

# FACTORS ASSOCIATED WITH THE OUTCOME OF PERCUTANEOUS CORONARY INTERVENTION AFTER 6 MONTHS IN PATIENTS $\geq 75$ YEARS OLD WITH ST-ELEVATION MYOCARDIAL INFARCTION

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Received: 06/08/2025

Revised: 08/09/2025; Accepted: 18/12/2025

## ABSTRACT

**Objective:** To evaluate factors associated with the outcomes of percutaneous coronary intervention (PCI) after 6 months in patients aged  $\geq 75$  years with ST-elevation myocardial infarction (STEMI).

**Subjects and Methods:** A prospective, interventional, cross-sectional study was conducted on 104 patients aged  $\geq 75$  years, diagnosed with acute STEMI and indicated for PCI at Vietnam National Heart Institute – Bach Mai Hospital, Hanoi Heart Hospital, and Huu Nghi Hospital during the period 2018–2023.

**Results:** The incidence of major adverse cardiovascular events (MACE) at 6 months post-PCI was 18.3%. The risk factors significantly associated with MACE were: age  $\geq 85$  years (OR = 5.39;  $p = 0.020$ ), diabetes mellitus (OR = 2.95;  $p = 0.037$ ), Killip class III+IV (OR = 4.44;  $p = 0.011$ ), TIMI risk score  $> 6$  (OR = 3.84;  $p = 0.019$ ), CK-MB  $> 39$  (OR = 3.35,  $p = 0.019$ ), TroponinT  $> 4084.2$  ng/L (OR = 8.02,  $p < 0.001$ ), ST-segment elevation  $\geq 4.0$  mm (OR = 4.03;  $p = 0.009$ ), triple-vessel disease (OR = 3.39;  $p = 0.016$ ), and left main coronary artery (LMCA) lesion (OR = 4.27;  $p = 0.046$ ).

**Conclusion:** The factors associated with adverse outcomes following PCI in patients aged  $\geq 75$  years with STEMI within 6 months were advanced age, diabetes, high Killip class, elevated TIMI score ( $> 6$ ), lower CK-MB concentration, Troponin T concentration, ST elevation  $\geq 4.0$  mm, triple-vessel coronary artery disease, and LMCA involvement.

**Keywords:** Primary coronary intervention, myocardial infarction, ST elevation,  $\geq 75$  years old.

## 1. INTRODUCTION

ST-elevation acute myocardial infarction (STEMI) accounts for a high incidence, mortality, and complication rate both globally and in Vietnam. It represents a major public health issue in developed countries and is increasingly recognized as a critical concern due to the severity of the condition [1]. People 60 years of age and older are frequently found to have the illness. Notably, older patients ( $\geq 75$  years old) are more likely to experience difficulties and adverse events because they frequently have complex coronary artery lesions, various comorbidities, and a lower ability for recovery. As a result, this population has a greater need for efficient treatment and improved quality of life after intervention. In order to minimize myocardial ischemia, reduce complications, and lower

mortality, the main objective of treating ST-elevation myocardial infarction (STEMI) is to quickly restore blood flow by revascularizing the occluded or severely narrowed coronary artery segment. In elderly patients, coronary arteries are often more severely affected, with calcified, tortuous, angulated lesions, involvement of the coronary ostia, multi-vessel disease, and more frequent left main coronary artery lesions. These complex anatomical features significantly reduce the success rate of percutaneous coronary intervention (PCI). Moreover, older patients with STEMI frequently present late to the hospital with atypical symptoms, often have multiple underlying conditions, and are at increased risk of mortality and post-infarction complications. [2]. However, in Vietnam, there is still a lack of studies

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focusing on the outcomes of primary percutaneous coronary intervention (PCI) in patients aged  $\geq 75$  years with ST-elevation myocardial infarction (STEMI), particularly studies that assess mid-term outcomes and investigate coronary lesions and related factors in this population. This study aims to evaluate factors associated with the outcomes of primary percutaneous coronary intervention (PCI) at 6-month follow-up in patients aged  $\geq 75$  years with STEMI.

## 2. SUBJECTS AND METHODS

### 2.1. Subjects

Patients aged  $\geq 75$  years diagnosed with ST-elevation myocardial infarction (STEMI) and indicated for primary percutaneous coronary intervention (PCI) at the Vietnam National Heart Institute – Bach Mai Hospital, Hanoi Heart Hospital, and Huu Nghi Hospital from 2018 to 2021.

#### - Inclusion Criteria

+ Patients aged  $\geq 75$  years, diagnosed with ST-elevation myocardial infarction (STEMI), indicated for primary percutaneous coronary intervention (PCI) between 2018 and 2021 at the study sites, and who provided informed consent to participate in the study.

+ The diagnosis of ST-elevation myocardial infarction (STEMI) was based on the Fourth Universal Definition of Myocardial Infarction (2018). The indication for primary percutaneous coronary intervention (PCI) followed the 2017 ESC Guidelines, as well as recommendations from the Vietnam National Heart Association and the Ministry of Health (2019).

#### - Exclusion Criteria

Patients with contraindications to antiplatelet medications; those who experienced a cerebrovascular accident or gastrointestinal bleeding within the past 3 months; patients with severe renal or hepatic failure; and those with terminal-stage cancer...

**2.2. Study period and locations:** From June 2018 to December 2021 at the Vietnam National Heart Institute – Bach Mai Hospital, Hanoi Heart Hospital, and Huu Nghi Hospital.

### 2.3. Research Methods

**2.3.1. Study design:** Descriptive cross-sectional study with analytical components.

#### 2.2.2. Sample Size and Sampling Method:

Convenience sampling was used by selecting all patients who met the inclusion and exclusion criteria during the study period. In practice, we enrolled 104 eligible patients throughout the study duration. Due to the COVID-19 pandemic occurring during data collection, only 104 patients were included.

### 2.4. Research Indicators

Assessment of the impact of various factors on major

adverse cardiovascular events (MACE) within 6 months after intervention, including:

- The influence of anthropometric characteristics and risk factors
- The influence of clinical features
- The influence of paraclinical characteristics
- The influence of cardiac enzyme levels
- The influence of electrocardiogram (ECG) and echocardiography findings
- The influence of coronary artery lesions

### 2.5. Criteria applied in the study

- Use of scoring systems such as coronary artery flow assessment by the TIMI grade (0–3), Killip classification (I–IV), GRACE 2.0 score, and TIMI Risk Score

#### \* Major Adverse Cardiovascular Events (MACE):

Major adverse cardiovascular events (MACE) that may occur after PCI include: death, myocardial infarction (MI), stroke, and other complications such as vascular complications, contrast-induced nephropathy, and bleeding. However, our study focused only on major cardiovascular events including: all-cause mortality, recurrent MI, and cerebral stroke.

- All-cause mortality: At the end of the study, all deaths were recorded regardless of cause. Mortality included cardiovascular death, non-cardiovascular death, and death of unknown cause. Among these, all-cause mortality is a commonly used variable in clinical PCI studies.

- Recurrent myocardial infarction: Patients who experienced recurrent MI requiring re-intervention represent the most common complication after PCI, often due to procedural complications such as slow flow or loss of side branches....

- Stroke: defined according to the Standardized Neurological Criteria for Cardiovascular Clinical Trials by the European Society of Cardiology (ESC), stroke is characterized by sudden onset of neurological deficits with focal symptoms rather than diffuse ones, lasting more than 24 hours or resulting in death within 24 hours, excluding traumatic brain injury. Diagnostic imaging methods include magnetic resonance imaging (MRI), computed tomography (CT), or both, with lesions corresponding to the clinical symptoms of stroke.

**2.6. Data analysis:** Data were entered and processed using medical statistical methods with SPSS version 26.0 software.

**2.7. Research Ethics:** The study was approved by the Ethics Committee of the 108 Clinical Medical Research Institute; and received approval from the Vietnam National Heart Institute – Bach Mai Hospital, Hanoi Heart Hospital, and Huu Nghi Hospital.

### 3. RESEARCH RESULTS

**Table 1. Influence of demographic characteristics and risk factors on major adverse cardiovascular events (MACE) in patients 6 months after intervention**

Index \ MACE		Yes (n=19)		No (n=85)		OR (95%CI), p
		n	%	n	%	
Age	≥85	8	34,8	15	65,2	5,39 (1,00-11,08), p=0,020
	75-<85	11	13,6	70	86,4	
Sex	Male	12	17,9	55	82,1	0,94 (0,33-2,63), p=0,899
	Female	7	18,9	30	81,1	
Hypertension	Yes	18	19,1	76	80,9	2,13 (0,25-17,92), p=0,486
	No	1	10,0	9	90,0	
Diabetes Mellitus (DM)	Yes	11	28,9	27	71,1	2,95 (1,07-8,18), p=0,037
	No	8	12,1	58	87,9	
History of dyslipidemia	Yes	15	21,1	56	78,9	1,94 (0,59-6,39), p=0,275
	No	4	12,1	29	87,9	
History of coronary artery revascularization	Yes	3	17,6	14	82,4	1,16 (0,23-5,89), p=0,862
	No	16	18,4	71	81,6	
Total		19	18,3	85	81,7	

Patients aged ≥85 have a 5.39 times higher risk of experiencing major adverse cardiovascular events (MACE) within 6 months after intervention compared to patients aged <85, which is statistically significant (95% CI: 1.00–11.08). Patients with concomitant diabetes mellitus have a 2.95 times higher risk of MACE within 6 months post-intervention compared to those without diabetes, also statistically significant (95% CI: 1.07–8.18).

**Table 2. Influence of clinical characteristics on major adverse cardiovascular events (MACE) in patients 6 months after intervention**

Index \ MACE		Yes(n=19)		No (n=85)		OR (95%CI), p
		n	%	n	%	
Typical angina	Yes	11	18,6	48	81,4	1,06 (0,39-2,90), p=0,910
	No	8	17,8	37	82,2	
Bleeding risk	Yes	10	25,6	29	74,4	2,15 (0,79-5,87), p=0,137
	No	9	13,8	56	86,2	
Killip	III, IV	6	42,9	8	57,1	4,44 (1,06-17,25), p=0,011
	I, II	13	14,4	77	85,6	
TIMI Risk Score	>6	15	26,3	42	73,7	3,84 (1,09-16,99), p=0,019
	≤6	4	8,5	43	91,5	
GRACE Score	>149,38	18	23,1	60	76,9	7,50 (0,95-59,26), p=0,056
	≤149,38	1	3,8	25	96,2	
Total		19	18,3	85	81,7	

Patients classified as Killip III and IV have a 4.44 times higher risk of experiencing major adverse cardiovascular events (MACE) within 6 months after intervention compared to patients classified as Killip I and II, which is statistically significant (95% CI: 1.06–17.25). Patients with a TIMI Risk Score >6 have a 3.84 times higher risk of MACE within 6 months post-intervention compared to those with a TIMI Score ≤6, also statistically significant (95% CI: 1.09–16.99).

**Table 3. Influence of paraclinical characteristics on major adverse cardiovascular events (MACE) in patients 6 months after intervention**

Index \ MACE		Yes (n=19)		No (n=85)		OR (95%CI), p
		n	%	n	%	
Creatinin	>115µmol/l	10	30,3	23	69,7	3,00 (1,08-8,30), p=0,035
	≤115µmol/l	9	12,7	62	87,3	
Glomerular Filtration Rate - GFR <60 (ml/ph)	Yes	11	40,7	16	59,3	5,93 (2,05-17,13), p=0,001
	No	8	10,4	69	89,6	
Glucose	≥7,0mmol/l	11	16,7	55	83,3	0,75 (0,27-2,07), p=0,578
	<7,0 mmol/l	8	21,1	30	78,9	
Dyslipidemia	Yes	15	19,7	61	80,3	1,48 (0,44-4,90), p=0,525
	No	4	14,3	24	85,7	
Anemia	Yes	9	22,5	31	77,5	1,57 (0,58-4,27), p=0,380
	No	10	15,6	54	84,4	
Platelets	Elevated	1	9,1	10	90,9	0,42 (0,05-3,47), p=0,418
	Not elevated	18	19,4	75	80,6	
Total		19	18,3	85	81,7	

Patients with elevated creatinine before intervention had a 3.00-fold higher risk of experiencing major adverse cardiovascular events (MACE) within 6 months after the intervention compared to those without elevated creatinine, which was statistically significant (95% CI: 1.08–8.30). Patients with a glomerular filtration rate (GFR) <60 ml/min had a 5.93-fold higher risk of MACE within 6 months after intervention compared to those without, also statistically significant (95% CI: 2.05–17.13).

**Table 4. Effect of cardiac enzyme characteristics on major adverse cardiovascular events (MACE) in patients 6 months after intervention**

Index \ MACE		Yes (n=19)		No (n=85)		OR (95%CI), p
		n	%	n	%	
CK-MB	>39,0 U/L	9	33,3	18	66,7	3,35 (1,19-9,09), p=0,019
	≤39,0 U/L	10	13,0	67	87,0	
Troponin T	>4084,2 ng/L	14	38,9	22	61,1	8,02 (2,59-24,84), p<0,001
	≤4084,2 ng/L	5	7,4	63	92,6	
NT-proBNP	>125 ng/dl	14	17,9	64	82,1	0,92 (0,30-2,86), p=0,884
	≤125 ng/dl	5	19,2	21	80,8	
Tổng		19	18,3	85	81,7	

Patients with CK-MB >39.0 U/L had a 3.35 times higher risk of experiencing MACE within 6 months after intervention compared to the other group, with a statistically significant difference (95% CI: 1.19–9.09). Patients with Troponin T >4084.2 ng/L had an 8.02 times higher risk of experiencing MACE within 6 months after intervention compared to the other group, with a statistically significant difference (95% CI: 2.59–24.84; p < 0.001).

**Table 5. Impact of Electrocardiographic and Echocardiographic Parameters on Major Cardiovascular Events in Patients Six Months After Intervention**

Index		MACE		Yes (n=19)		No (n=85)		OR (95%CI), p
				n	%	N	%	
Infarcted area (ECG)	Anteroseptal and large anterior wall infarction			10	19,2	42	80,8	1,14 (0,42-3,08), p=0,800
	Posterior and inferior wall infarction			9	17,3	43	82,7	
ST elevation	≥4,0 mm			8	38,1	13	61,9	4,03 (1,15-13,44), p=0,009
	<4,0 mm			11	13,3	72	86,7	
Total				19	18,3	85	81,7	

Patients with ST-segment elevation  $\geq 4.0$  mm had a 4.03 times higher risk of major adverse cardiovascular events (MACE) within 6 months after intervention compared to patients with ST-segment elevation  $< 4.0$  mm, with statistical significance (95% CI: 1.15–13.44).

**Table 6. The impact of coronary artery lesions on major cardiovascular events in patients 6 months after intervention**

Index		MACE		Yes (n=19)		No (n=85)		OR (95%CI), p
				n	%	n	%	
Number of coronary artery lesions	≥2 branches			10	32,3	21	67,7	3,39 (1,06-10,72), p=0,016
	1 branch			9	12,3	64	87,7	
Main Coronary Artery	Yes			4	44,4	5	55,6	4,27 (1,03-17,75), p=0,046
	No			15	15,8	80	84,2	
LAD	Yes			15	18,5	66	81,5	1,08 (0,32-3,64), p=0,902
	No			4	17,4	19	82,6	
LCx	Yes			12	23,5	39	76,5	2,02 (0,73-5,64), p=0,178
	No			7	13,2	46	86,8	
RCA	Yes			10	15,4	55	84,6	0,61 (0,22-1,66), p=0,328
	No			9	23,1	30	76,8	
TIMI	0			18	21,4	66	78,6	5,18 (0,65-41,34), p=0,113
	1-2			1	5,0	19	95,0	
Total				19	18,3	85	81,7	

Patients with lesions in  $\geq 2$  coronary artery branches had a 3.39-fold higher risk of major adverse cardiovascular events (MACE) within 6 months after intervention compared to patients with a single-branch lesion, which was statistically significant (95% CI: 1.06–10.72).

Patients with left main coronary artery lesions had a 4.27-fold higher risk of MACE within 6 months after intervention compared to the other groups, also statistically significant (95% CI: 1.03–17.75).

#### 4. DISCUSSION

The study showed that patients aged  $\geq 85$  years had a 5.39-fold higher risk of major adverse cardiovascu-

lar events (MACE) within 6 months after percutaneous coronary intervention (PCI) compared to the 75–84 year age group, with statistical significance (OR = 5.39; 95% CI: 1.00–11.08;  $p = 0.020$ ). These results are consistent with recent studies indicating that advanced age is a strong risk factor associated with poor prognosis following coronary intervention in patients with ST-segment elevation myocardial infarction (STEMI). In a retrospective study based on registry data by Masoudkabar et al., age  $\geq 75$  was identified as a significant prognostic factor increasing the rate of MACE after PCI in STEMI patients. [3]. Elderly patients often have diffuse coronary artery disease, endothelial dysfunction, reduced compensatory capacity, and an increased risk of complications due to comorbidities (such as heart



failure, renal failure, and other multiple internal medical conditions).

Patients with diabetes had a 2.95-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to non-diabetic patients (OR = 2.95; 95% CI: 1.07–8.18;  $p = 0.037$ ). This finding is consistent with previously published studies demonstrating that diabetes is a strong risk factor increasing mortality and rehospitalization rates after PCI. A 2025 study by Zhang et al. showed that elevated plasma glucose levels at admission in non-diabetic STEMI patients were associated with increased in-hospital MACE, particularly among females and the elderly, reinforcing the risk role of dysglycemia [4]. This phenomenon can be explained by diabetes increasing oxidative stress, endothelial dysfunction, chronic inflammation, and widespread atherosclerosis, which negatively affect coronary vessel healing after intervention. These factors contribute to a higher risk of thrombosis, restenosis, and early cardiovascular events.

The study results showed that patients with Killip class III and IV at admission had a 4.44-fold higher risk of major adverse cardiovascular events (MACE) within 6 months after percutaneous coronary intervention (PCI) compared to those with Killip class I and II (OR: 4.44; 95% CI: 1.06–17.25;  $p = 0.011$ ). These findings are consistent with previous studies indicating that higher Killip classes reflect acute heart failure, reduced perfusion, and severe left ventricular damage, thereby increasing mortality and cardiovascular events post-intervention. A study by van Diepen et al. also demonstrated that Killip III and IV are independent prognostic factors for in-hospital and post-PCI mortality in patients with ST-segment elevation myocardial infarction (STEMI), especially in the elderly population [5]. Patients with a TIMI score  $> 6$  had a 3.84-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to those with a TIMI score  $\leq 6$  (OR: 3.84; 95% CI: 1.09–16.99;  $p = 0.019$ ). The TIMI score is a risk assessment tool developed to predict survival and the likelihood of cardiovascular events in patients with ST-segment elevation myocardial infarction (STEMI). It includes factors such as age, blood pressure, heart rate, cardiac enzyme levels, and medical history. Patients with higher TIMI scores often carry multiple severe risk factors simultaneously, which explains their worse prognosis..

The study also showed that patients with serum creatinine levels  $> 115 \mu\text{mol/L}$  before intervention had a 3.00-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to those without elevated creatinine (OR = 3.00; 95% CI: 1.08–8.30;  $p = 0.035$ ). This finding is consistent with numerous international studies that have identified renal dysfunction as an adverse prognostic factor after PCI. The underlying mechanism may be that elevated creatinine reflects chronic or acute kidney injury, which reduces the metabolism and excretion of antiplatelet agents and contrast media, thereby increasing the risk of myocardial

injury or cardiovascular events.

Patients with an estimated glomerular filtration rate (GFR)  $< 60 \text{ mL/min}$  had a 5.93-fold higher risk of MACE within 6 months compared to those with  $\text{GFR} \geq 60$  (OR = 5.93; 95% CI: 2.05–17.13;  $p = 0.001$ ), indicating that this is a strong predictive factor. This finding aligns well with the study by Nakamura T et al. (2024), which showed that low GFR is a strong predictor of cardiovascular events and prolonged renal dysfunction after PCI. [6]. Reduced GFR is often accompanied by diffuse atherosclerosis, systemic inflammation, and decreased cardiovascular reserve, which increase the risk of heart failure and cardiovascular mortality.

At the 6-month follow-up in this study, patients with CK-MB levels  $> 39.0 \text{ U/L}$  had a 3.35-fold higher risk of major adverse cardiovascular events (MACE) compared to the other group, with a statistically significant difference (95% CI: 1.19–9.09). This finding is consistent with the majority of previous studies, confirming that elevated CK-MB levels after PCI indicate myocardial injury and are associated with poor prognosis. A large study involving 2,760 stable PCI patients by Christensen MK et al. demonstrated that increased peri-procedural CK-MB levels were independently associated with higher long-term mortality rates. [7]. Troponin T, a more specific and sensitive biomarker for the diagnosis of myocardial infarction, also demonstrated a strong prognostic role in this study. Patients with Troponin T levels  $> 4084.2 \text{ ng/L}$  had an 8.02-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to the other group (95% CI: 2.59–24.84;  $p < 0.001$ ). Troponin T directly reflects the extent of myocardial cell membrane injury, and its significant elevation is associated with more extensive infarction, left ventricular dysfunction, and a higher risk of recurrent cardiovascular events. This result is consistent with the study by Biener et al. (2022), which showed that elevated Troponin T levels are strongly associated with both short- and long-term MACE risk, especially in patients with known coronary artery disease [8]. Compared to our study, the results further reinforce the strong prognostic value of Troponin T and support the use of this biomarker in long-term risk stratification after intervention.

The results presented in Table 5 show that patients with ST-segment elevation  $\geq 4.0 \text{ mm}$  had a 4.03-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to those with ST-segment elevation  $< 4.0 \text{ mm}$  (OR = 4.03; 95% CI: 1.15–13.44;  $p = 0.009$ ). This is a statistically significant finding and is consistent with established pathophysiology as well as previous studies. ST-segment elevation in acute ST-elevation myocardial infarction (STEMI) reflects the extent of acute myocardial injury caused by complete coronary artery occlusion. A greater elevation suggests a larger infarct size or more severe myocardial ischemia. These findings are in line with the study by Lopez et al. (2014), which identified marked ST-segment elevation as a poor prognostic factor associated with

early cardiovascular mortality following PCI in STEMI patients [9].

The results in Table 6 indicate that patients with in two or more coronary artery branches had a 3.39-fold higher risk of major adverse cardiovascular events (MACE) within 6 months compared to those with single-vessel disease (OR = 3.39; 95% CI: 1.06–10.72;  $p = 0.016$ ). This is a statistically significant finding and is fully consistent with current medical evidence. Multivessel disease reflects the widespread extent of atherosclerosis and involvement of the entire myocardial perfusion system. Large-scale studies such as the SYNTAX trial have demonstrated that multivessel coronary artery disease is associated with worse outcomes following PCI [10]. Another statistically significant finding is that left main coronary artery (LMCA) disease was associated with a 4.27-fold increased risk of major adverse cardiovascular events (MACE) (OR = 4.27; 95% CI: 1.03–17.75;  $p = 0.046$ ). The LMCA is the sole vessel supplying nearly two-thirds of the left ventricular myocardium; therefore, its involvement can have profound hemodynamic and electrophysiological consequences.

## 5. CONCLUSION

In a study of 104 STEMI patients aged 75 years and older who underwent primary percutaneous coronary intervention (PCI), we observed that the cumulative incidence of major adverse cardiovascular events (MACE) at 6 months post-intervention was 18.3%. Factors associated with a significantly increased risk of MACE included: age  $\geq 85$  years (OR = 5.39;  $p = 0.020$ ), diabetes mellitus (OR = 2.95;  $p = 0.037$ ), Killip class III and IV (OR = 4.44;  $p = 0.011$ ), TIMI score  $> 6$  (OR = 3.84;  $p = 0.019$ ), CK-MB  $> 39$  U/L (OR = 3.35;  $p = 0.019$ ), Troponin T  $> 4084.2$  ng/L (OR = 8.02;  $p < 0.001$ ), ST-segment elevation  $\geq 4.0$  mm (OR = 4.03;  $p = 0.009$ ), involvement of  $\geq 2$  coronary arteries (OR = 3.39;  $p = 0.016$ ), and left main coronary artery (LMCA) disease (OR = 4.27;  $p = 0.046$ ). These factors were found to be significantly associated with MACE within 6 months after PCI in this elderly STEMI population.

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