include a perception that intervention in women pose higher risk with decreased treatment efficacy and difficulties with initial ACS diagnosis [28,29]. Early revascularization studies reported higher perioperative mortality for women than men, possibly explained by greater technical difficulty and diminished revascularization due to narrower coronary arteries, leading to incomplete symptom relief. However, long-term survival was similar, suggesting similar therapeutic benefit [28,30–32]. This is echoed by our findings that suggest that a lower rate of revascularization for women is not associated with a difference in downstream cardiac events.

This study has limitations. While the decision for index testing was randomized, there was still provider discretion allowed, which could

have allowed bias in index testing to persist. The analysis did not have a control group; it is possible that standardizing index testing reduced disparities from what would have existed in usual care and that would not have been detected. Although the source study was conducted across multiple US EDs, the sites were mostly urban academic medical centers, and thus may not be generalizable to all ED settings. The study screened a large number of patients to identify the cohort, which could have introduced selection bias. The study population also represents a convenience sample, with patients enrolled when study coordinators were available, mostly during weekdays during daytime hours. The initial trial also reported an imbalance between male patients among the invasive- and CMR-based groups, which may have unintentional effects on the sex-based analysis of this study. Due to limitations on how race data were collected, a more thorough analysis of race interactions could not be performed. Finally, while we can hypothesize on the source of the racial disparity, we were unable to adjust for secondary prevention measures and cannot determine the role of such measures on outcomes. The primary CMR-IMPACT trial had several strengths—a multicenter design, robust capture of follow up events, and the reflection of real clinical practice with early enrollment, whereby the admitting service and often the diagnostic strategy are determined near the time of admission [20].

In this US cohort, race- and sex-based differences exist in testing despite randomization of initial cardiac diagnostic testing for ED patients with chest pain and a detectable or mildly elevated serum troponin. Non-white patients had higher rates of ACS following discharge despite lower rates of obstructive CAD. Female patients had lower rates of revascularization without differences in downstream cardiac events, which may be a beneficial finding. Future racial disparity prevention should focus on identifying factors downstream of the initial encounter.

CRediT authorship contribution statement

Lucas M. Boyer: Writing – review & editing, Writing – original draft, Visualization. **Anna C. Snavely:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Jason P. Stopyra:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Subha V. Raman:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Jeffrey M. Caterino:** Writing – review & editing, Supervision, Conceptualization. **Carol L. Clark:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Alan E. Jones:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Michael E. Hall:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Carolyn J. Park:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Brian C. Hiestand:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Sujethra Vasu:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Michael A. Kutcher:** Writing – review & editing, Supervision, Data curation, Conceptualization. **W. Gregory Hundley:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Simon A. Mahler:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Chadwick D. Miller:** Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization.

Ethical statement

Manuscript is presented as original research, with data presented accurately and objectively. Data can be made available upon appropriate request. The provided work is original with all supporting works appropriately referenced. This work is not under consideration with any other publisher. All co-authors agreed to the publishing of this work and have all made significant contribution to the project. AI or AI-assisted technologies were not utilized in the scientific writing process.

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