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The factors related to hospitalization period in patients with acute myocardial infarction treated after primary percutaneous coronary intervention

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Original Article

Abstract

BACKGROUND: Decreasing the hospital length of stay (LOS) in ST-segment elevation myocardial infarction (STEMI) after primary percutaneous coronary intervention (PPCI) is an issue which is related to reducing hospital costs. This study was aimed to determine the average number of hospital LOS among patients with STEMI treated by PPCI and predictors of longer LOS.

METHODS: This cross-sectional study was performed on 561 patients with STEMI who referred to Heshmat Hospital, Rasht, north of Iran, within 2015-2018. As soon as STEMI was detected, patients were transferred to the catheterization laboratory (cath lab) in the shortest possible time and underwent PPCI. A questionnaire including characteristics of patients, procedures, and in-hospital adverse events was completed. Data were analyzed with SPSS software.

RESULTS: The mean age of patients was 59.36 ± 11.90 years. 74.2% (n = 416) of subjects were men and 25.8% (n = 145) were women. The hospital LOS of 3 to 6 days had the highest prevalence up to 47%. The results of the multiple logistic regression showed that risk of hospital LOS > 6 days in unsuccessful percutaneous coronary intervention (PCI) was 33.2 versus 66.8 in successful PCI (P = 0.001). Moreover, the risk of hospital LOS > 6 days in subjects who had post-procedure complication, problems at admission, and primary comorbidities was 9.13 (7.22-11.53)-fold, 4.09 (2.86-5.85)-fold, and 1.75 (1.35-2.27)-fold more than those who had not, respectively

CONCLUSION: By identifying controllable predictive factors associated with prolonged hospitalization after PPCI, the length of hospitalization can be decreased; also, the patient remission can be enhanced and hospital costs reduced.

Keywords: Myocardial Infarction; Percutaneous Coronary Intervention; Length of Stay

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Introduction

ST-elevation myocardial infraction (STEMI) is the worst manifestation of acute coronary syndrome (ACS) after sudden cardiac death. In addition, the incidence of ischemic heart disease (IHD) in developing countries is rising.[1,2] Cardiovascular disease (CVD) is the first cause of death in Iran with a massive burden[3] which needs special clinical services that can be very costly.[4] IHD in Iran over the age of 40 is 14 in 100, and the rate of myocardial infraction (MI) in both sexes remains high.[5] We have beds deficiency about 30% to 40%, and this deficiency is high in some areas. Reduction in the number of inpatient days increases hospital profit with more efficient bed management. Therefore, determination of the factors associated with reducing hospitalization period is vital. Recently, primary percutaneous coronary intervention (PPCI) is the preferred therapeutic strategy in patients with STEMI that improves short and long-term results and can decrease

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hospital length of stay (LOS).[6,7] This method has been associated with minimized risks of recurrent MI (reMI), intracranial hemorrhage (ICH), infarction-associated artery reocclusion, and myocardial ischemia.[8-10] In the current context, despite the rising cost of medical care, proper use of limited medical resources is important, and the hospital LOS is a determinable indicator for both the patient and the health care system. Identifying the predictors of long-term admissions can provide an opportunity to reduce the hospital LOS.[11] Long-term predictors include recurrent infarction, pulmonary edema, continuous hypotension, sustained ventricular tachycardia (VT), high-grade atrioventricular block (AV block), acute ventricular septal defect (VSD), frequent ischemia requiring emergency coronary artery bypass graft (CABG), ejection fraction (EF), insulin-dependent diabetes, transient ischemic attack (TIA) or cerebrovascular accident (CVA), sex, thrombolysis in myocardial infarction (TIMI) flow after PPCI, history of arrest during treatment, creatinine during admission, requiring anti-coagulant therapy or requiring intra-aortic balloon pump (IABP), and distance from the hospital.[10,12-14] Besides, geographic and hospital-dependent variables are important.[12] We aimed to determine the average number of hospital LOS among patients with STEMI treated by PPCI and evaluate the most important predictors of longer LOS in Heshmat Hospital, Rasht, north of Iran. Hence, by controlling the factors associated with the long-term admission of patients after PPCI, the length of hospitalization and subsequently contributing costs, manpower, and time in the health care system can be reduced.

Materials and Methods

This cross-sectional study was conducted on 561 patients with STEMI who were either referred to Heshmat Hospital or sent from other hospitals and were treated by PPCI after approval of Ethical Committee of Guilan University of Medical Sciences, Rasht (IR.GUMS.REC.1396.292). Sampling began in 2017 and continued until 2018. This paper was extracted from a specialty thesis (No.: 96072207) in Department of Cardiology, Heshmat Hospital, School of Medicine, Guilan University of Medical Sciences.

Also, considering the fact that patients were in 3 groups of short, intermediate, and long-term admission, the sample size of each of these subgroups is estimated at 187 people. Sample size was obtained by considering the error rate of 5% and the test power of 90% based on the performance curve for each group of about 186. Samples were collected in each group as available. The STEMI was diagnosed based on clinical symptoms including typical cardiac chest pain for more than 30 minutes and electrocardiographic (ECG) alterations with ST elevation of more than 1 mm in at least 2 continuous leads and more than 2 mm in 2 precordial leads or new left bundle branch block (LBBB). Patients with symptoms during the last 12 hours or sustained chest pain with ECG evidence of STEMI were included. As soon as STEMI was detected, patients were transferred to the catheterization laboratory (cath lab) and underwent PPCI. The LOS duration was calculated based on hours from moment of admission until the discharge order, divided on 24.

Patients with previous fibrinolytic therapy, death events during hospitalization, life expectancy lower than 1 year, those who needed IABP or required an emergent revascularization of non-infarct related artery [CABG or staged percutaneous coronary intervention (PCI)], as well as those who left the hospital before discharge with their own consent or transferred to another hospital for any reason were excluded.

A five-sectioned questionnaire including characteristics of the patient such as age and body mass index (BMI), comorbidities and past medical history, status and problems at admission, procedure success and complications, and post-PCI in-hospital events and complications was completed for each patient after signing the informed consent form.

Frequency and percentage were used to describe the qualitative data and mean and standard deviation (SD) were used to describe the quantitative data. Kolmogorov-Smirnov test (K-S test) was used for normality of groups. Chi-square test (for qualitative variables) and analysis of variance (ANOVA) test (for quantitative variables) were used to examine the relationship between groups. Multiple logistic regression test was performed to detect relationships between the independent variables in the presence of the other independent variables. Dependent variable in this model (length of hospital stay) was divided in two groups of less than 6 days and more than 6 days. The SPSS software (version 16, SPSS Inc., Chicago, IL, USA) was applied to perform statistical analysis. $P < 0.050$ was considered as statistically significant.

Results

The mean age of patients in the study was 59.36 ± 11.90 years. According to the age group classification, 25.7% of subjects (n = 144) were in the group of less than 50 years old, and 29.1% (n = 163), 28.5% (n = 160), and 16.8% (n = 94) of subjects were in the age groups of 51 to 60, 61 to 70, and above 70 years, respectively. 74.2% (n = 416) of subjects were men and 25.8% (n = 145) were women. Patient characteristics and procedure/in-hospital adverse events based on LOS groups are shown in table 1.

Table 1. Patient characteristics and procedure/in-hospital adverse events

Patient characteristics		LOS ≤ 3 days [n (%)]	LOS 3-6 days [n (%)]	LOS > 6 days [n (%)]	P*
Gender	Men	144 (77.0)	138 (73.8)	134 (71.7)	0.493
	Women	43 (23.0)	49 (26.2)	53 (28.3)	
Age (year)	< 50	53 (28.3)	59 (31.6)	32 (17.1)	0.003
	51-60	63 (33.7)	48 (25.7)	52 (27.8)	
	61-70	50 (26.7)	50 (26.7)	60 (32.1)	
	> 70	21 (11.2)	30 (16.0)	43 (23.0)	
BMI (kg/m^2)	< 19	0 (0)	1 (0.5)	0 (0)	< 0.001
	19-25	53 (28.3)	49 (26.2)	74 (39.6)	0.008
	25-30	120 (64.2)	109 (58.3)	96 (51.3)	
	> 30	14 (7.5)	28 (15.0)	17 (9.1)	
Education	Illiterate	38 (20.3)	49 (26.2)	72 (38.5)	0.017
	Primary	78 (71.7)	65 (34.8)	62 (23.2)	0.002
	Diploma	61 (32.6)	60 (32.1)	50 (26.7)	
	Higher	10 (5.3)	13 (7.0)	3 (1.6)	
Refer weekdays	Saturday-Wednesday	150 (80.2)	143 (76.5)	164 (87.7)	0.017
	Thursday-Friday	37 (19.8)	44 (23.5)	23 (12.3)	
Distance to the hospital	Saturday-Wednesday	150 (80.2)	143 (76.5)	164 (87.7)	0.840
	Thursday-Friday	37 (19.8)	44 (23.5)	23 (12.3)	
	< 30 minutes	98 (52.7)	96 (51.3)	88 (47.3)	
	30 minutes-2 hours	80 (43.0)	81 (43.3)	87 (46.8)	
	> 2 hours	8 (4.3)	10 (5.3)	11 (5.9)	
Refer season	Spring	49 (26.2)	39 (20.9)	48 (25.7)	0.024
	Summer	56 (29.9)	62 (33.2)	40 (21.4)	
	Autumn	45 (24.1)	54 (28.9)	44 (23.5)	
	Winter	37 (19.8)	32 (17.1)	55 (29.4)	
Admission time	6 AM-12 PM	33 (17.6)	45 (24.1)	40 (21.4)	0.332
	12 PM-6 PM	86 (46.0)	69 (36.9)	71 (38.0)	
	6 PM-6 AM	68 (36.4)	73 (39.0)	76 (40.6)	
DM		33 (17.6)	49 (26.2)	57 (30.5)	0.014
HTN		65 (34.8)	72 (38.5)	100 (53.5)	0.001
HLP		36 (19.3)	55 (29.4)	52 (27.8)	0.053
CVA/TIA		2 (1.1)	4 (2.1)	9 (4.8)	0.069
CKD		5 (2.7)	11 (5.9)	34 (18.2)	< 0.001
PD		2 (1.2)	5 (2.7)	4 (2.1)	0.523
PCI history		0 (0)	8 (4.3)	9 (4.8)	0.012
CABG history		5 (2.7)	2 (1.1)	7 (3.7)	0.249
IHD familial history		7 (3.7)	21 (11.2)	13 (7.0)	0.020
Smoking		65 (34.8)	77 (41.2)	73 (39.0)	0.430
Procedure/in-hospital adverse events					
Cardiogenic shock		0 (0)	0 (0)	8 (4.3)	< 0.001
Need to intubation		0 (0)	1 (0.5)	8 (4.3)	0.002
Heart arrest		0 (0)	0 (0)	5 (2.7)	0.006
Arrhythmia		0 (0)	9 (4.8)	13 (7.0)	0.002
Pulmonary edema		3 (1.6)	10 (5.3)	29 (15.5)	< 0.001
Kilip class	1	1 (33.3)	0 (0)	0 (0)	0.028
	2	0 (0)	9 (90.0)	20 (69.0)	
	3	2 (66.7)	1 (10.0)	7 (24.1)	
	4	0 (0)	0 (0)	2 (6.9)	
Heart rhythm during admission	Sinusoid	187 (100)	175 (93.6)	163 (87.2)	< 0.001
	VT	0 (0)	2 (1.1)	2 (1.1)	
	VF	0 (0)	7 (3.7)	11 (5.9)	
	AV block	0 (0)	3 (1.6)	11 (5.9)	
		Mean ± SD	Mean ± SD	Mean ± SD	
BMI (kg/m^2)		57.48 ± 10.91	58.12 ± 34.49	62.27 ± 11.74	
Education		26.71 ± 2.48	27.15 ± 3.16	26.28 ± 3.06	

* Chi-square test

LOS: Length of stay; BMI: Body mass index; DM: Diabetes mellitus; HTN: Hypertension; HLP: Hyperlipoproteinemia; CVA: Cerebrovascular accident; TIA: Transient ischemic attack; CKD: Chronic kidney disease; PD: Pulmonary disease; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass graft; IHD: Ischemic heart disease; VT: Ventricular tachycardia; VF: Ventricular fibrillation; AV block: Atrioventricular block; SD: Standard deviation

As shown in table 1, patients with longer LOS were older and more frequently had prior diabetes (P = 0.014), hypertension (HTN) (P = 0.001), and chronic kidney disease (CKD) (P < 0.001). In addition, there was significant differences between LOS groups in terms of BMI (P = 0.008), education (P = 0.002), refer days (P = 0.017), and season (P = 0.024). There were also differences in procedural characteristics and in-hospital adverse events. Patients in the long LOS group were more likely to have cardiogenic shock (P < 0.001), heart arrest (P = 0.006), arrhythmia (P = 0.002), pulmonary edema (P < 0.001), or need intubation (P = 0.002). The frequency of AV block and ventricular fibrillation (VF) was higher among patients with long LOS versus sinus heart rhythm in short LOS group (P < 0.001) (Table 1).

The results of the study of infarct frequency distribution in patients with MI treated with primary angioplasty in LOS groups are shown in figure 1. The frequency of anterior MI was significantly higher in longer LOS group (P = 0.021).

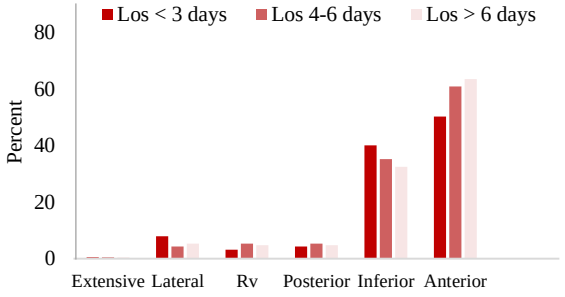

Figure 1. Length of stay (LOS) based on myocardial infarction (MI) anatomic location

Patients' admission variables based on LOS groups are shown in table 2. There was a statistically significant difference between the values of the variables of systolic blood pressure (SBP) (P < 0.001), diastolic blood pressure (DBP) (P < 0.001), EF (P = 0.001), creatinine (P < 0.001), glomerular filteration rate (GFR) (P < 0.001), and symptom onset (minutes) (P < 0.001) in LOS groups. SBP, DBP, EF, and GFR were lower in longer LOS group; creatinine and symptom onset were higher in longer LOS group.

The PCI findings among the three LOS groups are shown in table 3. There was a statistically significant difference between the frequency of the variables of post-PCI TIMI (P < 0.001), glycoprotein IIb/IIIa (GPIIb/IIIa) (P < 0.001), and involved arteries (P < 0.001) in LOS groups. Post-PCI TIMI among short, intermediate, and long LOS groups was 90.4%, 86.1%, and 67.4%, respectively. Also, for most of the patients with longer LOS, GPIIb/IIIa inhibitor had been used (67.6%).

The results of the study of frequency distribution of culprit artery types in patients with MI treated with primary angioplasty in LOS groups are shown in figure 2. The LOS status was statistically related to culprit artery type. Left anterior descending (LAD) and left circumflex (LCX) had higher frequencies in longer LOS groups.

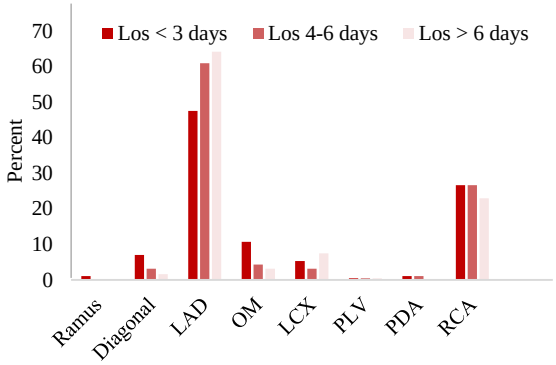

Figure 2. Length of stay (LOS) based on infarct-related artery

LAD: Left anterior descending; OM: Obtuse marginal; LCX: Left circumflex; PLV: Posterior left ventricular; PDA: Posterior descending artery; RCA: Right coronary artery

Table 2. Patients' admission variables based on length of study (LOS) groups

Variable	LOS < 3 days	LOS 3-6 days	LOS > 6 days	P*
	Mean ± SD	Mean ± SD	Mean ± SD	
SBP (mmHg)	138.17 ± 27.84	134.75 ± 26.95	126.63 ± 28.92	< 0.001
DBP (mmHg)	85.41 ± 13.80	82.51 ± 14.95	78.68 ± 17.03	< 0.001
Heart rate (bpm)	80.74 ± 12.91	81.57 ± 16.29	82.87 ± 20.10	0.461
LVEF (%)	39.79 ± 10.05	38.34 ± 9.30	35.99 ± 9.54	0.001
Creatinine (mg/dl)	0.98 ± 0.19	1.05 ± 0.24	1.14 ± 0.30	< 0.001
GFR (ml/min)	80.10 ± 9.21	76.85 ± 12.24	71.05 ± 14.80	< 0.001
Symptom onset (minute)	179.90 ± 157.90	179.10 ± 137.01	280.60 ± 382.50	< 0.001

* Analysis of variance (ANOVA)

LOS: Length of stay; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; LVEF: Left ventricular ejection fraction; GFR: Glomerular filteration rate; SD: Standard deviation

Table 3. Percutaneous coronary intervention (PCI) findings among the three lenght of study (LOS) groups

Variable		LOS < 3 days [n (%)]	LOS 3-6 days [n (%)]	LOS > 6 days [n (%)]	P*
Pre-PCI TIMI	0	137 (73.3)	129 (69.0)	131 (70.1)	0.527
	1	33 (17.6)	30 (16.0)	35 (18.7)	
	2	17 (9.1)	27 (14.4)	19 (10.2)	
	3	0 (0)	1 (0.5)	2 (1.1)	
Post-PCI TIMI	0	0 (0)	0 (0)	2 (1.1)	< 0.001
	1	1 (0.5)	4 (2.1)	4 (2.1)	
	2	17 (9.1)	22 (11.8)	55 (29.4)	
	3	169 (90.4)	161 (86.1)	126 (67.4)	
Collaterals	+	46 (24.6)	52 (27.8)	41 (21.9)	0.419
	-	141 (75.4)	135 (72.2)	146 (78.1)	
GPIIb/IIIa	+	91 (48.7)	97 (51.9)	125 (67.6)	< 0.001
	-	96 (51.3)	90 (48.1)	60 (32.4)	
Involved arteries	1	64 (34.2)	56 (29.9)	39 (20.9)	< 0.001
	2	89 (47.6)	67 (35.8)	69 (36.9)	
	3	34 (18.2)	64 (34.2)	79 (42.2)	

* Chi-square test

LOS: Length of stay; TIMI: Thrombolysis in myocardial infarction; PCI: Percutaneous coronary intervention; GPIIb/IIIa: Glycoprotein IIb/IIIa

The results of the multiple logistic regression are shown in table 4. The risk of length of hospital stay more than 6 days in unsuccessful PCI was 3.029 (2.31-3.97)-fold more than successful PCI. Also, the risk of length of hospital stay more than 6 days in subjects who had post-procedure complication, problems at admission, and primary comorbidities were 9.13 (7.22-11.53)-fold, 4.09 (2.86-5.85)-fold, and 1.75 (1.35-2.27)-fold more than those who had not, respectively. Furthermore, BMI had a significant role in the LOS in hospital. With increased BMI, LOS also increased.

Table 4. Variables in the equation of regression model

Variable	OR	95% CI	P*
Primary comorbidities	1.75	1.35-2.27	0.031
Successful PCI	3.02	2.31-3.97	< 0.001
Post-procedure complications	9.12	7.22-11.53	< 0.001
Problems at admission	4.09	2.86-5.85	< 0.001
Age group	0.90	0.81-1.00	0.359
BMI	1.56	1.28-1.89	0.016
Constant	0.23		0.110

* Multiple binary logistic regression

PCI: Percutaneous coronary intervention; BMI: Body mass index; OR: Odds ratio; CI: Confidence interval

The results of the study of frequency distribution of the number of coronary arteries involved in patients with MI treated with primary angioplasty in LOS groups are shown in figure 3. The three-vessel involvement was more frequent in the longer LOS group.

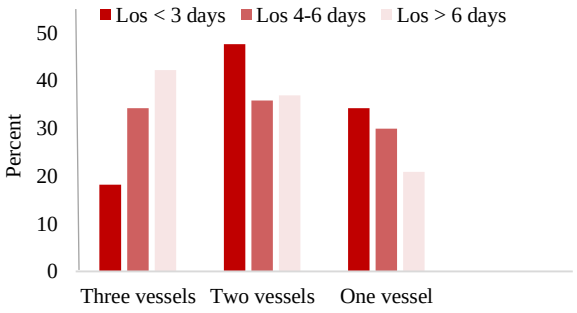

Figure 3. Length of stay (LOS) based on number of diseased coronary arteries

Discussion

The LOS of 3-6 days had the highest prevalence up to 47%, which was in accordance with the previous studies. Amazingly, the prevalence of other two groups was the same (26.5%). There are controversial studies about this issue that whether age is related to LOS periods.[15,16] In the current paper, the mean age of patients with LOS higher than 6 days was 62.27 ± 11.74. About 64.2% of patients with BMI of 25-30 kg/m^2 had the LOS > 6. In assessing the correlation between education and LOS, most of the illiterate patients had the highest LOS while the medium group had bachelor and higher education. In Germany, 19.1% of the patients who died due to MI had a low education and 13.1% had high education.[17] In the study by Ahmadi et al., the values were 34.0% and

11.0%, respectively.[18]

The distance between the place of residence and the hospital, as well as the time of admission throughout the day did not have a significant correlation with LOS. It seems that the admission in winter has a significant relation with long hospitalization. In our study, 30.5% of people with diabetes had a LOS of more than 6 days. In one study, there was a significant correlation between increased duration of hospitalization and diabetes.[19] Similarly, in another research, there was a correlation between the incidence of diabetes and LOS more than 5 days.[20] Also, 53.5% of people with HTN had LOS more than 6 days; whereas, Karabulut et al. reported that 73.0% of patients with HTN had a LOS longer than 72 hours.[19] Although we realized that just 29.4% of patients with hyperlipoproteinemia (HLP) had an average duration of admission, previous study showed that more than half of the people with HLP had an admission period of 72 hours.[19] In the study by Swaminathan et al., 65.3% of people with HLP had LOS less than 3 days, and this relationship was significant.[20] Only 9.1% of patients had a history of PCI. No patient who had discharged less than 3 days had a history of previous PCI. In the study by Isik et al., 15.4% of the people had a history of previous PCI, of which 7.8% had LOS less than 6 days and 6.6% had LOS of more than 6 days.[16] Only 7.5% of the patients had a history of CABG, of which 3.7% had LOS more than 6 days. Although 41.2% of our patients with a history of smoking had an average LOS, it does not seem a significant relation. In the study of Isik et al., 6% of smokers had LOS of less than 6 days.[16]

Regarding the incidence of complications at the time of admission and during PCI, pulmonary edema was the most frequent while cardiogenic shock and the need for intubation were the least frequent complications. In terms of infarction site, we found a significant correlation with the LOS, since more than half of the patients with anterior infarction had LOS more than 6 days. In Melberg et al.'s study, 43.0% of the patients had anterior infarction.[21] Similar to our findings, patients with anterior infarction had LOS more than 6 days which was significantly related.[16] The results of the data in terms of characteristics at the time of admission showed that the relation of all variables including SBP and DBP, heart rate per minute, left ventricular EF (LVEF), creatinine, GFR, and duration of onset of symptoms with LOS was significantly consistent with other researches.[16,19] The results showed that most of the patients who had only sinus heart rhythm had LOS less than 3 days. Patients with VT, VF, and AV block heart rhythms had an increased LOS. TIMI before PCI had no effect on LOS before angioplasty. However, TIMI after PCI was related to LOS. In culprit artery, the LAD was the most common involved vessel, and 64.0% of patients with LAD infarction had LOS more than 6 days. The right coronary artery (RCA) item also had the second highest incidence among patients in this study but did not directly affect the increase in LOS. In the study of Isik et al., the LAD item was the most common involved vessel and patients had LOS more than 6 days. Also, RCA did not have an effect on the LOS.[16]

Most of our patients with LOS more than 6 days required GP IIb/IIIa inhibitors and this relationship was significant. In the study of Melberg et al., the use of GP IIb/IIIa was associated with an increase in LOS, but this was not significant.[21] Patients with successful angioplasty in 90% of cases had LOS less than 3 days. In this study, increasing the duration of PCI increased the duration of hospitalization. Door-to-balloon duration and contrast volume did not have an effect on the increase in admission days. The most common complication was slow flow during PCI which had a direct relationship with LOS more than 6 days. The distribution of complications during hospitalization revealed that 94.7% of uncomplicated patients had short LOS during admission. In contrast, 39.0% of patients with kidney failure had long LOS. After that, vascular complications, anemia and the need for blood transfusion, and VT were the most frequent complications in our patients. Complications such as VF, thrombocytopenia, reocclusion, pericardial effusion, and reMI were less frequent, but there was a relationship between the incidence of these complications and the duration of admission. There was no relationship between other complications and hospitalization time.

Therefore, it is suggested that this study be carried out in a great sample size in other provinces so that better studies could be found in Iran. The impossibility of comparing the results of our study with other hospitals and examining the variables of the hospital such as scientific level, financing, and annual PPCI were the limitations of this study.

Conclusion

It seems that the proper use of medical facilities and resources in the current situation is a priority. The LOS, bed occupancy rate (BOR), and average patient's stay are the main economic indicators for reducing health care costs in the country. Also, identifying

related factors such as comorbidities, BMI, PCI failure, having post-treatment complications, and clinical symptoms and problems during admission can lead to minimizing overuse of medical resources and maximizing the patient's remission.

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Conflict of Interests

Authors have no conflict of interests.

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