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# Mortality following placement of drug-eluting and bare-metal stents for ST-segment elevation acute myocardial infarction in the Global Registry of Acute Coronary Events

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**Aims** To assess mortality after drug-eluting stent (DES) or bare-metal stent (BMS) for ST-segment elevation myocardial infarction (STEMI).

**Methods and results** In this multinational registry, 5093 STEMI patients received a stent: 1313 (26%) a DES and 3780 (74%) only BMS. Groups differed in baseline characteristics, type, or timing of percutaneous coronary intervention, with a higher baseline risk for patients receiving BMS. Two-year follow-up was available in 55 and 60% of the eligible BMS and DES patients, respectively. Unadjusted mortality was lower during hospitalization, similar for the first 6 months after discharge, and higher from 6 months to 2 years, for DES patients compared with that of BMS patients. Overall, unadjusted 2-year mortality was 5.3 vs. 3.9% for BMS vs. DES patients ($P = 0.04$). In propensity- and risk-adjusted survival analyses (Cox model), post-discharge mortality was not different up to 6 months ($P = 0.21$) or 1 year ($P = 0.34$). Late post-discharge mortality was higher in DES patients from 6 months to 2 years (HR 4.90, $P = 0.01$) or from 1 to 2 years (HR 7.06, $P = 0.02$). Similar results were observed when factoring in hospital mortality.

**Conclusion** The observation of increased late mortality with DES vs. BMS suggests that DES should probably be avoided in STEMI, until more long-term data become available.

**Keywords** Risk score • STEMI • Drug-eluting stent • Bare-metal stent

## Introduction

Drug-eluting stents (DESs) present a major advance in interventional cardiology. Their use is associated with a marked and sustained reduction in the rate of re-stenosis and the attendant risks of repeat revascularization after percutaneous coronary intervention, whether performed electively or for treatment of acute myocardial infarction.[1,2] Concerns exist, however, over the long-term safety of DESs,[3–5] particularly the risk of late-stent thrombosis.[6] This catastrophic event is associated with high fatality rates[7] and occurs especially after discontinuation or reduction in oral antiplatelet therapy.[8] Further concerns stem from the fact that late-stent thromboses appear to accrue regularly over time in the year following placement of a DES, at least up to 3 years of

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follow-up.[9] Randomized clinical trials have compared DESs with bare-metal stents (BMSs),[2] but only limited follow-up is available so far, mostly up to a year, a time when the excess of late-stent thromboses reported with DESs has not yet occurred.[1]

The Global Registry of Acute Coronary Events (GRACE) is a multinational study of patients hospitalized for acute coronary syndromes with follow-up at 6 months and 2 years.[10,11] GRACE provides an opportunity to compare follow-up with DESs and BMSs in the setting of ST-segment acute myocardial infarction in a population from routine clinical practice as opposed to the highly selected populations participating in randomized clinical trials.

# Methods

Detailed information on the data collection methods for GRACE has been published.[10,11] GRACE is designed to reflect an unselected population of patients with an acute coronary syndrome (ACS), irrespective of geographic region. A total of 123 hospitals located in 14 countries in North and South America, Europe, Australia, and New Zealand have contributed data to this observational study. Data from 74 sites in 14 countries were used for this analysis.

Adult patients ($\geq$18 years) admitted with a presumptive diagnosis of ACS at participating hospitals were potentially eligible for this study. Eligibility criteria were a clinical history of ACS accompanied by at least one of the following: electrocardiographic changes consistent with ACS, serial increases in biochemical markers of cardiac necrosis (CK-MB, creatine phosphokinase, or troponin), and documented coronary artery disease. Patients with non-cardiovascular causes for the clinical presentation such as trauma, surgery, or aortic aneurysm were excluded. Patients were followed up at approximately 6 months and 2 years by telephone, clinical visits, or through calls to their primary care physician to ascertain the occurrence of several long-term outcomes. Where required, study investigators received approval from their local hospital ethics or institutional review board for conducting this study. While 6-month follow-up was built-in the registry from the onset, 2-year follow-up was implemented more recently and some participating sites either declined or did not receive approval for such 2-year follow-up. Therefore, follow-up rates reported account for the lack of eligibility of patients from these sites as well as for patients who have not yet reached follow-up. Unfortunately, no reliable data are available on the use of antiplatelet agents beyond 6 months following discharge.

To enrol an unselected population of patients, sites were encouraged to recruit the first 10–20 consecutive eligible patients each month. Regular audits were performed at all participating hospitals over a 2-year cycle. Data were collected by trained study coordinators using standardized case report forms. Demographic characteristics, medical history, presenting symptoms, duration of pre-hospital delay, biochemical and electrocardiographic findings, treatment practices, and a variety of hospital outcome data were collected. Standardized definitions of all patient-related variables, clinical diagnoses, and hospital complications and outcomes were used.[9]

Patients were diagnosed with ST-segment elevation myocardial infarction (STEMI) when they had new or presumed new ST-segment elevation $\geq$1 mm seen in any location, or new left bundle branch block on the index or subsequent electrocardiogram with at least one positive cardiac biochemical marker of necrosis (including troponin measurements, whether qualitative or quantitative). Hospital-specific feedback regarding patient characteristics, presentation, management, and outcomes were provided to each centre on a quarterly basis. This analysis focuses on patients with a confirmed diagnosis of STEMI who had at least one stent implanted during their hospital stay between January 2004 and December 2007. Selection of the type of stent was based on physician preference.

## Statistical analysis

Continuous variables in comparison groups are summarized as medians with interquartile ranges and were analysed by the Wilcoxon rank sum test. Categorical variables are reported as frequencies and percentages and were tested using the $\chi^2$ trend test or Fisher's exact test. All tests were two-sided and no correction for multiple testing was done. A propensity analysis was performed to adjust for differences in baseline between groups of STEMI patients who received DESs and those who received BMSs. The multiple logistic regression model predicting DESs contained GRACE risk score for hospital mortality, number of dilated vessels and stents, diabetes, and type of percutaneous coronary intervention. The propensity score (probability of DES) for STEMI patients was categorized into quintiles, and matching of clinical characteristics between patients receiving DESs and those receiving BMSs across quintiles of propensity score was verified (Appendix 1). Later on, the quintile was included in final model as a categorical variable. The GRACE risk score is a powerful and validated (both internally[12] and externally[13,14]) tool to predict in-hospital and post-discharge[12] mortality. The impact of DESs on 6-month and 2-year follow-up mortality rates was analysed by a Kaplan–Meier and Cox regression model to account for patient dropout over time, adjusted for factors demonstrated to be related to post-discharge survival and propensity for using DESs (i.e. probability score). The proportional hazards assumption was verified by assessing the statistical significance of the time by continuous variable interactions for GRACE risk score ($P = 0.36$) and for propensity score ($P = 0.71$).

# Results

## Study population

A total of 65 127 patients were enrolled in GRACE between April 1999 and December 2007, of which 26 150 were admitted after January 2004, when information regarding type of stent started to be collected. A total of 10 811 patients underwent one percutaneous coronary intervention and 10 094 received at least one stent during their index hospitalization, of whom 9874 were discharged alive (*Figure 1*). Data from 851 patients with multiple percutaneous coronary interventions during hospitalization were excluded because the type of stent could not be ascertained in patients with staged interventions. A total of 5093 patients had a final diagnosis of STEMI, of which 1313 (26%) received at least one DES, whereas 3780 (74%) received BMSs only. Rate of stent use by enrolment year is displayed in *Figure 2*. The proportion of patients receiving DESs increased from 19% in 2004 to 35% in 2006 and decreased to 22% in 2007.

There were marked differences in the baseline characteristics of the two groups (*Table 1*). Risk factors for atherosclerosis, such as diabetes, hypertension, increased body mass index, and hyperlipidaemia, were more common in patients receiving DESs; these patients also had higher rates of prior history of cardiac events or cardiac procedures. Conversely, patients receiving a BMS more frequently had a history of angina and a higher Killip class.

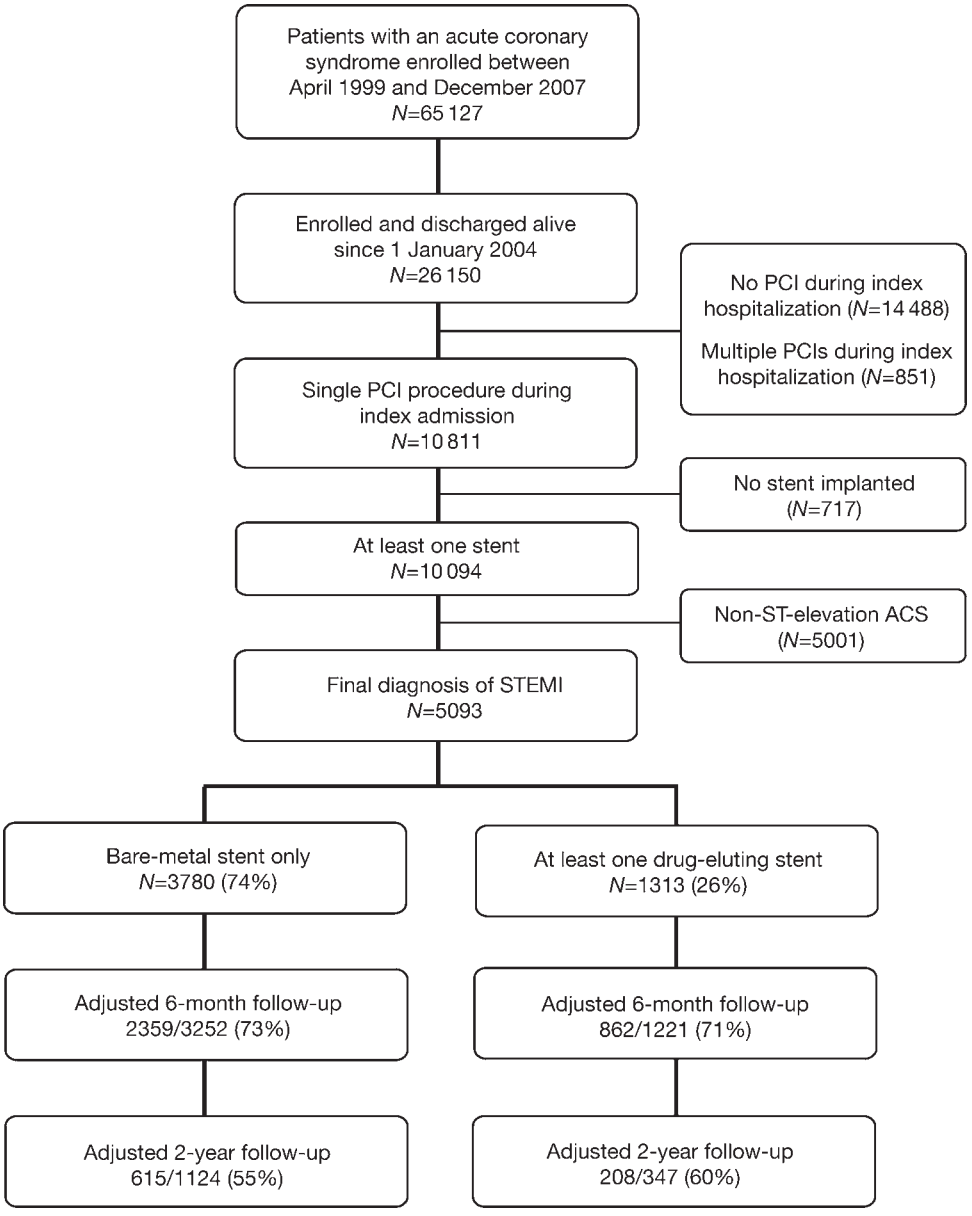



**Figure 1** Flow chart of patient participation and follow-up. PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.

The type of percutaneous coronary intervention differed between the two groups: patients receiving BMSs only underwent primary or rescue percutaneous coronary intervention more frequently, resulting in a shorter delay from symptom onset to coronary intervention. Overall, the average GRACE risk score was higher among patients receiving BMSs than in those receiving DESs, indicating that patients receiving BMSs were at greater risk of death.

Six-month follow-up data in eligible patients (i.e. who had reached 6-month follow-up at the time of this analysis) were available in 73% of the BMS patients and in 71% of the DES patients. Corresponding figures for 2-year follow-up were 55 and 60%, respectively. Treatment with thienopyridines was 94 vs. 93% at discharge ($P = 0.08$), 53% ($n = 1246$) vs. 65% ($n = 557$) at 6 months ($P < 0.001$), and 20% ($n = 120$) vs. 26% ($n = 53$; $P = 0.07$) at 2 years, for patients with BMSs or DESs, respectively.

## Hospital and post-discharge outcomes

Rates of in-hospital cardiac arrest or ventricular fibrillation and major bleeding were higher in patients who received a BMS only, whereas congestive heart failure was more frequent in patients with a DES (*Table 2*).

Mortality rates are summarized in *Table 3* and *Figure 3*. Unadjusted mortality during the index hospitalization was higher in patients receiving bare-metal vs. DESs (3.7 vs. 2.1%, $P < 0.01$). After multivariable logistic regression analysis, the odds ratio for

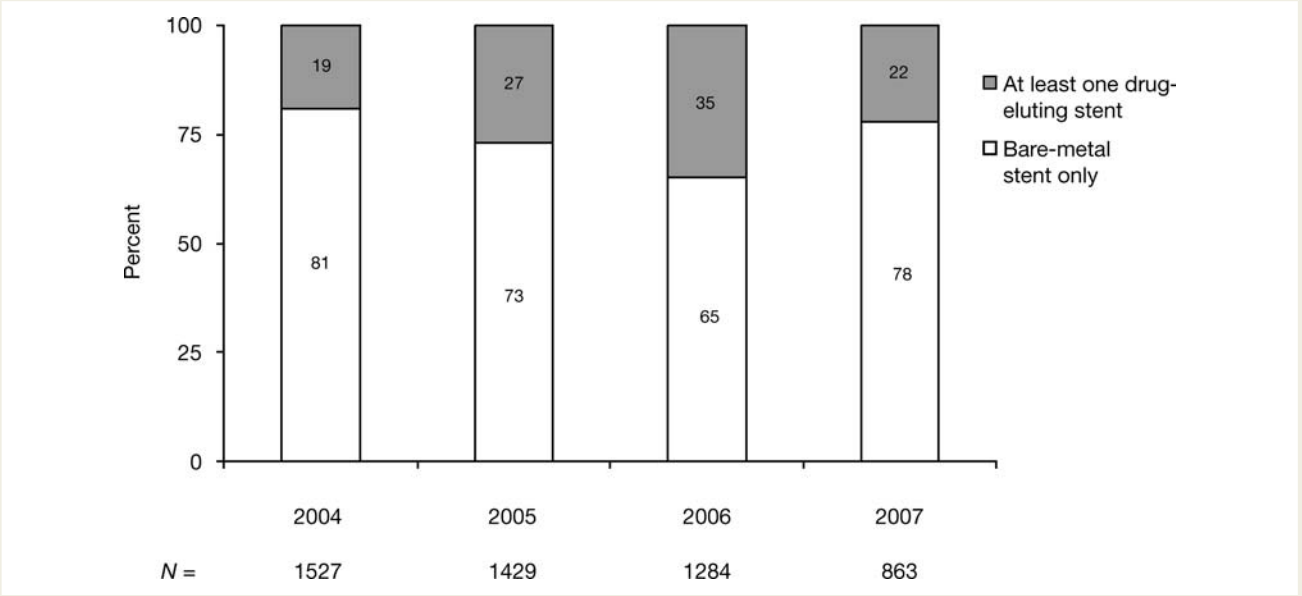



**Figure 2** Proportion of drug-eluting and bare-metal stents by enrolment year ($P < 0.0001$).

hospital mortality in patients with BMS vs. DES was 1.59 (95% confidence interval [CI] 1.002–2.564, $P = 0.05$).

Unadjusted mortality from discharge to 6 months was 2.2% for bare-metal and 1.5% for DESs ($P = 0.21$). From 6 months to 2 years, mortality was lower for patients receiving BMSs (1.6 vs. 6.3%, $P < 0.01$). Cumulative mortality from discharge to 2 years was similar between the two groups (2.5 vs. 2.7%, $P = 0.78$).

Therefore, the overall unadjusted mortality from admission to 2 years was higher for patients receiving BMSs (5.3 vs. 3.9%, $P = 0.04$).

Kaplan–Meier survival analysis in hospital survivors is shown in *Figure 3*. After discharge, mortality appeared to increase steadily in patients with DESs, whereas it tended to reach a plateau between 6 months and 1 year in those with only BMSs. Mortality curves appeared to cross around 1 year of follow-up.

Given the important differences in the baseline characteristics, timing and type of percutaneous coronary intervention, and risk of death between patients receiving BMSs and DESs, post-discharge mortality was analysed in a series of Cox models, adjusting for GRACE risk score, number of dilated vessels and stents, diabetes, type of percutaneous coronary intervention, and propensity to receive a DES. To account for the lack of constant hazard, we performed two landmark analyses of post-discharge mortality: one with analysis from 6 months to 2 years and another from 1 year to 2 years (see table in *Figure 3*). The results are consistent regardless of the timing and type of adjustment: early post-discharge mortality was not significantly different up to 6 months [hazard ratio (HR) for the fully adjusted and propensity-adjusted model 0.65, 95% CI 0.33–1.27, $P = 0.21$] or at 1 year (HR 0.74, 95% CI 0.39–1.38, $P = 0.34$) after discharge. However, late post-discharge mortality was consistently higher in patients with a DES vs. BMS only, for the period from 6 months to 2 years (HR 4.90, 95% CI 1.42–16.9, $P = 0.01$) or from 1 year to 2 years (HR 7.06, 95% CI 1.36–36.6, $P = 0.02$).

Similar findings were observed when mortality was analysed from hospital admission to 2-year follow-up. After comprehensive adjustment (GRACE risk score, number of dilated vessels, diabetes, type of percutaneous coronary intervention, and propensity to receive a DES), early mortality was not different between patients receiving DESs or BMSs (HR 0.71, 95% CI 0.49–1.02, $P = 0.07$ from admission to 6 months; HR 0.74, 95% CI 0.52–1.05, $P = 0.09$ from admission to 1 year), whereas late mortality was higher for patients receiving DESs (HR 4.79, 95% CI 1.4–16.4, $P = 0.01$ from 6 months to 2 years; HR 6.94, 95% CI 1.34–35.8, $P = 0.02$ from 1 to 2 years).

## Discussion

This analysis from a multinational observational study provides insights into mortality outcomes after percutaneous coronary intervention for STEMI in patients receiving DESs or BMSs. The overall mortality appeared higher than that reported from a meta-analysis of randomized clinical trials,[2] as would be expected when comparing a routine practice population with the highly selected participants in such trials,[15] but was lower than that reported in a registry study.[16] Hospital mortality was lower in patients receiving DESs vs. BMSs only; whether this finding reflects a lower baseline risk of hospital death, as shown by the lower GRACE risk score, and later procedures in patients with DESs, whether it results from residual confounding, or whether this is the result of genuine improved early safety of DESs compared with BMSs is unclear in this non-randomized comparison. In both randomized trials comparing DESs with BMSs in the setting of acute myocardial infarction[2] and in registry studies,[17] there was no clear early mortality difference. In studies with a maximum follow-up of 12 months, clinical outcomes were similar to or better with DESs than with BMSs.[18–21] In GRACE, after hospital discharge and up to 1 year, there was no statistically

**Table 1 Baseline characteristics and hospital and discharge treatments**

| | BMS only ($n$ = 3780)[a] | At least one DES ($n$ = 1313)[a] | $P$-value | $P$-value adjusted by propensity score |
|---|---|---|---|---|
| Age in years, median (IQR) | 61 (52–71) | 61 (52–71) | 0.21 | 0.83 |
| Women, $n$ (%) | 940 (25) | 344 (26) | 0.35 | 0.19 |
| Body mass index in kg/m$^2$, median (IQR) | 27 (24–29) | 27 (25–30) | <0.0001 | 0.0004 |
| Medical history, $n$ (%) | | | | |
| Smoker | 2440 (65) | 830 (63) | 0.32 | 0.20 |
| Angina | 873 (23) | 255 (20) | <0.01 | 0.11 |
| Myocardial infarction | 477 (13) | 214 (16) | <0.001 | 0.02 |
| Percutaneous coronary intervention | 323 (8.6) | 174 (13) | <0.0001 | <0.0001 |
| Coronary artery bypass graft | 128 (3.4) | 57 (4.4) | 0.12 | 0.55 |
| Diabetes | 623 (17) | 313 (24) | <0.0001 | 0.40 |
| Hypertension | 1894 (50) | 710 (54) | <0.01 | 0.08 |
| Hyperlipidaemia | 1461 (39) | 605 (46) | <0.0001 | 0.001 |
| Internal cardiac defibrillator | 4 (0.1) | 6 (0.5) | 0.02 | 0.03 |
| Percutaneous coronary intervention, $n$ (%) | | | <0.0001 | 0.44 |
| Primary | 2435 (66) | 693 (55) | | |
| Rescue | 423 (11) | 132 (10) | | |
| Urgent | 448 (12) | 290 (23) | | |
| Elective | 389 (11) | 153 (12) | | |
| Clinical presentation | | | | |
| Pulse beats per minute, median (IQR) | 75 (65–88) | 75 (65–90) | 0.52 | 0.62 |
| Systolic blood pressure in mmHg, median (IQR) | 135 (120–153) | 135 (118–155) | 0.22 | 0.93 |
| Diastolic blood pressure in mmHg, median (IQR) | 80 (70–90) | 80 (70–90) | 0.19 | 0.05 |
| Cardiac arrest, $n$ (%) | 136 (3.6) | 45 (3.4) | 0.76 | 0.09 |
| Thrombolysis, $n$ (%) | 743 (20.1%) | 232 (17.8%) | 0.07 | <0.0001 |
| Killip class, $n$ (%) | | | <0.001 | 0.02 |
| I | 3207 (86.8) | 1175 (91.1) | | |
| II | 352 (9.5) | 80 (6.2) | | |
| III | 77 (2.1) | 20 (1.6) | | |
| IV | 58 (1.6) | 14 (1.1) | | |
| Grace risk score, median (IQR) | 137 (117–159) | 134 (114–157) | 0.03 | 0.75 |
| Delay from symptom onset to PCI in min, median (IQR) | 133 | 212 | <0.0001 | 0.04 |
| Hospital medications, $n$ (%) | | | | |
| Aspirin | 3625 (96) | 1253 (96) | 0.51 | 0.49 |
| Beta-blocker | 3394 (90) | 1220 (93) | <0.001 | 0.01 |
| Angiotensin-converting enzyme inhibitor | 3107 (83) | 1066 (82) | 0.52 | 0.72 |
| Statin | 3323 (88) | 1173 (90) | 0.66 | 0.09 |
| Thienopyridine | 3474 (92) | 1143 (87) | <0.0001 | <0.0001 |
| Low-molecular-weight heparin | 2096 (56) | 673 (52) | 0.01 | <0.0001 |
| Unfractionated heparin | 1882 (50) | 764 (59) | <0.0001 | <0.0001 |
| Warfarin | 146 (3.9) | 81 (6.3) | <0.001 | <0.0001 |
| Intravenous glycoprotein IIb/IIIa blocker | 2129 (57) | 915 (70) | <0.0001 | <0.0001 |
| Discharge medications, $n$ (%) | | | | |
| Aspirin | 3343 (97) | 1199 (96) | 0.20 | 0.07 |
| Beta-blocker | 3057 (89) | 1128 (90) | 0.07 | 0.18 |
| Angiotensin-converting enzyme inhibitor | 2777 (81) | 979 (79) | 0.14 | 0.27 |
| Statin | 3174 (92) | 1157 (93) | 0.39 | 0.27 |
| Thienopyridine | 3233 (94) | 1166 (93) | 0.82 | 0.46 |
| Warfarin | 156 (4.6) | 78 (6.4) | 0.82 | 0.001 |

BMS, bare-metal stent; DES, drug-eluting stent; IQR: interquartile ratio.
[a]Because of minor variations in data capture, denominators may vary from 3759 to 3780 and from 1304 to 1313.

**Table 2 Clinical outcomes in hospital**

| Hospital events, *n* (%) | BMS only | At least one DES | *P*-value |
|---|---|---|---|
| Recurrent ischaemia | 625 (17) | 235 (18) | 0.26 |
| Congestive heart failure | 413 (11) | 177 (14) | 0.01 |
| Cardiogenic shock | 204 (5.4) | 66 (5.0) | 0.59 |
| Cardiac arrest or ventricular fibrillation | 251 (6.7) | 66 (5.1) | 0.04 |
| Atrial fibrillation or flutter | 251 (6.7) | 93 (7.1) | 0.57 |
| Sustained ventricular tachycardia | 148 (3.9) | 46 (3.5) | 0.50 |
| Reinfarction | 75 (2.0) | 33 (2.5) | 0.26 |
| Stroke | 23 (0.6) | 7 (0.5) | 0.76 |
| Major bleeding | 121 (3.2) | 27 (2.1) | 0.03 |

BMS, bare-metal stent; DES, drug-eluting stent.

**Table 3 Unadjusted mortality up to 2 years following hospital discharge**

| Time period | BMS, *n*/*N* (%) | At least one DES, *n*/*N* (%) | *P*-value |
|---|---|---|---|
| In-hospital | 140/3779 (3.7) | 27/1313 (2.1) | <0.01 |
| Discharge to 6 months | 52/2359 (2.2) | 13/862 (1.5) | 0.21 |
| Six months to 2 years | 9/563 (1.6) | 11/175 (6.3) | <0.01 |
| Admission to 2 years | 201/3780 (5.3) | 51/1313 (3.9) | 0.04 |
| Discharge to 2 years | 61/2407 (2.5) | 24/885 (2.7) | 0.78 |

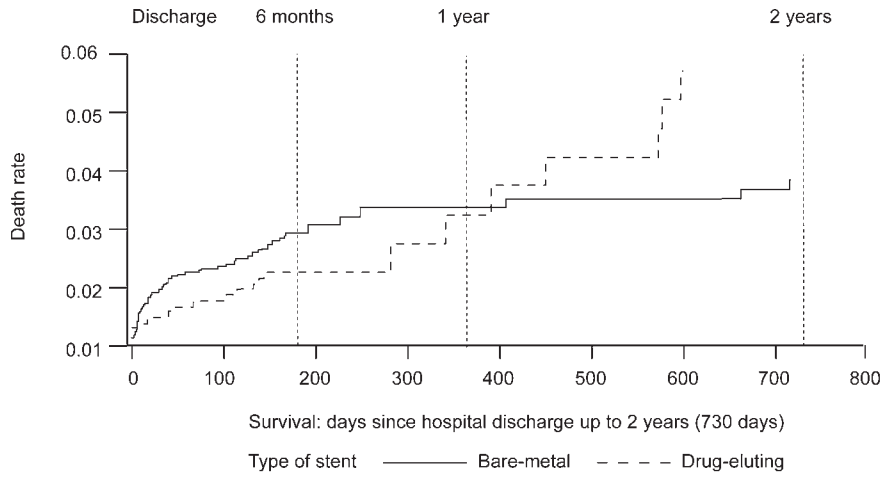
BMS, bare-metal stent; DES, drug-eluting stent.

significant difference in survival between the two groups. From 6 months to 2 years, however, at a time when thienopyridines were being discontinued in most patients (although less frequently in patients with DESs than with BMSs), there was increased mortality in patients with a DES. Similarly, in a study by Daemen *et al.*,[16] the reduction in target-vessel revascularization that was observed at 1 year with DES had disappeared by 3 years. The excess late mortality with DESs persisted after adjustment for propensity to receive a DES, GRACE risk score, number of dilated vessels, diabetes, and type of percutaneous coronary intervention. This difference in the timing of fatal events between patients treated with DESs and BMSs is the main result of our analysis.

Several randomized trials have compared clinical outcomes in patients with STEMI treated with DESs or BMSs.[22–29] In aggregate, they found a reduction in risk of reintervention with DESs, without an excess risk of death or myocardial infarction, up to 1 year.[2] Few data are available regarding long-term outcomes for patients receiving DESs. The STRATEGY (Single High Dose Bolus Tirofiban and Sirolimus Eluting Stent vs. Abciximab and Bare Metal Stent in Myocardial Infarction) trial,[25] which compared BMSs with abciximab and DESs with tirofiban in 175 patients, reported 2-year outcomes, without any indication for increased mortality or adverse clinical outcomes with DESs. The current analysis suggests that there may be an increased risk of late mortality with DESs vs. BMSs in patients with STEMI. This excess late mortality was observed despite the fact that more patients with DESs than with BMSs continued clopidogrel at 6 months. This observation is important in a non-randomized setting, which may better reflect patients' true long-term adherence to medications, particularly dual-antiplatelet therapy, compared with individuals enrolled in clinical trials. Although patients in trials are regularly followed and are often provided with medications, patients in routine practice may have poor adherence, be unable to pay for their medications or may discontinue antiplatelet therapy because of minor bruising or bleeding.

These observations should be interpreted with caution given the observational and non-randomized nature of the GRACE data set. There is potential residual confounding from measured and, more importantly, unmeasured variables. In fact, there are important differences in the baseline characteristics between the groups. Although these resulted in a lower risk for hospital mortality in the group treated with DESs, differences in important risk factors correlated with late disease progression, such as diabetes, dyslipidaemia, and hypertension, may account in part for the increased late mortality seen with DESs. Given the differences in the hazards between the various periods, adjustment for differences between groups and propensity to receive DESs had to be performed separately for the early and late periods after stent placement. However, regardless of the time point selected for landmark analyses of late mortality, of the type of adjustment, and of whether mortality was assessed from initial admission or from hospital discharge, the findings were consistent: there was no significant difference in adjusted 'early' (up to 1 year after discharge) mortality between groups, whereas late mortality (from 6 months to 2 years or from 1 year to 2 years) was consistently increased with DESs. The number of late events driving the differences observed is small and, importantly, the number of patients with incomplete follow-up is substantial. No information was collected regarding type of DESs or BMSs (although it is likely that the vast majority of DESs were of the first generation, i.e. sirolimus- or paclitaxel-eluting stents), or regarding angiographic lesion characteristics (such as lesion length, vessel reference diameter, presence of a bifurcation) that may impact outcomes. Finally, the comparison is between patients receiving 'BMSs only' and 'at least one DES', although this would tend to minimize differences between the groups.

Acknowledging these limitations, increased late mortality with DESs following STEMI is biologically plausible. There is general agreement that DESs carry an increased risk of late-stent thrombosis compared with BMSs,[5] although recently late-stent thrombosis has also been reported with BMSs.[30] Although the risk is small, stent thrombosis is potentially lethal, and this has raised concerns that the benefit related to prevention of repeat revascularization with DESs may be offset by a small increase in late mortality related to late-stent thrombosis.[3] Unfortunately, the randomized trials available so far comparing DESs with BMSs have not been powered for mortality, but careful meta-analysis of the totality of evidence from the randomized clinical trials suggests that there is no increase in mortality with DESs vs. BMSs up to 3 years.[31] This may be related to the fact that recurrent revascularization




| Hazard ratio (Cox regression) | Discharge to 6 months (*P*-value) | Six months to 2 years (*P*-value) | Discharge to 1 year (*P*-value) | 1 to 2 years (*P*-value) |
|---|---|---|---|---|
| Adjusted by GRACE risk score | 0.72 (0.32) | 5.55 (<0.01) | 0.82 (0.51) | 8.01 (0.01) |
| Adjusted by GRACE risk score, number of dilated vessels/stents, diabetes and type of PCI (primary vs. other) | 0.65 (0.21) | 4.98 (0.01) | 0.74 (0.35) | 7.18 (0.02) |
| Adjusted by GRACE risk score and propensity | 0.68 (0.26) | 5.37 (<0.01) | 0.77 (0.41) | 7.77 (0.01) |
| Adjusted by GRACE risk score, propensity, number of dilated vessels/stents (single vs. multiple), diabetes, and type of PCI (primary vs. other) | 0.65 (0.21) | 4.90 (0.01) | 0.74 (0.34) | 7.06 (0.02) |

**Figure 3** Landmark analysis of post-discharge survival at 6 months and at 1 year in patients with ST-segment elevation myocardial infarction treated with drug-eluting or bare-metal stents.

in itself is linked to adverse outcomes, including mortality.[32] However, in the context of acute myocardial infarction, several elements may result in an increased risk of late-stent thrombosis: first the thrombus burden is greater in ST-segment elevation than in NSTEMI,[33,34] and data show higher mortality as a function of increased thrombus burden.[35] In addition, the potential for late acquired malapposition of the stent struts to the vessel wall is greater because sizing of the stent is done in the context of massive thrombosis and vessel vasoconstriction. Once the vessel has recanalized and thrombosis subsided, the reference diameter may be larger than had appeared when the stent was deployed. Late-stent malapposition is a potential factor favouring late-stent thrombosis, and the frequency of late malapposition appears greater after primary percutaneous intervention with DESs[36] than with BMSs.[37] Finally, acute myocardial infarction most often stems from rupture or erosion of an atherosclerotic coronary plaque, and placing stent struts in direct contact with the underlying lipidonecrotic core may prevent proper plaque healing,[38] particularly as re-endothelialization of DES struts is incomplete after up to 40 months, whereas it is generally complete by 6 months with a BMS.[39]

Although the overall unadjusted mortality was slightly lower with DESs vs. BMEs, the finding of increased late mortality (unadjusted and adjusted) with DESs suggests that DESs should be used cautiously in patients with STEMI, until more long-term data from appropriately powered randomized clinical trials become available. This is especially true for patients where long-term adherence to dual-antiplatelet therapy may be difficult for whatever reason.

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# Appendix 1

Matching of characteristics between patients receiving DESs and BMSs across quintiles of propensity score:

| | Type of stent | GRACE risk score (mean) | Single stent (%) | Single dilated vessels (%) | Primary PCI (%) | Diabetes (%) |
|---|---|---|---|---|---|---|
| All patients included in propensity analysis ($N = 4300$) | BMS 3140 (73%) | 139.8 | 74 | 91 | 66 | 21 |
| | DES 1160 (27%) | 137.2 | 61 | 82 | 54 | 30 |
| Propensity score: quintile 1 ($N = 860$) | BMS 714 (83%) | 159.3 | 100 | 100 | 100 | 1 |
| | DES 146 (17%) | 159.6 | 98 | 100 | 100 | 0 |
| Propensity score: quintile 2 ($N = 860$) | BMS 677 (79%) | 130.9 | 91 | 100 | 88 | 7 |
| | DES 183 (21%) | 134.0 | 90 | 100 | 83 | 8 |
| Propensity score: quintile 3 ($N = 860$) | BMS 654 (76%) | 145.5 | 72 | 99 | 50 | 21 |
| | DES 206 (24%) | 146.2 | 77 | 100 | 53 | 30 |
| Propensity score: quintile 4 ($N = 860$) | BMS 605 (70%) | 124.7 | 67 | 93 | 47 | 33 |
| | DES 255 (30%) | 126.5 | 65 | 95 | 45 | 34 |
| Propensity score: quintile 5 ($N = 860$) | BMS 490 (57%) | 134.9 | 27 | 56 | 30 | 57 |
| | DES 370 (43%) | 132.4 | 21 | 46 | 28 | 50 |

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