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Fractional flow reserve use during elective coronary angiography among elderly patients in the US

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ABSTRACT

Fractional flow reserve (FFR) is a physiologic measurement of coronary artery perfusion. Studies have demonstrated its benefit in lowering cost and improving outcomes in patients undergoing elective coronary angiography, though follow-up surveys have demonstrated low usage nationwide. We sought to investigate the actual usage in elderly patients undergoing elective coronary angiography. Overall utilization of FFR for elective coronary angiography was 6.3%. Age, sex, race, prior stress testing and region of the country were all statistically significant predictors for FFR use. There still exist many barriers to widespread adoption of this modality, which require further exploration.

Recent reports suggest physiologic assessment of coronary artery disease (CAD) prior to revascularization is low despite guidelines supporting its use [1,2]. In prior work, we found <10% of Medicare beneficiaries undergoing elective percutaneous coronary intervention (PCI) received fractional flow reserve (FFR) or equivalent physiological measurements [3]. A critique of that analysis (and similar studies from the National Cardiovascular Data Registry [4]) was the focus on patients undergoing PCI. Low use in this setting may be explained by omitting situations in which FFR was used, but PCI was deferred. Studying FFR in all-comers for elective, diagnostic coronary angiography would allow better determination of factors associated with its use.

We used the 20% random sample from the Medicare Carrier, Medicare Provider and Analysis, Outpatient and Denominator files. We restricted patients in our cohort to their index coronary angiogram between January 1, 2012 and December 31, 2014. We included Medicare beneficiaries aged 65 to 99 years old who were fee-for-service eligible for at least three months prior and one month after their procedure to fully capture claims around the procedure. To ensure that the angiograms were elective, we excluded those with a history of acute myocardial infarction or those with emergency department visits at the time of their procedure. We excluded patients who underwent valve studies or procedures within the past year or had a diagnosis of valvular disease. We then determined the use of FFR, stratified on the basis of no revascularization versus revascularization with either coronary artery bypass grafting (CABG) or PCI within 30 days of index coronary angiogram. International Classification of Diseases-9 codes to identify diseases and procedures in this analysis are available in the Supplementary materials. We constructed multivariable logistic regression models to evaluate for factors associated with FFR use. All data were analyzed using SAS version 9.4. We will make statistical code available upon request and plan to place it in a public Github repository following publication.

Our cohort included 136,110 patients who underwent elective coronary angiograms. The average age was 74.0 (±6.1), 45.3% were women, and 7.3% were black. 6.3% of our cohort underwent FFR. 50,896 (37.4%) underwent revascularization within 30 days of their coronary angiogram: 41,763 treated with PCI and 9133 with CABG. FFR was performed in 3848 (7.6%) of those who underwent revascularization and 4719 (5.5%) in whom revascularization was not performed. 2542 (53.9%) of the 4719 non-revascularized patients who had undergone FFR had received stress testing within 30 days of coronary angiography while 57.5% of the 80,495 non-revascularized patients who had not undergone FFR had received stress testing (Fig. 1).

Predictors of FFR use included: age, gender, race, region, prior stress testing, and diagnostic study only versus revascularization (Table 1). Older patients, women, black patients, and patients who did not undergo subsequent revascularization had lower odds of

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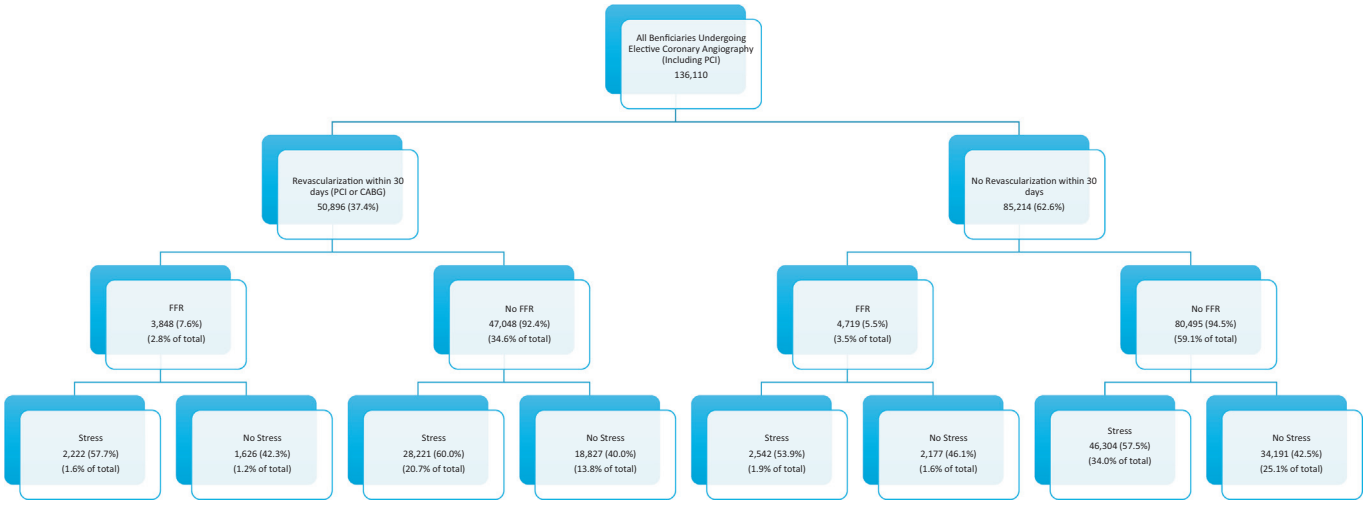


Fig. 1. 2012–2014 rates of stress testing, FFR, and revascularization in beneficiaries undergoing elective coronary angriography.

receiving FFR. Prior stress testing within 30 days of the diagnostic coronary angiography was also a negative predictor for FFR use. FFR use, varied across US regions from 4.1% to 8.6% with a mean of 6.8% ± 1.7%. The South Atlantic and East South Central regions showed lower FFR use while the New England and West North Central regions had greater FFR use (Fig. 2).

Our findings supplement our prior report by documenting low utilization of FFR for ruling out ischemia even when including elective coronary angiograms that do not proceed to PCI. Several large-scale trials have demonstrated the benefits of the FFR-guided approach to coronary interventions including decreased cost and cardiovascular outcomes in patients undergoing elective procedures.

This study has several limitations. We cannot account for visual assessment of the degree of stenosis. Prior work demonstrates considerable across operator-level variation in visual assessment in intermediate stenoses [5], and this variability could have impacted our findings. Our study also did not assess certain factors such as the failure of medical therapy or extent of clinical symptoms, which may have played a role in decisions to perform FFR. More studies are needed to understand potential barriers to its adoption and potential ways to improve its utilization.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2019.01.005.

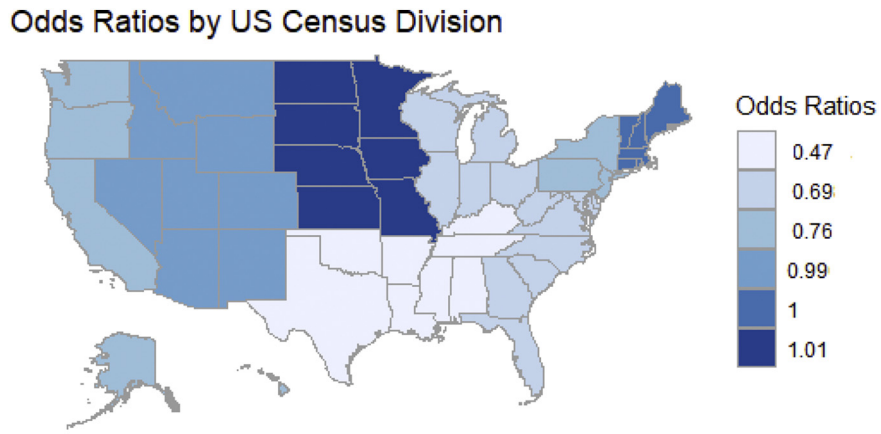
Conflicts of interest

Brahmajee Nallamothu receives funding from American Heart Association for editorial work for their journals.

Table 1
Rates and odds ratios of FFR by region, age, sex, race, and prior stress testing, and revascularization.

	Number undergoing FFR	Number undergoing elective coronary angiography	Percentage	Odds ratio (CI)	p-Value[a]
Age					
>65–75	5058	78,376	6.45%	N/A	N/A
>75–85	3049	49,129	6.21%	0.939 (0.896–0.984)	0.0081
>85	460	8605	5.35%	0.78 (0.706–0.861)	<0.0001
Sex					
Female	3577	61,682	5.80%	0.94 (0.898–0.984)	0.0078
Male	4990	74,428	6.70%	N/A	N/A
Race					
Non-black	8120	125,481	6.47%	N/A	N/A
Black (or African American)	393	9873	3.98%	0.675 (0.608–0.749)	<0.0001
Revascularization (PCI or CABG)					
Yes	3848	50,896	7.56%	N/A	N/A
No	4719	85,214	5.54%	0.737 (0.704–0.771)	<0.0001
Prior stress test					
Yes	4764	79,289	6.01%	0.869 (0.831–0.908)	<0.0001
No	3803	56,821	6.69%	N/A	N/A
Region					
New England	336	3935	8.54%	N/A	N/A
Middle Atlantic	928	14,370	6.46%	0.764 (0.67–0.871)	<0.0001
East North Central	1389	23,315	5.96%	0.698 (0.616–0.791)	<0.0001
West North Central	949	10,993	8.63%	1.015 (0.89–1.157)	0.8274
South Atlantic	1884	29,848	6.31%	0.751 (0.665–0.849)	<0.0001
East South Central	624	13,498	4.62%	0.531 (0.463–0.61)	<0.0001
West South Central	871	21,194	4.11%	0.474 (0.415–0.54)	<0.0001
Mountain	646	7617	8.48%	0.996 (0.867–1.144)	0.9532
Pacific	940	11,340	8.29%	0.985 (0.864–1.123)	0.8235

[a] p-Value of N/A signifies referent category.



Region	OR (95% CI)
New England (Referent)	1 (NA)
Middle Atlantic	0.764 (0.67-0.871)
East North Central	0.698 (0.616-0.791)
West North Central	1.015 (0.89-1.157)
South Atlantic	0.751 (0.665-0.849)
East South Central	0.531 (0.463-0.61)
West South Central	0.474 (0.415-0.54)
Mountain	0.996 (0.867-1.144)
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Fig. 2. US census region choropleth map showing odds ratios of Medicare patients receiving FFR during elective coronary angiography. Referent group is the New England region.

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