

Use of drug-eluting stents in elderly patients with acute myocardial infarction

An analysis of the Hungarian Myocardial Infarction Registry

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Abstract

Background: Bare-metal stents (BMS) are frequently implanted in elderly patients instead of drug-eluting stents (DES). We aimed to compare the prognosis of patients treated for myocardial infarction with the two types of stents over the age of 75.

Methods: Data of patients registered in the Hungarian Myocardial Infarction Registry, a mandatory nationwide programme for hospitals treating patients with myocardial infarction were processed. From patients included between January 2014 and December 2017 we created two groups according to DES and BMS implantation. The outcome measures included all-cause mortality, the composite of cardiac events (MACE), repeated revascularisation and transfusion. Propensity score matching was used to balance the groups and Cox proportional hazards' models to estimate the risk during the 1st year after the index event.

Results: From 7383 patients (age: 81.08 ± 4.38 years) 3266 (44.2%) patients received DES. The PS-matched cohort included 5780 cases with balanced characteristics. In the DES group, the mortality (HR 0.66 [0.60-0.72]), MACE (HR 0.66 [0.60-0.72]) and the rate of transfusion (HR 0.84 [0.73-0.97]) were significantly lower. The PS-matched cohort showed a similar trend but with a lower rate of benefits with a 21% reduction of mortality and 23% of MACE. Difference in transfusion did not reach the level of significance. In multivariate models, stent type prevailed as an independent predictor of mortality and but not of transfusion.

Conclusions: Based on our analysis of a real-life, high-risk population, implantation of DES seems to be an advantageous strategy for elderly patients.

1 | INTRODUCTION

Drug-eluting stents (DES) are widely used in the treatment of coronary stenosis. Compared with DES, the time required for the development of the endothelial coverage is shorter, thus the risk of suspension of double antiplatelet therapy (DAPT) may be lower with bare-metal stents (BMS).¹ Elderly patients have a higher bleeding risk and this may lead to the use of BMS during

coronary interventions.² In line with several trials the recent "Short Duration of Dual antiplatelet Therapy With Synergy II Stent in Patients Older Than 75 Years Undergoing Percutaneous Coronary Revascularization" (SENIOR) trial found that among elderly patients, the use of DES with a short duration of DAPT strategy is beneficial compared with BMS and a similar duration of DAPT. This trial demonstrated benefits regarding the composite endpoint of all-cause mortality, myocardial infarction, stroke and ischaemia-driven target

lesion revascularisation, while no difference was detected in bleeding risk between the groups.³

However, the recommended DAPT duration is longer and the risk profile of patients may be different in cases with acute myocardial infarction (AMI). Thus, it is unclear how the choice of stent influences the outcomes in a high-risk unselected elderly population with myocardial infarction (MI).

The aim of this study was to compare the outcomes in a large unrestricted MI registry between the two types of stents in elderly patients undergoing coronary intervention.

2 | MATERIALS AND METHODS

The Hungarian Myocardial Infarction Registry (HUMIR) is a prospective, registry collecting clinical data on consecutive patients treated for an AMI in Hungary. The data on capture and follow-up procedures of the HUMIR has already been published in details previously.⁴⁻⁷ Briefly, the patient's data are collected prospectively according to the statute of CCXLVI./2013 of Hungary via a national internet-based registry. Data capture covers 178 structured categories including those regarding the performed coronary interventions and included 92% of all AMI cases in 2017. An independent ethical board supervises the use of the data and permitted the current analysis of anonymised records.

Outcome data including vital status and repeated hospitalisations are regularly received from the electronic database of the national healthcare insurance provider.⁴⁻⁷ The protocol of the study is in accordance with the Declaration of Helsinki and it was approved by the Hungarian National Committee on Health Research Ethics.

For the purpose of the current analyses records of patients between 1 January 2014 and 31 December 2017, all patients with AMI were selected for enrolment if a coronary intervention was performed successfully. The patients were eligible over the age of 75, including cases with and without ST-segment elevation if coronary intervention was performed. We created two groups according to the type of the implanted stent (DES or BMS); cases where stent was not implanted or both DES and BMS were implanted during the intervention were excluded.

DAPT was the intended antiplatelet strategy during the 1st year after the intervention. P2Y₁₂-inhibitor treatment before intervention comprised clopidogrel, usually given in a loading dose of 600 mg, but left to the decision of the treating physicians. After the intervention, prasugrel and clopidogrel were available for long-term treatment. Importantly, it was left to the discretion of the treating physicians whether to leave the patients on clopidogrel or switch to prasugrel but in the case of the latter a 5 mg reduced daily dose was proposed over 75 years' age. Ticagrelor was not reimbursed in Hungary at the time of the study, restricting its use to a 0.08% in our dataset. Altogether, prasugrel use was also rare and reached 2.95% in the study population. Thienopyridines were supplemented with low dose aspirin—typically 100 mg—with an optional loading dose of 300–500 mg. The intended length of DAPT was 12 months

What's known

- Management of the acute coronary syndrome in elderly people population is challenging.
- Compared with drug-eluting stents, the time required for the development of the endothelial coverage is shorter, thus the risk of suspension of double antiplatelet therapy may be lower with bare-metal stents.
- Bare-metal stents have been frequently implanted in elderly patients so far.

What's new

- Our results show that drug-elusive stents are advantageous in elderly patients.
- We found that stent type prevailed as an independent predictor of mortality.

regardless of the stent type. The use of perioperative anticoagulation, as well as the administration of platelet IIb/IIIa inhibitors, were allowed according to the local protocols.

The primary efficacy endpoint was the all-cause mortality within 1 year after the index procedure. Secondary endpoints included the blood transfusion and two composite endpoints: major adverse events (MACE) and repeat revascularisation. MACE included composite events of death, recurrent MI and stroke, while coronary intervention or bypass surgery defined the repeat revascularisation.

Events were obtained from the vital status database of the National Health Insurance Fund. Data related to recurrent hospitalisation for AMI, stroke, repeat revascularisation, as well as for bleeding event leading to blood transfusion were extracted from the database of the National Health Insurance Fund.

Variables are presented as means $\pm$ SD, medians with 25th and 75th quartiles or as frequencies and percentages. Unpaired t-tests were used for comparisons of continuous variables between groups. Categorical variables were compared using χ^2 or Fisher's exact tests.

As the patients were not randomly assigned to DES or BMS treatments, we assumed that treatment selection may have an impact on the results potentially biasing towards favouring the DES treatment. Thus, we intended to balance the groups with the help of multiple characteristics that may potentially influence both device selection and outcomes. For this aim we built a propensity score (PS)-matched cohort with a comparable chance for either strategy by adjusting for differences in the baseline characteristics. In a logistic regression model for DES vs BMS groups, the probability of both treatment was computed. Clinical factors from the medical history as well as patient characteristics at presentation and with potential influence on the decision were used as predictors in calculating the PS (Table 1). In the PS-matching procedure randomly selected patients in the DES group were matched with a patient from the BMS group with the closest estimated PS value. A 1-to-1 matched analysis without replacement was performed with the match tolerance set to <0.01.

TABLE 1 Characteristics of the patient population before and after propensity score matching

Clinical characteristics	Entire cohort (n = 7383)			Propensity-matched cohort (n = 5780)		
	DES group (n = 3266)	BMS group (n = 4117)	P value	DES group (n = 2890)	BMS group (n = 2890)	P value
Age, (years)	79.8 (77.2-83.2)	80.8 (77.8-84.5)	<.001	80.0 (77.4-83.5)	80.1 (77.3-83.5)	.974
Men	1642 (50.3%)	1801 (43.7%)	<.001	1389 (48.1%)	1391 (48.1%)	.958
Presentation						
ST segment elevation myocardial infarction	1181 (36.2%)	2132 (51.8%)	<.001	1170 (40.5%)	1200 (41.5%)	.422
Shock	62 (1.9%)	104 (2.5%)	.071	57 (2.0%)	58 (2.0%)	.925
Reanimation	86 (2.6%)	139 (3.4%)	.065	78 (2.7%)	80 (2.8%)	.872
Prehospital thrombolysis	2 (0.1%)	9 (0.2%)	.127	2 (0.1%)	3 (0.1%)	1.000
Killip Class			<.001			.924
I	2873 (88.0%)	3453 (83.9%)		2522 (87.3%)	2538 (87.8%)	
II	278 (8.5%)	449 (10.9%)		264 (9.1%)	251 (8.7%)	
III	82 (2.5%)	140 (3.4%)		81 (2.8%)	80 (2.8%)	
IV	24 (0.7%)	59 (1.4%)		23 (0.8%)	21 (0.7%)	
Heart rate (bpm)	77 (68-90)	78 (68-90)	.100	77 (68-90)	78 (68-90)	.862
Systolic blood pressure (mm Hg)	134 (120-150)	130 (115-150)	<.001	133 (118-150)	132 (118-150)	.964
Diastolic blood pressure (mm Hg)	78 (68.0-84.0)	76 (67-85)	.167	78 (69-84)	78 (69-85)	.531
Weight (kg)	74 (68-81)	74 (65-80)	<.001	74 (68-80)	74 (66-80)	.682
Height (cm)	166 (162-170)	166 (160-170)	.005	166 (160-170)	166 (160-170)	.689
Medical history						
Hypertension	2896 (88.7%)	3560 (86.5%)	.005	2547 (88.1%)	2529 (87.5%)	.469
Diabetes mellitus	1300 (39.8%)	1293 (31.4%)	<.001	1056 (36.5%)	1052 (36.4%)	.913
Hyperlipidaemia	1093 (33.5%)	1131 (27.5%)	<.001	916 (31.7%)	893 (30.9%)	.514
Peripheral artery disease	483 (14.8%)	564 (13.7%)	.183	420 (14.5%)	435 (15.1%)	.578
Smoker	167 (5.1%)	229 (5.6%)	.395	154 (5.3%)	154 (5.3%)	1.000
History of heart failure	617 (18.9%)	589 (14.3%)	<.001	489 (16.9%)	471 (16.3%)	.525
Prior myocardial infarction	977 (29.9%)	876 (21.3%)	<.001	744 (25.7%)	749 (25.9%)	.881
Prior stroke	363 (11.1%)	491 (11.9%)	.279	328 (11.3%)	339 (11.7%)	.651
Prior coronary intervention	976 (29.9%)	722 (17.5%)	<.001	687 (23.8%)	669 (23.1%)	.576
Prior coronary bypass grafting	283 (8.7%)	189 (4.6%)	<.001	184 (6.4%)	180 (6.2%)	.829
Oral anticoagulation	262 (8.0%)	335 (8.1%)	.864	221 (7.6%)	245 (8.4%)	.267

In Cox-regression analyses, associations between clinical outcomes and stent type were first analysed in univariable models. We determined hazard ratios (HRs) together with 95% confidence intervals (95% CIs). A multivariable Cox proportional hazards model was used to determine the independent predictors of all-cause mortality and blood transfusion. In this analysis potential, clinically relevant predictors of outcome were also included then were further entered into a multivariable regression model. In the multivariable model, a backward stepwise conditional method was used to find the independent predictors. During this approach, a stepwise removal of the weakest factors without significantly decreasing overall model performance was performed. Aalen's additive regression model

analysis was used to evaluate time-dependent changes in the risk of transfusions between the DES vs BMS-group. All reported *P* values are two-sided and *P* values of <.05 were considered to indicate statistical significance. This analysis was conducted using the SPSS 24 statistical package.

3 | RESULTS

From 1 January 2014 to 31 December 2017 data of 40 968 patients hospitalised for an AMI were entered into the registry. 36 177 (88.3%) of these patients were treated with coronary intervention,

8532 (23.6%) of them were over the age of 75. After excluding those patients (13.5%) in whom no stent was implanted or both BMS and DES were implanted, an unmatched patient pool of 7383 cases was obtained. In 4117 (55.8%) cases BMS, in 3266 (44.2%) cases DES was implanted (Figure 1).

As expected, there were numerous differences in baseline characteristics between the two groups. To adjust for these differences, PS matching was performed that resulted in a matched population of 5780 patients with balanced characteristics (Table 1).

During the follow-up period, 2054 patients died, resulting in a 1-year all-cause mortality rate of 27.8%, in this unselected, high-risk elderly cohort. DES-treated subjects had a highly significant, 34% lower hazard for all-cause mortality compared with the BMS group (22.7% vs 31.9%, $P < .001$). Rates of all individual endpoints including ischemic events, revascularisation and blood transfusion were lower in the BMS group and these differences reached high levels of significance, except for the low rate endpoints of repeated MI and coronary bypass operations (Figure 2 and Table 2).

In the propensity-matched cohort, similar trends were detected. However, the magnitude of reduction was less pronounced for the ischemic endpoints (21% vs 34% reduction of mortality, 34% vs 23% reduction of MACE, in the overall and the PS-matched cohort, respectively). Blood transfusion rate reduction was 11% in the PS-matched cohort and this did not reach the level of significance. Reduction of repeat revascularisation was highly significant in the PS-matched cohort (Table 2). The observed 5.3% absolute risk reduction of mortality in the matched cohort corresponds to 19 patients needed to treat, to prevent one death.

Aalen's additive regression model analysis showed no sign of time-dependent changes in the risk of transfusions between the DES- and BMS-treated elderly population (Supporting information Figure 1).

When assessed in multiple regression models, stent type prevailed as an independent predictor of mortality but not of blood transfusion (Table 3, Supporting information Table 1).

4 | DISCUSSION

In a large registry of AMI patients undergoing coronary intervention procedure, we have found that the DES was underused in elderly people despite the fact that current guidelines clearly specify that DES should be used in AMI regardless of age. Better prognosis was seen among those venerable patients who underwent coronary intervention at the event of AMI and received a DES.

The incidence of AMI is increasing in elderly patients, representing a growing segment of the population with amplified frailty and a higher rate of comorbidities.^{8,9} Elderly account for one third of the patients undergoing hospitalisation for an acute coronary syndrome (ACS),¹⁰ however, they are inadequately represented in clinical trials.^{11,12} Based on the limited evidence, the management of this population is considerably challenging. Real word data showed that coronary intervention is beneficial among elderly patients in MI.⁷ In the last decade some safety concerns with early generation DES have arisen after reports suggesting a higher incidence of late stent thrombosis (ST) associated with DES implantation in

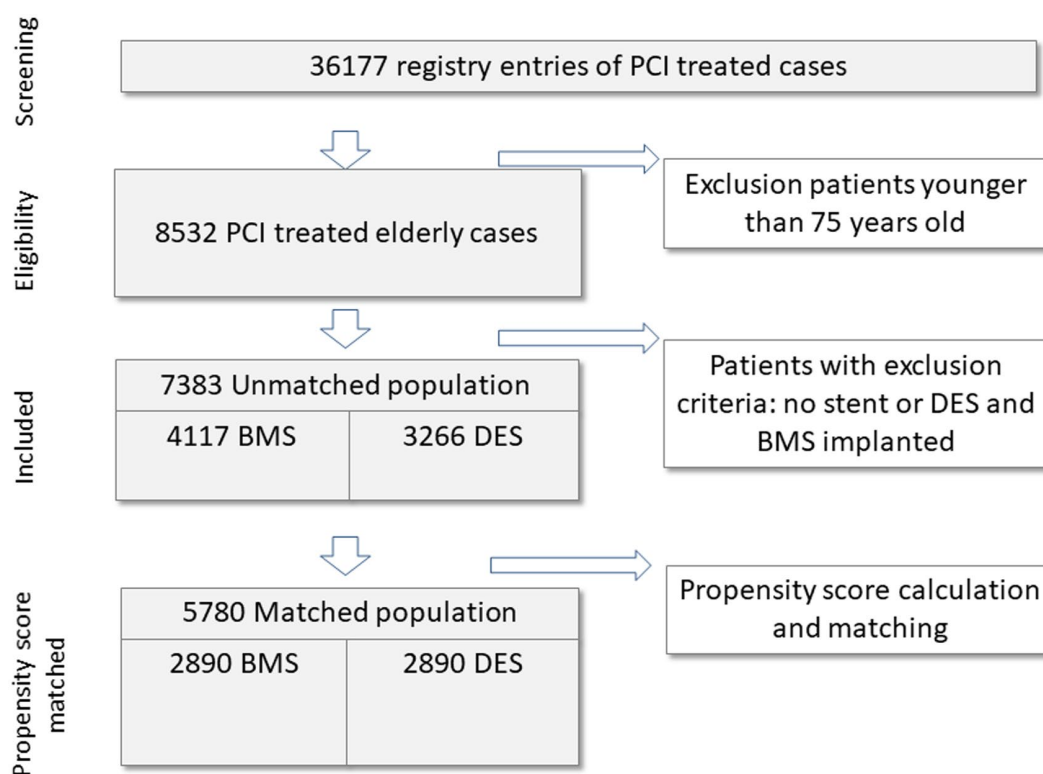
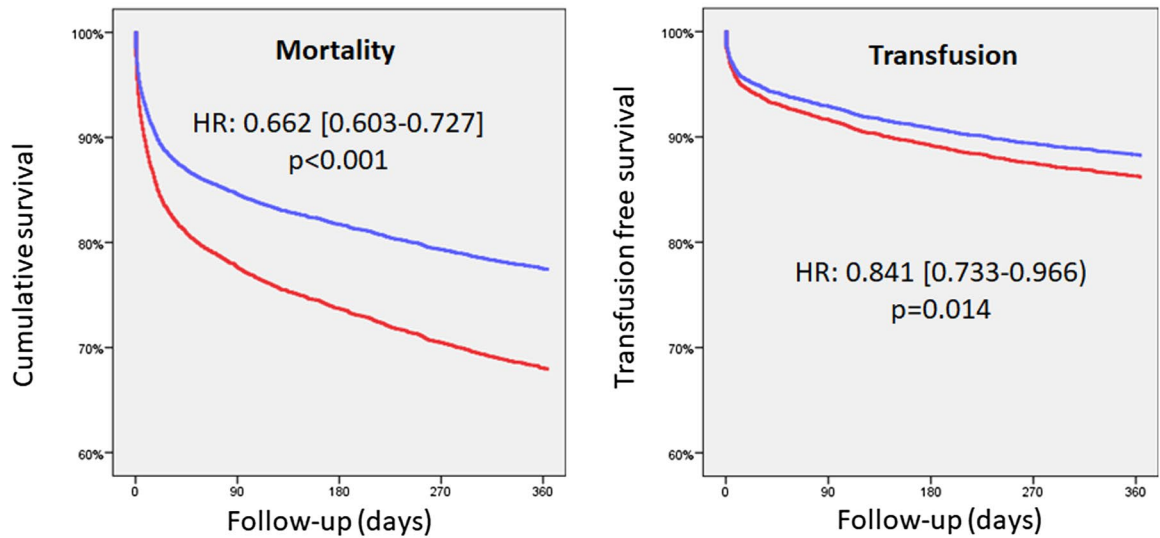


FIGURE 1 Flowchart of patient selection. BMS, bare-metal stent; DES, drug-eluting stent; PCI, percutaneous coronary intervention

(A)

Entire cohort (n=7383)

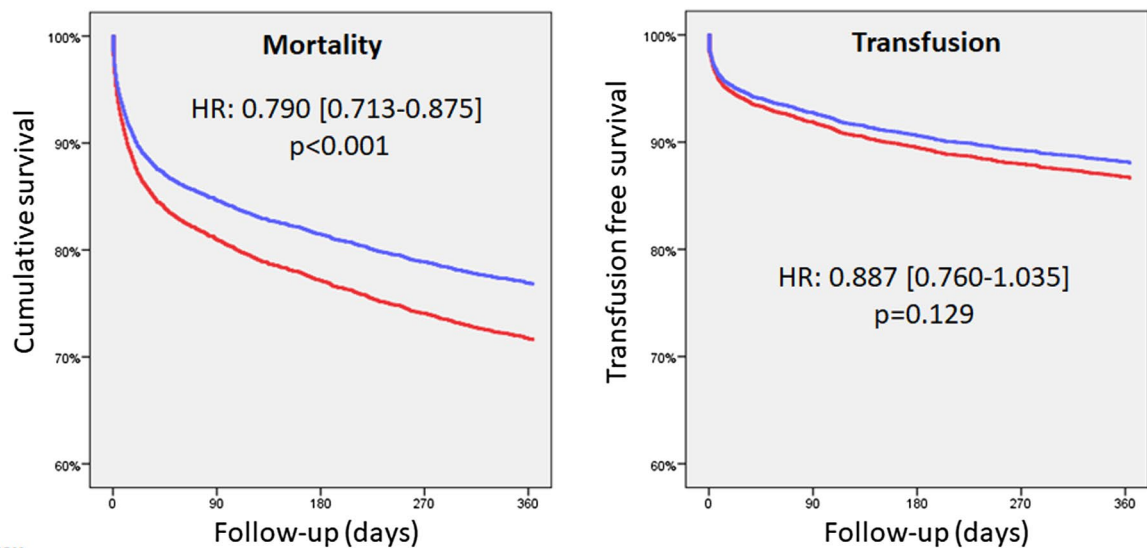


PATIENTS AT RISK

	DES	3266	2792	2689	2594	2526		3266	2667	2514	2412	2324
	BMS	4116	3173	3017	2902	2807		4116	2979	2788	2653	2541

(B)

PS matched cohort (n=5780)



PATIENTS AT RISK

	DES	2890	2451	2359	2278	2221		2890	2337	2201	2116	2042
	BMS	2890	2337	2225	2144	2069		2890	2195	2063	1967	1882

FIGURE 2 Kaplan-Meier curves of overall survival and blood transfusion-free survival comparing drug-eluting (DES) or bare-metal stent (BMS) implanted patients. Panel A shows the survival differences seen in the overall cohort, while data from the propensity score (PS) are depicted in panel B. BMS, bare-metal stent; DES, drug-eluting stent; HR, hazard ratio; PS, propensity score

comparison to BMS.¹³ Early generation DES have now been supplanted by new-generation DES with higher efficacy and safety in comparison with both early generation DES and BMS.¹⁴ However, in several countries elderly patients still frequently receive BMS with the intent to shorten the duration of DAPT, to reduce bleeding complications.² Though, the 2018 European guidelines on myocardial revascularisation recommend DES over BMS for any percutaneous coronary intervention (PCI) and the use of BMS is decreasing in developed countries, BMS use still accounts for approximately 20% of

all PCI procedures in the USA.¹⁴⁻¹⁶ Previous studies demonstrated the short- and long-term efficacy of DES among elderly patients.¹⁷⁻²² It is of particular importance that none of these analyses found increased bleeding risk associated with DES.

Most recently, the SENIOR trial compared DES to BMS applying a short duration of DAPT in age ≥ 75 patients, who underwent percutaneous coronary revascularisation. Antiplatelet strategy consisted DAPT for 1 month in patients with a stable presentation and 6 months for those with an unstable presentation. The rate of

Unmatched cohort (7383)	DES (3266)	BMS (4117)	Hazard ratio (95% confidence interval), P value
Overall mortality	740 (22.7%)	1314 (31.9%)	0.66 [0.60-0.73], $P < .001$
Blood transfusion	347 (10.6%)	479 (11.6%)	0.84 [0.73-0.97], $P = .014$
Major adverse cardiovascular events (death, myocardial infarction, stroke)	763 (23.4%)	1351 (32.8%)	0.66 [0.60-0.72], $P < .001$
Major adverse cardiac events + Repeat revascularisation	987 (30.2%)	1692 (41.1%)	0.67 [0.62-0.72], $P < .001$
Myocardial infarction	40 (1.2%)	64 (1.6%)	0.69 [0.46-1.03], $P = .068$
Stroke	61 (1.9%)	105 (2.6%)	0.69 [0.50-0.95], $P = .023$
Repeat revascularisation	256 (7.8%)	403 (9.8%)	0.70 [0.61-0.83], $P < .001$
PCI	237 (7.3%)	372 (9.0%)	0.72 [0.61-0.84], $P < .001$
CABG	23 (0.7%)	36 (0.9%)	0.66 [0.39-1.14], $P = .134$
PS-matched cohort (5780)	DES (2890)	BMS (2890)	Hazard ratio (95% confidence interval), P value
Overall mortality	669 (23.1%)	821 (28.4%)	0.79 [0.71-0.88], $P < .001$
Blood transfusion	310 (10.7%)	336 (11.6%)	0.89 [0.76-1.04], $P = .129$
Major adverse cardiovascular events (death, myocardial infarction, stroke)	685 (23.7%)	854 (29.6%)	0.77 [0.70-0.85], $P < .001$
Major adverse cardiac events + Repeat revascularisation	873 (30.2%)	1121 (38.8%)	0.73 [0.67-0.80], $P < .001$
Myocardial infarction	33 (1.1%)	51 (1.8%)	0.62 [0.40-0.95], $P = .029$
Stroke	48 (1.7%)	80 (2.8%)	0.60 [0.42-0.86], $P = .005$
Repeat revascularisation	213 (7.4%)	322 (11.1%)	0.62 [0.52-0.73], $P < .001$
PCI	196 (6.8%)	247 (8.6%)	0.59 [0.49-0.72], $P < .001$
CABG	18 (0.6%)	28 (1.0%)	0.54 [0.30-1.01], $P = .052$

Abbreviations: BMS, bare-metal stent; CABG, coronary artery bypass grafting; DES, drug-eluting stent; PCI, percutaneous coronary intervention; PS, propensity score.

TABLE 2 Primary and secondary outcomes in unmatched and propensity-matched cohorts

patients with ACS was 45%. The primary endpoint (composite of all-cause mortality, MI, stroke or ischaemia-driven target lesion revascularisation (TLR)) occurred less frequently in the DES group with BMS-like DAPT regimen, however, this difference was caused by a significantly lower rate of TLR in the DES group. Meanwhile rates of all-cause mortality, cardiovascular death, MI and stroke were similar between groups. Similarly to the earlier studies, no difference was found either in bleeding complications or ST at 1-year follow.³ Most data supported the use of new-generation DES in elderly populations, however, while these trials included different proportions of ACS cases the "Clinical Evaluation of Everolimus Eluting Coronary Stents in the Treatment of Patients With ST-Segment Elevation Myocardial Infarction" (EXAMINATION) trial studied everolimus-eluting stents in ST-segment elevation myocardial infarction (STEMI). In contrast, to the earlier trials, results of a post hoc analysis of elderly (age ≥ 75) patients found no benefit of DES either in

the primary composite endpoint of all-cause death, any MI or any revascularisation, or in MI, or in the need for subsequent revascularisation.²³ The decision for the implantation of BMS rather than DES is driven principally by concerns about higher bleeding risk and DAPT compliance.¹⁶ Accordingly, prolonged DAPT seems to be the main reason against the use of DES in elderly patients undergoing PCI.²⁴ In cases with acute MI the recommended duration of DAPT is 12 months regardless of the type of the stent implanted, however, in case of bleeding, interruption after 1 month is considered to be less dangerous with BMS compared with DES. Theoretically the possible earlier cessation of DAPT in case of BMS might prevent the development of bleeding complications, however, we found no excess of severe, blood transfusion requiring events in the DES cohort.²⁵ Using the data capture of a national MI registry we studied an unselected high-risk patient-group of AMI with a 28% risk of death within 1 year after the stent implantation. Our data clearly refute the assumption

TABLE 3 Results of the multivariable Cox regression analysis for the identification of the independent predictors of mortality and bleeding

Independent predictors of outcome	Mortality (Hazard ratio)	95% confidence interval	P value	Bleeding (Hazard ratio)	95% confidence interval	P value
DES	0.75	0.67-0.83	<.001	0.88	0.76-1.03	.112
Resuscitation	2.32	1.88-2.88	<.001	2.32	1.59-3.37	<.001
Shock	1.87	1.43-2.44	<.001	–		
Killip status	1.33	1.22-1.45	<.001	–		
Heart rate (beat/min)	1.01	1.01-1.01	<.001	1.01	1.003-1.01	.001
Systolic pressure (mm Hg)	0.99	0.98-0.99	<.001	1.00	0.99-1.00	.057
Diastolic pressure (mm Hg)	–			0.99	0.98-0.99	<.001
Creatinine level (μmol/L)	1.01	1.004-1.01	<.001	1.005	1.004-1.006	<.001
STEMI	0.75	0.67-0.83	<.001	1.27	1.07-1.50	.006
Prior myocardial infarction	–			0.83	0.69-1.003	.054
Prior stroke	1.46	1.27-1.69	<.001	–		
Prior heart failure	1.55	1.36-1.75	<.001	1.44	1.19-1.76	<.001
Diabetes mellitus	1.21	1.09-1.34	<.001	1.40	1.20-1.64	<.001
Peripheral artery disease	1.35	1.18-1.54	<.001	–		
Hyperlipidaemia	0.87	0.77-0.98	.018	–		
Prior PCI	0.84	0.74-0.96	.008	–		
Ejection fraction ^a	1.68	1.58-1.79	<.001	1.24	1.13-1.37	<.001
Number of revascularised vessels	1.24	1.01-1.54	<.001	1.24	1.01-1.54	.045
Male sex	–			0.80	0.66-0.96	.020
Height (cm)	–			1.01	1.001-1.03	.042
Bodyweight (kg)	0.99	0.99-0.99	<.001	0.99	0.98-0.998	.009

Abbreviations: DES, drug-eluting stent; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.

^aEjection fraction was categorically coded as EF > 50%, 40%-49%, 30%-39% or <29%.

of the higher safety of BMS in a frail and elderly population. The analysis of the clinical characteristics in our cohort supported that BMS was preferably implanted in fragile cases with higher age and multiple risks. However, prognostic benefit in terms of mortality, major ischemic events as well as that of the repeat revascularisation prevailed in the propensity-matched analyses. Besides the favourable rate of MACE, bleeding events were not more frequent in the DES group even in our matched sample.

Some limitations of our study need to be acknowledged. Most importantly this is not a randomised trial capable of providing a completely unbiased assessment of treatment effect. Data regarding actual duration of antiplatelet use and type of bleeding events are not available. Therefore, blood transfusion has been used as a surrogate in this study. Similarly, repeat revascularisation is used instead of target vessel revascularisation as specific data are lacking in this regard. In fact, the lower blood transfusion rate of the DES-treated cases, together with the clinical characteristics of the unbalanced cohort support the potential influence of a selection bias with DES implanted in healthier patients with potentially a better outcome. The PS matching balanced the significant differences observed between the DES and BMS groups in the entire cohort. However, the influence of potentially uncontrolled variables may also not be entirely

excluded. Keeping this limitation in mind and considering that our data originate from a nation-wide, multi-centre registry, together with the statistically robust difference in the propensity-matched cohorts confirms the validity of the results.

5 | CONCLUSIONS

In conclusion, our analysis of a real-life, high-risk elderly population, demonstrated that DES implantation is an advantageous strategy for elderly patients. The observed benefits may be enhanced by the treatment selection, but even after propensity matching of the treatment groups our data still support the ischemic benefit and revealed no signal of higher bleeding risk. These data support that DES is underused in the aged population and endorse the guideline recommended use of DES even in high-risk elderly patients with AMI.

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DISCLOSURES

None.

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REFERENCES

- Habib A, Finn AV. Endothelialization of drug eluting stents and its impact on dual anti-platelet therapy duration. *Pharmacol Res*. 2015;93:22-27. <https://doi.org/10.1016/j.phrs.2014.12.003>.
- Gerber RT, Satpal F, Mrcep SA, et al. Age is not a bar to PCI: insights from the long-term outcomes from off-site PCI in a real-world setting. *J Interv Cardiol*. 2017;30:347-355. <https://doi.org/10.1111/joic.12400>.
- Varenne O, Cook S, Sideris G, et al. Drug-eluting stents in elderly patients with coronary artery disease (SENIOR): a randomised single-blind trial. *Lancet*. 2018;391:41-50. [https://doi.org/10.1016/S0140-6736\(17\)32713-7](https://doi.org/10.1016/S0140-6736(17)32713-7).
- Jánosi A, Ofner P, Merkely B, et al. Short and long term prognosis of patients with myocardial infarction. Hungarian Myocardial Infarction Registry. *Orv Hetil*. 2013;154:1297-1302. <https://doi.org/10.1556/OH.2013.29679>.
- Jánosi A, Ofner P, Forster T, Édes I, Tóth K, Merkely B. Clinical characteristics, hospital care, and prognosis of patients with ST elevation myocardial infarction: Hungarian Myocardial Infarction Registry. *Eur Hear J Suppl*. 2014;16:A12-A15. <https://doi.org/10.1093/eurheartj/sut004>.
- Komócsi A, Aradi D, Szűk T, et al. Comparison of platelet function guided versus unguided treatment with P2Y12 inhibitors in patients with acute myocardial infarction (from the Hungarian Myocardial Infarction Registry). *Am J Cardiol*. 2018;121:1129-1137. <https://doi.org/10.1016/j.amjcard.2018.01.032>.
- Komócsi A, Simon M, Merkely B, et al. Underuse of coronary intervention and its impact on mortality in the elderly with myocardial infarction. A propensity-matched analysis from the Hungarian Myocardial Infarction Registry. *Int J Cardiol*. 2016;214:485-490. <https://doi.org/10.1016/j.ijcard.2016.04.012>.
- Gerber Y, Rihal CS, Sundt TM, et al. Coronary revascularization in the community. *J Am Coll Cardiol*. 2007;50:1223-1229. <https://doi.org/10.1016/j.jacc.2007.06.022>.
- Masoudi FA, Ponirakis A, De LJA, et al. Trends in U.S. Cardiovascular Care: 2016 Report from 4 ACC National Cardiovascular Data Registries. *J Am Coll Cardiol*. 2017;69:1427-1450. <https://doi.org/10.1016/j.jacc.2016.12.004>.
- Sandhu K, Nadar S. Percutaneous coronary intervention in the elderly. *Int J Cardiol*. 2015;199:342-355. <https://doi.org/10.1016/j.ijcard.2015.05.188>.
- Graham MM, Ghali WA, Faris PD, et al. Survival after coronary revascularization in the elderly. *Circulation*. 2002;105:2378-2384. <https://doi.org/10.1161/01.CIR.0000016640.99114.3D>.
- Kaehler J, Meinertz T, Hamm CW. Coronary interventions in the elderly. *Heart*. 2006;92:1167-1171. <https://doi.org/10.1136/hrt.2005.071266>.
- Qasim A, Cosgrave J, Latib A, Colombo A. Long-term follow-up of drug-eluting stents when inserted for on- and off-label indications. *Am J Cardiol*. 2007;100:1619-1624. <https://doi.org/10.1016/j.amjcard.2007.07.013>.
- Neumann F-J, Sousa-Uva M, Ahlsson A, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J*. 2019;40:87-165. <https://doi.org/10.1093/eurheartj/ehy394>.
- Rymer JA, Harrison RW, Dai D, et al. Trends in bare-metal stent use in the United States in patients aged ≥ 65 years (from the CathPCI Registry). *Am J Cardiol*. 2016;118:959-966. <https://doi.org/10.1016/j.amjcard.2016.06.061>.
- Morice M-C, Urban P, Greene S, Schuler G, Chevalier B. Why are we still using coronary bare-metal stents? *J Am Coll Cardiol*. 2013;61:1122-1123. <https://doi.org/10.1016/j.jacc.2012.11.049>.
- Forman DE, Cox DA, Ellis SG, et al. Long-term paclitaxel-eluting stent outcomes in elderly patients. *Circ Cardiovasc Interv*. 2009;2:178-187. <https://doi.org/10.1161/CIRCINTERVENTIONS.109.855221>.
- Wang TY, Masoudi FA, Messenger JC, et al. Percutaneous coronary intervention and drug-eluting stent use among patients ≥ 85 years of age in the United States. *J Am Coll Cardiol*. 2012;59:105-112. <https://doi.org/10.1016/j.jacc.2011.10.853>.
- Puymirat E, Mangiacapra F, Peace A, et al. Safety and effectiveness of drug-eluting stents versus bare-metal stents in elderly patients with small coronary vessel disease. *Arch Cardiovasc Dis*. 2013;106:554-561. <https://doi.org/10.1016/j.acvd.2013.06.056>.
- Kurz DJ, Bernheim AM, Tüller D, et al. Improved outcomes of elderly patients treated with drug-eluting versus bare metal stents in large coronary arteries: results from the BASel Stent Kosten-Effektivitäts Trial PROspective Validation Examination randomized trial. *Am Heart J*. 2015;170:787-795. <https://doi.org/10.1016/j.ahj.2015.07.009>.
- de Belder A, de la Torre Hernandez JM, Lopez-Palop R, et al. A prospective randomized trial of everolimus-eluting stents versus bare-metal stents in octogenarians: the XIMA Trial (Xience or Vision Stents for the Management of Angina in the Elderly). *J Am Coll Cardiol*. 2014;63:1371-1375. <https://doi.org/10.1016/j.jacc.2013.10.053>.
- Morice M-C, Talwar S, Gaemperli O, et al. Drug-coated versus bare-metal stents for elderly patients: A predefined sub-study of the LEADERS FREE trial. *Int J Cardiol*. 2017;243:110-115. <https://doi.org/10.1016/j.ijcard.2017.04.079>.
- Ielasi A, Brugaletta S, Silvestro A, et al. Everolimus-eluting stent versus bare-metal stent in elderly (≥ 75 years) versus non-elderly (< 75 years) patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention: insights from the examination trial. *Int J Cardiol*. 2015;179:73-78. <https://doi.org/10.1016/j.ijcard.2014.10.038>.
- Spertus JA, Kettelkamp R, Vance C, et al. Prevalence, predictors, and outcomes of premature discontinuation of thienopyridine therapy after drug-eluting stent placement: results from the PREMIER registry. *Circulation*. 2006;113:2803-2809. <https://doi.org/10.1161/CIRCULATIONAHA.106.618066>.
- Valgimigli M, Bueno H, Byrne RA, et al. 2017 ESC focused update on dual antiplatelet therapy in coronary artery disease developed in collaboration with EACTS. *Eur Heart J*. 2018;39:213-260. <https://doi.org/10.1093/eurheartj/ehy334>.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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