Research Brief

Appropriateness of angiography for suspected coronary artery disease

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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.1,2

Since CAG is an invasive surgery and is not risk-free, patients’ correct selection can avoid the risks and costs associated with it.1,3-5 So the standard angiography rate can be an indicator for appropriateness of angiography to the patient’s actual need.6

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.7 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)7 and the scenarios designed by Hanan8 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 designed by 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
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 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 | NA | appropriate | 361   | (14.8%)                  |
| 4        | No          | NA                 | Yes NA Moderate | NA | uncertain | 645   | (26.3%)                  |
| 5        | No          | NA                 | Yes NA Low | NA          | inappropriate | 360   | (14.6%)                  |
| 6        | Yes         | High Risk | Yes/No NA NA | NA | appropriate | 217   | (8.8%)                   |
| 7        | Yes         | Moderate Risk | Yes NA NA | NA          | inappropriate | 145   | (5.9%)                   |
| 8        | Yes         | Moderate Risk | No NA NA | NA          | uncertain | 145   | (5.9%)                   |
| 9        | Yes         | Low Risk       | Yes NA NA | NA          | uncertain | 143   | (5.8%)                   |
| 10       | Yes         | Low Risk      | No NA NA | NA          | inappropriate | 6     | (0.2%)                   |

NA: Not Applicable.

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)          | 5.006     |
| Age <55                                | –0.418    | 0.177 (-0.766, 0.070) | 5.553 (0.018)          | 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                                   |           |                    |                          |           |
| Sex Male                               |           |                    |                          |           |
| Family history of heart disease Yes   | 0.201     | 0.689 (-1.149, 1.552) | 0.085 (0.770)          | 1.223     |
| 2014                                   |           |                    |                          |           |
| Diabetes Yes                           | –0.669    | 0.116 (-0.897, –0.442) | 33.176 (0.000)         | 0.512     |
| Diabetes No                            |           |                    |                          |           |
| High Cholesterol Yes                   | 0.889     | 0.389 (0.125, 1.653) | 5.197 (0.023)          | 2.432     |
| High Cholesterol No                   |           |                    |                          |           |
| Smoking Yes                            | 0.816     | 0.170 (0.481, 1.150) | 22.878 (0.000)         | 2.261     |
| Smoking No                             |           |                    |                          |           |
| High Blood Pressure Yes                | –0.204    | 0.196 (-0.590, 0.182) | 1.071 (0.301)          | 0.816     |
| High Blood Pressure No                 |           |                    |                          |           |
| Peripheral Vascular Disease Yes       | 0.376     | 0.313 (-0.237, 0.990) | 6.511 (0.213)          | 0.741     |
| Cerebrovascular Disease Yes            | –0.329    | 0.305 (-0.927, 0.269) | 3.389 (0.281)          | 0.308     |
| Cerebrovascular Disease No             |           |                    |                          |           |
| Chronic heart failure Yes              | –0.372    | 0.053 (-0.476, –0.268) | 40.179 (0.000)         | 0.689     |
| Kidney failure Yes                     | –0.494    | 0.163 (-0.814, –0.173) | 9.116 (0.003)          | 0.610     |
| Kidney failure No                      |           |                    |                          |           |
| Angina symptoms Regular                | –0.531    | 0.196 (-0.916, –0.146) | 7.514 (0.007)          | 0.588     |
| Angina symptoms Irregular              |           |                    |                          |           |
| Stress test results Negative           | 1.129     | 0.294 (0.551, 1.706) | 14.683 (0.000)         | 3.091     |
| Stress test results Positive           |           |                    |                          |           |
| Global risk score High                 | –0.112    | 0.220 (-0.544, 0.320) | 0.256 (0.613)          | 0.894     |
| Global risk score Moderate             | 0.359     | 0.013 (0.332, 0.387) | 76.072 (0.000)         | 1.432     |
| Global risk score Low                  |           |                    |                          |           |
| Goodness-of-fit                        |           |                    |                          |           |

Quasi Likelihood under Independent model (QIC): 608.602
Corrected Quasi Likelihood under Independent model (QICC): 617.612

a0 means that the lowest group is considered the base.
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.

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.

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.

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.

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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