



## Research Brief

## Appropriateness of angiography for suspected coronary artery disease

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## ABSTRACT

The aim of this study was to assess the appropriate use of diagnostic catheterizations (DC) for the patients with suspected coronary artery disease performed in Iran. The Electronic Health Record System database and manual review of files were utilised to collect data between 2012 and 2014. Patients were categorized in three groups as appropriate, uncertain, and inappropriate usage of DC and the logistic regression was used to investigate the relationships between variables. One-quarter of the 2458 angiographies were rated as inappropriate, out of which 99% had no previous stress test. The rate of inappropriate DC between various hospitals were approximately the same. The regression showed that some risk factors (Sex, high cholesterol, smoking, chronic heart failure, renal failure, diabetes) were significantly associated with inappropriate rate.

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## 1. Introduction

Since the clinical presentation of cardiovascular diseases can be asymptomatic and may initially have no symptoms, identifying high-risk people and taking preventative measures are the most critical steps that can be taken. Coronary angiography (CAG) is an invasive imaging technique used for assessing coronary anatomy and determining the extent and severity of coronary lumen obstruction and remain as the gold standard for the evaluation of coronary artery disease (CAD) because the other techniques have not yet been able to detect the degree of blockage of the arteries accurately as it.<sup>1,2</sup>

Since CAG is an invasive surgery and is not risk-free, patients' correct selection can avoid the risks and costs associated with it.<sup>1,3–5</sup> So the standard angiography rate can be an indicator for appropriateness of angiography to the patient's actual need.

In Iran, the appropriateness of angiography is of great importance to policymakers and patients because ensuring patient health is a priority, and at the same time, the health system is facing funding pressures.<sup>6</sup> Therefore, evaluating the appropriateness of

CAG to identify patients' actual needs is a critical issue, so in this study, we used criteria introduced by Patel et al for diagnostic catheterization (DC)<sup>7</sup> and the scenarios designed by Hanan<sup>8</sup> to derive the appropriateness rate of angiographies for the patients with suspected CAD which performed in Iran.

## 2. Methods

We used the Electronic Health Record System (SEPAS) and manual review of archived patient records in four teaching hospitals in Tehran to identify patients who underwent elective angiography and collecting data between 2012 and 2014. A sample size of 3228 was considered by assuming 10% of standard angiography cases exist routinely in hospitals and 1.5% standard error. To assess the patients with suspected CAD those who had previous revascularization or positive angiogram were **excluded, and finally**, 2458 patients who underwent elective coronary angiography surgery were selected.

We used one of the most reliable criteria for coronary angiography -appropriate use criteria (AUC) for diagnostic catheterization (DC)- introduced by Patel et al in 2012 and the scenarios that Hannan designed to categorize patients in three groups: appropriate, uncertain, and inappropriate. In designing scenarios, previous non-invasive stress test results, clinical features to identify symptoms, and global risk of disease, were considered factors to

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**Table 1**  
Classification of Patients undergone angiography by Relevance.

Scenario	Stress test	Stress test result	Symptoms	Risk of CAD	likelihood of CAD in clinical assessment	Group	Number/Percent of patients
1	No	NA	No	High	NA	uncertain	215 (8.7%)
2	No	NA	No	Moderate/Low	NA	inappropriate	221 (9.0%)
3	No	NA	Yes	NA	High	appropriate	361 (14.8%)
4	No	NA	Yes	NA	Moderate	uncertain	645 (26.3%)
5	No	NA	Yes	NA	Low	inappropriate	360 (14.6%)
6	Yes	High Risk	Yes/No	NA	NA	appropriate	217 (8.8%)
7	Yes	Moderate Risk	Yes	NA	NA	appropriate	145 (5.9%)
8	Yes	Moderate Risk	No	NA	NA	uncertain	145 (5.9%)
9	Yes	Low Risk	Yes	NA	NA	uncertain	143 (5.8%)
10	Yes	Low Risk	No	NA	NA	inappropriate	6 (0.2%)

NA:Not Applicable.

categorize patients in 10 scenarios. After determining patients' status and developing appropriateness rate for angiography, the logistic Generalized Estimating Equations model (logistic-GEE) was used to investigate the relationship of inappropriateness rates between different hospitals with demographic characteristics and risk factors of disease.

### 3. Results

Of the 2458 patients who underwent elective coronary angiography, 60% were males, the majority of them were between the ages of 55–64 years, while the lowest were over 75 years of age. About 93% had health insurance coverage and living in areas of low to middle socio-economic status. According to Hanan

appropriateness category (2014), all study patients were rated as appropriate, uncertain, or inappropriate and categorized into ten specific scenarios (Table 1).

Approximately 99% of patients in the inappropriate category have never undergone prior stress testing without symptoms with a low/moderate risk score or low likelihood of CAD in clinical assessment. Overall, angiographies were performed inappropriately in 23.8% of 2458 patients as well 46.7% were uncertain, and 29.5% were appropriate. The distribution of patients who underwent angiography based on the three appropriate, uncertain, and inappropriate categories in four hospitals was approximately identical.

The results of the GEE model showed that women are more likely to be in an inappropriate group than men (OR = 1.176).

**Table 2**  
Estimated parameters of inappropriateness rate equation based on patient characteristics at hospital level.

Variable	Parameter	Standard Deviation	confidence interval(95%)	Wald chi2	P-Value	Odds Ratio	
Intercept	1.611	0.335	(0.935, 2.268)	23.039	0.000 <sup>a</sup>	5.006	
Age	<55	-0.418	0.177	(-0.766, 0.070)	5.553	0.018 <sup>a</sup>	0.658
	55–64	-0.222	0.343	(-0.896, 0.452)	0.418	0.518	0.801
	65–74	-0.132	0.286	(-0.694, 0.430)	0.212	0.645	0.876
	>75	a <sub>0</sub>	–	–	–	–	–
Sex	Female	0.162	0.057	(0.049, 0.274)	7.927	–	1.176
	Male	–	–	–	–	–	–
Family history of heart disease	Yes	0.201	0.689	(-1.149, 1.552)	0.085	0.770	1.223
	No	a <sub>0</sub>	–	–	–	–	–
Diabetes	Yes	-0.669	0.116	(-0.897, -0.442)	33.176	0.000 <sup>a</sup>	0.512
	No	a <sub>0</sub>	–	–	–	–	–
High Cholesterol	Yes	0.889	0.389	(0.125, 1.653)	5.197	0.023 <sup>a</sup>	2.432
	No	a <sub>0</sub>	–	–	–	–	–
Smoking	Yes	0.816	0.170	(0.481, 1.150)	22.878	0.000 <sup>a</sup>	2.261
	No	a <sub>0</sub>	–	–	–	–	–
High Blood Pressure	Yes	-0.204	0.196	(-0.590, 0.182)	1.071	0.301	0.816
	No	a <sub>0</sub>	–	–	–	–	–
Peripheral Vascular Disease	Yes	0.376	0.313	(-0.237, 0.990)	6.511	0.213	0.741
	No	a <sub>0</sub>	–	–	–	–	–
Cerebrovascular Disease	Yes	-0.329	0.305	(-0.927, 0.269)	3.389	0.281	0.308
	No	a <sub>0</sub>	–	–	–	–	–
Chronic heart failure	Yes	-0.372	0.053	(-0.476, -0.268)	49.179	0.000 <sup>a</sup>	0.689
	No	a <sub>0</sub>	–	–	–	–	–
Kidney failure	Yes	-0.494	0.163	(-0.814, -0.173)	9.116	0.003 <sup>a</sup>	0.610
	No	a <sub>0</sub>	–	–	–	–	–
Angina symptoms	Regular	-0.531	0.196	(-0.916, -0.146)	7.314	0.007 <sup>a</sup>	0.588
	Irregular	a <sub>0</sub>	–	–	–	–	–
stress test results	Negative	1.129	0.294	(0.551, 1.706)	14.683	0.000 <sup>a</sup>	3.091
	Positive	a <sub>0</sub>	–	–	–	–	–
global risk score	High	-0.112	0.220	(-0.544, 0.320)	0.256	0.613	0.894
	Moderate	0.359	0.013	(0.332, 0.387)	76.072	0.000 <sup>a</sup>	1.432
	Low	a <sub>0</sub>	–	–	–	–	–
Goodness-of-fit	Quasi Likelihood under Independent model (QIC): 608.602 Corrected Quasi Likelihood under Independent model (QICC): 617.612						

a<sub>0</sub> means that the lowest group is considered the base.

<sup>a</sup> 0.05 is considered significant.

Concerning heart disease risk factors, patients with high cholesterol (OR = 2.432) and smokers (OR = 2.261) with positive effects and chronic heart failure (OR = 0.689) and renal failure (OR = 0.610) as well as patients without diabetes (OR = 0.512) with negative effects were more likely to be in inappropriate category rather than their counterparts.

Among those with a probability of CAD in clinical assessment, patients with no angina symptoms (OR = 0.558) with a negative effect, medium global risk score (OR = 1.432) with the positive impact, and negative stress test results (OR = 3.091) with positive impact had significantly associated with inappropriateness rate (Table 2).

#### 4. Discussion

Most of all angiographies were performed in men, and most of the patients were less than 55 years old, which is similar to the effects of other studies.<sup>8–10</sup>

Besides, approximately one quarter (23.9%) of the angiographies were inappropriate, so performing noninvasive tests to assess the coronary artery status before coronary angiography can reduce the number of inappropriate angiographies. Patel (2012), Hanan (2014), Bradley (2014), Dessai (2015), and Ko (2013) also reported about a quarter of the angiographies were inappropriate.<sup>3,7,8,11,12</sup>

The Appropriateness of coronary angiography in four teaching hospitals was almost the same, and in all of them, one-quarter of all angiographies were inappropriate. Chan (2011) also showed that patients' rate in the inappropriate group with acute symptoms was almost similar among hospitals.<sup>13</sup>

Findings on the relationship between the inappropriateness rate and patients' characteristics across the hospitals indicated that performing angiography according to the risk factors and preclinical assessments may not be adequate and need more precise evaluations. In similar studies, the results were in line with the present study results.<sup>7,8</sup>

Since coronary angiography (CAG) is an aggressive procedure that places a substantial burden on both patients and the health care system and is associated with complications and deaths, therefore, ordering noninvasive tests (such as echocardiography, stress test, heart scan) before surgery is necessary to reduce the number of inappropriate angiographies. Finally, the national CAG guidelines' preparation seems essential, along with the laws and regulations that enforce physicians to comply with them.

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#### Declaration of competing interest

"The authors have no conflicts of interest to declare."

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