THE MEDICAL BULLETIN OF
SISLI ETFAL HOSPITAL

DOI: 10.14744/SEMB.2019.00878
Med Bull Sisli Etfal Hosp 2019;53(2):179–185

Original Research

In-hospital Outcomes of Patients with ST-segment Elevation Myocardial Infarction who were Intubated before Primary Percutaneous Intervention: Experience of a tertiary center

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Abstract

Objectives: ST-segment elevation myocardial infarction (STEMI) complicated by respiratory failure is associated with a greater number of in-hospital and out-of-hospital adverse cardiovascular events (CVEs). The aim of this study was to analyze in-hospital outcomes and the factors affecting the outcomes of intubated patients diagnosed with STEMI who underwent primary percutaneous coronary intervention (pPCI) at a single tertiary care center.

Methods: The data of 592 patients diagnosed with acute STEMI who were admitted to the emergency department between May 2017 and January 2019 and subsequently underwent pPCI were retrospectively reviewed. Cardiovascular risk factors as well as biochemical and angiographic characteristics of patients who were intubated in the emergency room or ambulance due to cardiac arrest and those who were not intubated were compared. Adverse CVEs were defined as in-hospital death, cerebrovascular stroke, and acute stent thrombosis.

Results: A total of 60 patients (70% male; mean age: 63.6±14.0 years) who were intubated and 532 non-intubated patients (81% male; mean age: 60.2±12.1 years) were included in the study. The angiographic features of the 2 groups were similar. An adverse CVE was experienced by 43.3% of the intubated patients and 3.6% of the non-intubated patients. Multivariate analysis indicated that age (odds ratio [OR]: 1.065; p<0.001), serum lactate level (OR: 1.308; p<0.001), and left ventricle ejection fraction (OR: 0.946; p<0.001) were independent predictors of in-hospital adverse CVE in the intubated patient group.

Conclusion: The results of this single-center study showed that 1 in 10 patients hospitalized with STEMI were intubated, and approximately 4 in 10 intubated STEMI patients had an in-hospital CVE.

Keywords: In-hospital outcomes; intubated patients; ST-segment elevation myocardial infarction.

Please cite this article as "Yıldız SS, Sığırcı S, Gürdal A, Keskin K, Kilci H, Doğan GM, et al. In-hospital Outcomes of Patients with ST-segment Elevation Myocardial Infarction who were Intubated before Primary Percutaneous Intervention: Experience of a tertiary center. Med Bull Sisli Etfal Hosp 2019;53(2):179–185".

Coronary artery disease (CAD) continues to be the most common cause of death in our country as well as all over the world.[1, 2] Acute ST- segment elevation myocardial infarction (STEMI) is considered the most severe form of CAD due to the high rate of mortality and other complications.[3] Given the current use of stents, the most recent guidelines strongly suggest that the first treatment option to be considered in cases of STEMI should be primary

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Submitted Date: March 26, 2019 **Accepted Date:** April 11, 2019 **Available Online Date:** July 12, 2019

percutaneous intervention (pPCI) performed by an experienced team in a hospital properly equipped for the procedure.[4] However, despite advances in pPCI and coronary revascularization techniques, acute STEMI is still associated with high in-hospital mortality and complication rates.

Mortality and complication rates after pPCI ranging from 7% to 15% have been reported in the literature.[5, 6] It has been established that the rate of discharge from the hospital before undergoing pPCI is quite low in STEMI patients who are intubated or experience cardiac arrest outside a hospital with a return to spontaneous circulation.[7] There are studies reporting better survival outcomes in these patients following successful pPCI. Most of these studies are retrospective and single-center in design, and analyzed factors affecting the follow-up results of intubated STEMI in-patients based on the records of the center.[8–10] Knowledge about successful post pPCI in-hospital outcomes and cardiac events affecting these outcomes in intubated patients with recovery of spontaneous circulation following cardiac arrest occurring before pPCI or in the hospital remains very limited. The aim of this study was to analyze in-hospital events and the parameters affecting these events in post- pPCI STEMI patients who were intubated in the hospital or prior to arrival and were admitted to the emergency room of a tertiary center.

Methods

The data of 592 patients who were diagnosed with acute STEMI in the emergency service between May and May 2017 were retrospectively reviewed. The details of patients who underwent intubation due to cardiac arrest in the emergency room or ambulance prior to pPCI were analyzed. Patients who died prior to undergoing pPCI, patients intubated in the intensive care unit after a successful pPCI, patients under 18 years of age, pregnant and breastfeeding women, patients undergoing emergency coronary angiography and not treated with balloon angioplasty or stenting, cases with established oncological diseases, those on hemodialysis or with severe liver failure were excluded from the study.

Indications for intubation and mechanical ventilatory support included impaired consciousness for whom adequate oxygenation or airway patency was difficult to maintain, and cases with acute respiratory failure according to blood gas parameters, severe left heart failure causing acute pulmonary congestion, supraventricular or ventricular arrhythmias, or cardiac arrest. All of the patients enrolled in the study were treated with pPCI and revascularization of the artery responsible for the infarction.

Data related to clinical, laboratory, and angiographic features; the door-to-balloon time; and cardiovascular risk factors were obtained from the hospital medical files and recorded for statistical analysis. The laboratory parameters used were obtained from blood samples taken at admission to the emergency service. This study was conducted in accordance with the principles of the Helsinki Declaration and good clinical practice and was approved by the Institutional Ethics Committee of Sisli Hamidiye Etfal Education and Research Hospital on 05/03/2019 (Number: 2294).

Definitions

Intubated patients were those who had been provided with an endotracheal tube by emergency healthcare personnel to provide respiratory support following cardiac arrest or by emergency service personnel during the evaluation process for a suspected myocardial infarction or subsequent cardiac arrest.

Non-intubated patients with STEMI who were brought into cardiac intensive care units (CICU) after the pPCI were not included in this study.

As usual, acute myocardial infarction was defined as ≥0.1 mV ST-segment elevation measured at the J point in 2 contiguous electrocardiography leads. That is, ST-segment elevations in V2-V3 leads of ≥0.25 mV in men under 40 and ≥0.2 mV in those over 40 years of age, and ≥0.15 mV in women or the presence of a recent-onset confirmed or suspected left bundle branch block.[11] Left ventricular ejection fraction (LVEF) was measured using the biplane Simpson method in patients who were brought into the CICU within the first 24 hours after the pPCI, according to the recommendations of the American Society of Echocardiography.[12] Left ventricular systolic dysfunction was defined as LVEF of <40%. Thrombolysis in Myocardial Infarction (TIMI) flow rate was evaluated visually by the surgeon based on angiographic images to determine the success of the vascular surgery performed to perfuse the infarcted area.[13] Major or fatal bleeding or symptomatic intracranial bleeding was defined as a 5 g/L reduction in hemoglobin concentration, bleeding requiring 2 units of red blood cells or the equivalent, a complete blood transfusion, or bleeding that caused hypotension requiring intravenous inotropic agent support.[14] In-hospital mortality, stent thrombosis, and cerebrovascular events were defined as major in-hospital adverse events.

Angiography and Procedural Characteristics

All of the patients evaluated by cardiologists in the emergency service and diagnosed with STEMI were brought to the angiography laboratory. All patients intubated before hospital arrival or in the emergency department were given 300 mg acetylsalicylic acid and 600 mg clopidogrel loading dose and 80 mg atorvastatin using a nasogastric catheter before the invasive laboratory procedures. After the guiding catheter was inserted into the artery responsible for the infarction, unfractionated heparin was administered at a dose of 70-100 U/kg. Thrombus aspiration was performed using an aspiration catheter in the patients who were determined to have a high coronary thrombus load according to the angiographic images.

Pre- and post-dilatation balloon angioplasties were performed with coronary balloons fitted to the diameter of the artery responsible for infarction in all cases. Vascular patency was achieved with the implantation of bare or drug-eluting stents. A grade 3 flow according to the TIMI scoring system and residual in- stent stenosis of <20% were accepted as a successful percutaneous coronary intervention.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean±SD or median (minimum-maximum) for discrete numerical variables, and nominal variables were described using the number and percentage of cases. Student's t-test was used to compare continuous variables with normal distribution and the Mann-Whitney U test was applied to compare the variables that did not demonstrate normal distribution. Comparisons of categorical variables were performed using a chi-square test and Fisher's exact test.

Cox regression analysis was used to determine predictors of unintended in-hospital cardiac events for patients intubated before PCI. Multivariate Cox regression analysis was performed to determine the parameters meeting the criterion of $p<0.1$ in the univariate Cox analysis, and the independent predictors of in-hospital adverse events in intubated patients. Relative risk with a 95% confidence interval was calculated for each variable. Statistical significance was accepted at $p<0.05$.

Results

Table 1 lists demographic characteristics, cardiovascular risk factors, and laboratory parameters of the 592 patients included in the study. Among these patients, 60 were intubated to provide respiratory support as a result of out-of-hospital or in-hospital cardiac arrest. Hyper-

Table 1. Demographic features, cardiovascular risk factors, and laboratory findings of intubated and non-intubated STEMI patients

Variables	Total n=592	Intubated (n=60, 10.1%)	Non-intubated (n=532, 89.9%)	p
Age, years	60.6±12.3	63.6±14.0	60.2±12.1	0.042
Gender, male %	80.2	70.0	81.4	0.041
HT, %	47.4	45.8	48.8	0.682
DM, %	28.5	30.5	29.0	0.880
Previous CAD, %	21.1	15.3	22.3	0.245
Dyslipidemia, %	31.7	19.0	34.7	0.042
Smoking,%	55.6	54.8	52.6	0.746
Infection, %	15.0	42.4	12.3	<0.001
Acute anterior wall MI, %	42.9	57.1	41.4	0.019
Hemoglobin A1c, %	6.3±1.5	6.2±2.6	6.3±1.4	0.822
Hgb, g/dL	14.2±1.9	13.7±2.1	14.3±1.9	0.040
WBC, ×109/L	12.4±4.3	14.9±5.8	12.1±4.1	<0.001
Neutrophil, ×109/L	63.8±15.4	69.1±17.5	63.2±15.1	0.006
Lymphocyte, %	27.3±13.5	23.1±16.0	27.7±13.2	0.013
Platelet count, ×109/L	250.5±69.5	250.5±75.7	250.5±68.9	0.997
Creatinine, mg/dL	1.0±0.2	1.1±0.5	1.0±0.2	<0.001
TSH, mU/L	1.7±1.1	1.5±1.0	1.7±1.2	0.673
Total cholesterol, mg/dL	184.9±46.7	172.5±45.9	185.9±46.7	0.074
LDL cholesterol, mg/dL	116.9±41.2	105.4±40.6	117.9±41.2	0.066
HDL cholesterol, mg/dL	40.3±10.4	38.9±11.2	40.4±10.4	0.360
Triglyceride, mg/dL	141.1±82.4	142.0±94.2	141.0±81.5	0.939
LVEF, %	46.3±9.9	37.7±8.1	46.6±9.8	0.001

CAD: Coronary artery disease; DM: Diabetes mellitus; HDL-C: High-density lipoprotein cholesterol; Hgb: Hemoglobin; HT: Hypertension; LDL-C: Low-density lipoprotein cholesterol; LVEF: Left ventricular ejection fraction; MI: Myocardial infarction; STEMI: ST-elevation myocardial infarction; TSH: Thyroid-stimulating hormone; WBC: White blood cell. Numerical values were expressed as mean±SD.

tension (HT), diabetes, family history of coronary artery disease (CAD), glycated hemoglobin, thyroid-stimulating hormone (TSH), and cholesterol parameters were similar in the intubated and non-intubated patients with STEMI. However, increased age, male sex, infection, and acute anterior wall STEMI were more frequently detected in intubated STEMI patients (p=0.042, p=0.041, p<0.001, and p=0.19, respectively).

The admission creatinine value, and white blood cell and neutrophil counts were significantly higher in intubated STEMI patients compared with non-intubated STEMI patients (p<0.001, p<0.001, and p=0.006, respectively). The left ventricle ejection fraction (LVEF), hemoglobin levels, and lymphocyte counts evaluated within the first 24 hours were statistically significantly lower in intubated STEMI patients (p=0.001, p=0.04, and p=0.013, respectively).

Table 2 illustrates the comparison of in-hospital adverse CVEs (acute stent thrombosis, death, and ischemic stroke), tamponade, major bleeding, and hospitalization time for intubated and non-intubated STEMI patients. Adverse CVEs occurred in 26 (43.3%) intubated patients and 19 (3.6%) non-intubated patients, (p<0.001). The rates of mortality and ischemic stroke as well as the duration of hospitalization increased in intubated STEMI patients compared with non-intubated STEMI patients (30% vs 1.3%, p<0.001; 10% vs 0.8%, p<0.001; and 5.2±2.4 days vs 10.7±3.9 days, p=0.035, respectively).

Table 3 provides demographic data, cardiovascular risk factors, and biochemical parameters of the study groups. Of the 60 intubated STEMI patients, 26 were found to have developed adverse CVEs (adverse CVE+ group) and 34 intubated STEMI patients had no CVEs (CVE-group) There were no significant intergroup differences with respect to male gender, HT, diabetes mellitus, CAD history, dyslipidemia, infection, or acute anterior wall STEMI (p>0.05 for all).

Similarly, no intergroup difference was detected in the laboratory parameters of lymphocyte and platelet counts, or levels of creatinine, TSH, or cholesterol (p>0.05 for all). The serum lactate level, hemoglobin, white blood cell count, and neutrophil values were significantly higher in the CVE+ group than the CVO- group (p<0.001, p=0.005, p=0.035, and p=0.007, respectively). LVEF values were significantly lower in the CVE- group (p<0.001).

In Table 4, the CVE+ and CVE- intubated STEMI in-patients are compared in terms of angiographic features. No significant difference was found between the groups when the number of affected vessels, number of stents, stent type, stent diameter, and TIMI flow grade were compared (p>0.05 for all).

Table 5 shows the results of the univariate and multivariate analysis to identify predictors of CVE in STEMI patients intubated in and outside of the hospital. In univariate analysis, age (odds ratio [OR]: 1.065, confidence interval [CI]: 1.044-

Table 2. In-hospital post-pPCI outcomes of intubated and non-intubated STEMI patients

	Non-intubated STEMI n=532, 89.9%	Intubated STEMI n=60, 10.1%	p
Ischemic stroke, n (%)	4 (0.8)	6 (10)	<0.001
Major bleeding, n (%)	1 (0.2)	2 (3.3)	0.103
Death, n (%)	8 (1.3)	18 (30)	<0.001
Acute stent thrombosis, n (%)	7 (1.3)	2 (3.3)	0.378
Tamponade, n (%)	5 (1)	2 (3.3)	0.167
Adverse CVE, n (%)	19 (3.6)	26 (43.3)	<0.001
Hospital stay, days	5.2±2.4	10.7±3.9	0.035

CVE: Cardiovascular event; pPCI: Primary percutaneous coronary intervention; STEMI: ST-elevation myocardial infarction.

Table 3. Demographic characteristics, cardiovascular risk factors, and laboratory test values in intubated patients who did and did not experience cardiovascular events

Variables	Adverse CVE (+) n=26	Adverse CVE (-) n=34	p
Age, years	66.9±14.9	61.2±13.1	0.01
Male, n (%)	21(82)	17 (50)	0.04
HT, n (%)	16 (60)	14 (42)	0.08
DM, n (%)	9 (36.4)	8 (23.1)	0.394
History of CAD, n (%)	4 (15.4)	5 (15.2)	0.980
Dyslipidemia, n (%)	4 (15.4)	7 (21)	0.767
Infection, n (%)	12 (45.5)	13 (34.5)	0.608
Acute anterior wall MI, n (%)	15 (58)	20 (58)	1.000
Serum lactate, mmol/L	8.3±4.1	4.4±2.3	<0.001
Hgb, g/dL	10.3±2.1	14.0±1.8	0.005
WBC, ×109/L	17.5±5.0	13.9±6.1	0.035
Neutrophil, ×109/L	75.9±16.7	65.5±14.3	0.007
Lymphocyte, %	25.1±15.8	20.4±16.4	0.08
Platelet count, ×109/L	270.5±93.1	236.4±58.0	0.092
Creatinine, mg/dL	1.2±0.6	1.0±0.31	0.093
TSH, mU/L	2.0±2.8	1.3±1.5	0.364
Total cholesterol, mg/dL	158.5±41.0	178.1±47.2	0.216
LDL-C, mg/dL	96.1±36.4	108.9±42.2	0.380
HDL-C, mg/dL	39.0±11.1	38.8±11.5	0.959
Triglyceride, mg/dL	99.2±38.7	159.2±104.5	0.062
LVEF, %	27.8±6.7	40.3±11.1	<0.001

CAD: Coronary artery disease; CVE: Cardiovascular event; DM; Diabetes mellitus, HDL-C; High-density lipoprotein cholesterol; Hgb; Hemoglobin; HT: Hypertension; LDL-C: Low-density lipoprotein cholesterol; LVEF: Left ventricular ejection fraction; MI: Myocardial infarction; TSH; Thyroid-stimulating hormone; WBC; White blood cell.

Table 4. Angiographic characteristics of intubated patients who did and did not experience adverse cardiovascular events

Variables	Adverse CVE (+) n=26	Adverse CVE (-) n=34	p
Number of vessels	1.33±0.2	1.32±0.2	1.000
Number of stents	1.44±0.3	1.42±0.3	1.000
DES, n (%)	24 (92.3)	28 (93.3)	0.926
Bare metal stent, n (%)	2 (97.7)	2 (96.7)	1.000
Failed pPCI, n (%)	0 (0)	0 (0)	1.000
Length of the stent, mm	20.66±9.4	21.47±9.5	0.893
Diameter of the stent, mm	3.07±0.44	3.05±0.46	0.917
IAB, n (%)	0 (0)	0 (0)	1.000
Postprocedure TIMI score, n (%)			
0	0 (0)	0 (0)	1.000
1	0 (0)	0 (0)	1.000
2	1 (3.6)	2 (3)	0.988
3	24 (92.3)	34 (94.4)	0.875

CVE: Cardiovascular event; DES: Drug-eluting stent; IAB: Intraaortic balloon; pPCI: Primary percutaneous intervention; TIMI: Thrombolysis in Myocardial Infarction.

1.086; p<0.001), male gender (OR: 0.315, CI: 0.190-0.523; p<0.001), serum lactate level (OR: 3.660, CI: 2.142-6.253; p<0.001), LVEF (OR: 0.942, CI: 0.914-0.971; p<0.001), and hemoglobin (OR: 0.783, CI: 0.694-0.883; p<0.001) were associated with adverse CVEs.

Multivariate analysis revealed that age (OR: 1.065, CI: 1.034-1.098; p <0.001), serum lactate level (OR: 1.308, CI: 1.043-2.645; p<0.001), and LVEF (OR: 0.946, CI: 0.910-0.985; p<0.001) were found to be independent predictors of adverse CVEs among in-patients with STEMI.

Discussion

The main finding of this study based on real-life experience was that STEMI patients who were intubated in both in-hospital and out-of-hospital settings and treated with pPCI after they regained spontaneous circulation experienced adverse CVEs 12 times more frequently than non-intubated patients.

The risk of experiencing an in-hospital CVE was not affected by cardiovascular risk factors or successful angiographic revascularization. However, an increased serum lactate level, advanced age, and low LVEF were found to be independent predictors of adverse in-hospital CVEs among intubated patients.

Most cardiac arrests are primarily due to acute coronary syndrome. Early diagnosis and treatment of these patients as soon as possible is essential.[15] A subgroup analysis of a multicenter study conducted by Kouraki et al.[16] included patients with diagnoses of STEMI and non-STEMI. Most of these patients were intubated outside of the hospital. The in-hospital mortality rate among these patients was 48% and it increased to 69% in patients with cardiogenic shock. In a single-center study, Lesage et al.[17] reported that among 157 patients there was a 28-day mortality rate of 52%. In this study, the serum creatinine level and low LVEF were reported as independent predictors of in-hospital mortality based on a multivariate analysis. Our study included only STEMI patients treated with pPCI. The lower in-hospital mortality rate when compared with other studies may be related to a younger study population.

In our study, age, serum lactate level, and initial bedside LVEF measurements were found to be independent predictors of in-hospital adverse CVEs.

A single-center, retrospective study performed by Velibey et al.[18] in our country analyzed the first- and fifth-year CVE results of STEMI patients who experienced cardiac arrest outside of the hospital. In this study, the in-hospital mortality rate of these patients was 33%. The authors reported that advanced age, HT, history of stroke, and blood urea nitrogen value were independent predictors of in-hospital

Table 5. Results of univariate and multivariate analyses to determine predictors of in-hospital adverse CVEs in intubated patients with ST-elevation myocardial infarction

Variables	Univariate			Multivariate		
	OR	(95 %CI)	p	OR	(95% CI)	p
Age	1.065	1.044–1.086	<0.001	1.065	1.034–1.098	<0.001
Gender (male)	0.315	0.190–0.523	<0.001	0.713	0.331–1.537	0.388
Serum lactate	3.660	2.142–6.253	<0.001	1.308	1.043–2.645	<0.001
Anterior wall MI	1.599	0.972–2.501	0.066	0.796	0.374–1.693	0.553
LVEF	0.942	0.914–0.971	<0.001	0.946	0.910–0.985	0.006
Hemoglobin	0.783	0.694–0.883	<0.001	0.914	0.769–1.087	0.311
WBC	1.033	0.981-1.088	0.218	1.071	0.993–1.156	0.075

CI: Confidence interval; CVE: Cardiovascular event; LVEF: Left ventricular ejection fraction; MI: Myocardial infarction; OR: Odds ratio; WBC: White blood cell.

mortality according to multivariate analysis.

Our research, as is the case with other studies, was designed as a retrospective, observational study. As a result of the heterogeneous distribution of patient groups, all laboratory and clinical data were not available; therefore, different endpoints have been used in various studies. In our study, as in others, the common parameter that predicted in-hospital death was advanced age. The most important feature that differentiates our study from other research is the inclusion of patients intubated for cardiac arrest that occurred in both in-hospital and out-of-hospital settings. All of these patients were treated successfully with pPCI as soon as diagnosis of STEMI was made. Therefore, procedural success did not affect the occurrence of adverse CVEs in intubated patients. Complete data on serum lactate levels at the time of initial admission was not available in other studies.

We found that a high serum lactate level and a low LVEF were independent predictors of adverse CVEs.

Conclusion

In conclusion, this study demonstrated that STEMI patients intubated following in-hospital and out-of-hospital cardiac arrest were associated with an increased number of in-hospital adverse events. Our study may help cardiologists in the emergency room to identify cardiac arrest patients at risk of death, cerebrovascular accident, or acute stent thrombosis in the follow-up of intubated patients who have undergone pPCI. Prospective large-scale studies are needed to further analyze the risks and the parameters.

Limitations of the Study

The most important limitation of our research is that it was a retrospective and observational study. The diagnosis was made after the first medical contact in the emergency department, which is one of the important parameters affecting the survival of the patients with or without intubation, and door-to-balloon time records were not taken into consideration because they were not available in all cases. Similarly, the time of resuscitation and intubation, the duration of resuscitation and the time to recovery of spontaneous circulation were not fully recorded for all patients.

All of the patients who were intubated and underwent pPCI were hospitalized for follow-up and treatment after the procedure, but none of these patients, especially those intubated outside the hospital, were treated for hypothermia, despite the recommendation of current protocol.[19] Finally, incomplete data made it impossible to analyze the return to neurological status among the intubated patients who had a cerebrovascular event.

Disclosures

Ethics Committee Approval: By the institutional Ethics Committee of Sisli Hamidiye Etfal Education and Research Hospital on 05/03/2019 (Number: 2294).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – S.S.Y.; Design – S.S.Y., S.S.; Supervision – K.K., K.O.K.; Materials – S.S., H.K.; Data collection &/or processing – S.S., G.Ç., T.H.; Analysis and/or interpretation – S.S.Y., G.M.D.; Literature search – S.S.Y., H.K., T.H.; Writing – S.S.Y.; Critical review – K.O.K.

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