Predictors of Iranian Patients’ Medication Adherence After Coronary Angioplasty

Atefeh Allahbakhshian1, Rasoul Nazifi2, Akram Ghahramanian1, Faranak Jabbarzadeh Tabrizi1, Shahrriar Ostovar1,2*

Abstract

Objectives: Poor medication adherence (MA) is a significant concern in patients with cardiovascular disease (CVD) in low and middle-income countries. Thus, understanding the factors affecting this concern is the first step in designing effective interventions in such societies. In this regard, the purpose of this study was to investigate MA in a sample of Iranian patients after coronary angioplasty and to identify prediction factors based on the World Health Organization framework.

Materials and Methods: This descriptive-correlational research was conducted on 203 patients post carotid artery (CA) who were recruited from the Cardiology Clinics of Tabriz between November 2016 and February 2017. Data were collected based on socio-demographic characteristics and the Persian version of the Morisky Medication Adherence Scale (MMAS), and the Charlson comorbidity index was used as well. Finally, the multiple linear regression method was applied to identify the significant predictors of MA.

Results: The mean (standard deviation) MMAS score was 5.85 (±1.83). A multivariable model (adjusted \( R^2 = 0.136 \)) predicted adherence using experienced medication side effects (\( B = -1.094, 95\% \) confidence interval (CI) = -1.700 – -0.489, \( P < 0.001 \)) and having a recall (\( B = 0.658, 95\% \) of CI = 0.153-1.163, \( P = 0.011 \)) and hospitalized history due to current disease (\( B = -0.537, 95\% \) of CI = -1.031 – -0.043, \( P = 0.033 \)).

Conclusions: The results of this study provide a better conception of the role of patients’ experiences about medication side effects and the presence of a recall member in the family for MA after angioplasty. Patients’ problems and concerns related to the side effects of medications must be resolved to improve MA.

Keywords: Medication adherence, Coronary angioplasty

Introduction

Cardiovascular disease (CVD) is the major cause of mortality in the world, substantially in low- and middle-income countries (1). However, the disease process can be remarkably slowed by cardioprotective medications and lifestyle changes (2) Sub-optimal medication adherence (MA) is a significant concern in patients with chronic illnesses (3), particularly in those suffering from CVD (4). MA relegates to the extent to which a patient operates in accordance with the prescribed interval and dose. While poor MA is associated with increased patient morbidity (5), mortality (4-6), healthcare costs (7), and increased risk of cardiovascular events (8,9), including myocardial infarction (4) and fatal stroke (6), it has been found that high adherence to the prescribed medication contributes to a decrease in cardiovascular events in the future, low readmission rates, and reduction in health care costs and morbidity and mortality (3,6,10).

Adherence to secondary medication is crucial in patients who have undergone carotid artery (CA) and stenting (11). According to the results of previous research, there is a strong relationship between discontinuing antiplatelet drugs and development of thrombosis post coronary stenting (5).

In general, adherence to long-term medication is approximately 57% in CVD (12). Based on the data from Iran, as a middle-income country, the use of secondary prevention medications was estimated to be less than 20% (13).

Several studies have attempted to investigate the reasons for medication non-adherence and reported multiple factors (4,9) such as patient, condition, therapeutic, socioeconomic, and system-related factors. The awareness of these factors may inform efforts to improve adherence rates (2,14). Non-adherence can propel to the inappropriate effects of treatment and poor outcomes (15). Therefore, identifying and subsequently addressing the barriers are important in improving MA, which could lead to improved patient outcomes and reduced health care costs (16).

The World Health Organization (WHO) suggests the consideration of macro- and micro-level factors including the health care system, medical conditions of the patient, and therapeutic and socioeconomic factors when studying
Factors related to the health care system included those caused by drug prescription, including drug regimen complexity, drug side effects, duration of antibiotic use, the required time for the effectiveness of drugs, changes in the treatment regimen, and the patient’s previous experience of treatment (29).

Factors related to the patient included particular characteristics of each person, including demographic characteristics, abilities, and awareness of the disease, attitudes, opinions, and the patient’s expectations of treatment (29).

Factors related to the patient’s medical condition encompassing disease-related symptoms, the level of disability, the severity of the disease, and the associated depression (29). The Charlson comorbidity index was used to score the coexistence of several medical disorders. Accordingly, myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular accident, dementia, lung disease, connective tissue disorders, stomach ulcers, liver disease, and diabetes were scored 1. Complications caused by diabetes, paraplegia, kidney disease, and cancer received a score of 2, the presence of metastatic cancer and severe liver disease were scored 3, and finally, AIDS received a score of 6. The minimum and maximum scores on this scale were zero and 30, respectively (30).

Factors related to treatment included those caused by drug prescription, including drug regimen complexity, drug side effects, duration of antibiotic use, the required time for the effectiveness of drugs, changes in the treatment regimen, and the patient’s previous experience of treatment (29).

Factors related to the health care system included the relationship between the patient and health care providers, access to medicines, patient education, time allocated to counseling, medical expenses,
insurance coverage, the complexity of the health system (bureaucracy), and medication uptake monitoring (29).

5. Socioeconomic factors were related to the economic and social situations of the patient (e.g., occupation, religion, education, social support, financial situation, cost of drugs, cultural beliefs, the presence of a person in the patient's family as a reminder, and distance from the health center).

Data Analysis
To analyze the data, SPSS statistical software (version 14) was applied, and a $P < 0.05$ was considered statistically significant. The data were analyzed in three steps. In the first step, the correlation between each independent variable and MA scores was assessed using an independent $t$ test. The analysis of variance and Pearson correlation coefficient were applied for categorical and quantitative variables, respectively. Independent variables showing a $P$ value of less than 0.20 (31) with MA in bivariate analysis were included in multiple linear regression.

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Results
The mean age of the study participants was $55.62 \pm 7.30$ years, and the majority of participants were males (82.3%). Nearly half of the participants (48.8%) reported having hypertension and 29.1% of them suffered from diabetes. Only 36% of patients reported having no comorbidities. Of a total of 203 participants, 60% had undergone angioplasty with stent implantation. The bivariate correlations of the MMAS score with each participant's characteristics were tested before multivariate analysis (Table 1).

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Results
The mean age of the study participants was $55.62 \pm 7.30$ years, and the majority of participants were males (82.3%). Nearly half of the participants (48.8%) reported having hypertension and 29.1% of them suffered from diabetes. Only 36% of patients reported having no comorbidities. Of a total of 203 participants, 60% had undergone angioplasty with stent implantation. The bivariate correlations of the MMAS score with each participant's characteristics were tested before multivariate analysis (Table 1).

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Results
The mean age of the study participants was $55.62 \pm 7.30$ years, and the majority of participants were males (82.3%). Nearly half of the participants (48.8%) reported having hypertension and 29.1% of them suffered from diabetes. Only 36% of patients reported having no comorbidities. Of a total of 203 participants, 60% had undergone angioplasty with stent implantation. The bivariate correlations of the MMAS score with each participant's characteristics were tested before multivariate analysis (Table 1).

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.

Hierarchical multiple regression with backward entry was used to identify significant predictors of MA. Data examination represented no problems with multicollinearity. The investigation of the scatter plots of pairs in independent and dependent variables revealed no violation of the linearity assumption, and the examination of partial regression plots demonstrated no violation of the assumption of homoscedasticity. Five regression models were separately constructed with entries into patient, condition, treatment, healthcare system, and socioeconomic related factors as independent variables, and MA was considered as a dependent variable. In the final step, an overall regression analysis was conducted to test the predictive value of a model that included only independent variables indicating significant contributions to MA in the above tested models.
indicated satisfactory internal consistency (Cronbach’s α = 0.721).

Table 2 presents the levels of MA in the study sample. The mean of MA for patients in the sample was 5.85 ± 1.83. Only 32% of patients had high adherence to their prescribed cardiac medications while 45.8% of them were found to have low adherence.

The results of regression analysis (Table 3) revealed that among the patient-related factors, no variable could significantly predict MA (P > 0.05). Among the condition-related factors, comorbidities (B = -0.937, 95% of CI = -1.809 – -0.065, P = 0.035) and hospitalization due to the current disease (B = -0.669, 95% of CI = -1.229 – -0.109, P = 0.020) significantly predicted MA. Among treatment-related factors, the side effects of medications (B = -1.288, 95% of CI = -1.907 – -0.669, P = 0.001), and among socioeconomic factors, recall (B = 0.863, 95% of CI = 0.299-1.427, P = 0.003) had significant effects on the models. Among health care system-related factors, no variable could significantly predict MA (P > 0.05). The adjusted R² values for the five described models were 2.8, 2.7, 12.2, 2.4, and 4%, respectively.

The overall regression model showed that the side effects of medications (B = -1.094, 95% of CI = -1.700 – -0.489, P < 0.001) and recall (B = 0.863, 95% of CI = 0.299-1.427, P = 0.003) had significant effects on the models.

<table>
<thead>
<tr>
<th>Medication Adherence Level</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High adherence (score = 8)</td>
<td>65</td>
<td>32</td>
</tr>
<tr>
<td>Moderate adherence (6 to &lt; 8)</td>
<td>45</td>
<td>22.2</td>
</tr>
<tr>
<td>Low adherence (&lt;6)</td>
<td>93</td>
<td>45.8</td>
</tr>
</tbody>
</table>

Note. CAD: Coronary artery disease; HTN: Hypertension; ACEI: Angiotensin-converting enzyme inhibitor; PPI: Proton pump inhibitor.
<table>
<thead>
<tr>
<th>Predictors</th>
<th>B</th>
<th>95% CI for B Lower Bound</th>
<th>95% CI for B Upper Bound</th>
<th>Beta</th>
<th>P Value</th>
<th>Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comorbidity</td>
<td>-0.375</td>
<td>-0.878</td>
<td>0.128</td>
<td>-0.099</td>
<td>0.143</td>
<td>0.136</td>
</tr>
<tr>
<td>Hospitalization history due to current disease</td>
<td>-0.537</td>
<td>-1.031</td>
<td>-0.043</td>
<td>-0.144</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>Side effects of medications</td>
<td>-1.094</td>
<td>-1.700</td>
<td>-0.489</td>
<td>-0.239</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Recall</td>
<td>0.658</td>
<td>0.153</td>
<td>1.163</td>
<td>0.172</td>
<td>0.011</td>
<td></td>
</tr>
</tbody>
</table>

\( P < 0.001 \), recall \( B = 0.658, 95\% \text{ CI} = 0.153 - 1.163, \ P = 0.011 \), and hospitalization history due to the current disease \( B = -0.537, 95\% \text{ CI} = -1.031 - 0.043, \ P = 0.033 \) significantly explained 13.6% of the total variance for MA (Table 4). Beta coefficients demonstrated that the two predictors of side effects and hospitalization history have a negative effect whereas recall has a positive effect on MA (Table 4).

**Discussion**

Most prescribed cardiovascular drugs should be taken for a long time to improve symptoms and prevent subsequent cardiac events (32). However, evidence from a wider literature suggests that adherence to cardiac medications decreases over time (33). In the current study, only 32% of patients with post angioplasty highly adhered to their prescribed cardiovascular medications, which is in accordance with the findings of previous similar studies. For instance, Bansilal et al reported that MA to cardiovascular drugs in a long time was 34% in patients with myocardial infarction or atherosclerotic disease (6). Similarly, a meta-analysis by Chowdhury et al estimated the rate of MA to cardiovascular medications about 40.\% (3). However, the adherence rate in our study is higher than that of the previously reported one (20%) in an international epidemiological study (13). This difference can be related to variations in the samples, study tools, and assessment time. In our study, patients had undertaken angioplasty within the preceding month, and evidence from wider literature shows that patients are more likely to adhere to their medications in the acute phase of their disease (34).

In addition, the number of comorbidities significantly contributed to the prediction of MA. Confirming the findings of the current study, Wong et al reported a significant relationship between the number of comorbidities and medication poor adherence (35). However, in a study by Gholamlaliei et al, there was no significant relationship between the number of comorbidities including hypertension and MA in patients with diabetes (18).

In our study, the number of previous hospitalizations was another predictor of non-adherence. It is stated that poor adherence can lead to rehospitalisation (4) thus patients with poor adherence are more likely prone to hospitalization.

In the current study, there was a significant relationship between the side effects of drugs and MA, which is consistent with the findings of Momary et al, demonstrating that the experience of bloodshed adversely affects patients’ adherence to clopidogrel (36).

In this study, having a family member to remind patients to take their medicine contributed to MA, which corroborates with the results of previous research (37). According to a review of qualitative studies, patients stated that having family support has a positive role in MA (38). In another study, patients receiving no help in their tasks had a barrier to MA (16). Forgetfulness was reported as the most common cause of non-adherence to medications by patients in Iran (39). Considering that forgetfulness is an unintentional reason for medication non-adherence (9), some practical and affordable interventional strategies such as sending short texts or involving the family in patient care can be effective in improving MA in patients after angioplasty (40).

The findings of this study should be interpreted in the context of some limitations. First, this study used a non-random sampling method, leaving the potential for bias. However, the results of our study mainly resonate with the findings of other studies conducted in Iran. Eventually, this study was based on self-reported data from study participants, which may be incomplete or inaccurate.

**Conclusions**

In general, adherence to cardiac medications is low in post-CA patients, including patients from Iran. The side effects of medications, the presence of a family member as the reminder, and the number of previous hospitalizations were factors that significantly and independently predicted MA in Iranian patients post CA. These results suggest that interventions for improving MA in patients post angioplasty should focus on patient education and consult them for detecting and decreasing concerns about the prescribed medication and use approaches for consumption recall. Considering the multifactorial nature of adherence problems, future studies are needed to identify the effect of manipulating these factors on MA in controlled trials.

**Authors’ Contribution**

AA: concept and design; AG and FJ: data collection and interpretation of the data. RN and SO: performing of the study and writing of the draft. All authors read and approved the study.
Conflict of Interests

Authors have no conflict of interests.

Ethical Issues

This study was approved by the Ethics Committee of Tabriz University of Medical Sciences (license number: IR.TBZMED.REC.1395:432) and written informed consent was provided by participants prior to the study.

Financial Support

This work was supported by Tabriz University of Medical Sciences, Iran.

Acknowledgments

We would like to present our gratitude to the participants of this study for sharing their experiences during the data collection stage.

References

30. Charlson M, Sztatrowski TP, Peterson J, Gold J. Validation

Copyright © 2021 The Author(s); This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.