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Impact of beta blockers on functional outcomes, death, and rehospitalization in older nursing home residents following acute myocardial infarction

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Abstract

Importance—Beta blockers are a mainstay of treatment after acute myocardial infarction (AMI). Yet, these medications are commonly not prescribed for older nursing home residents after AMI, in part owing to concerns about potential functional harms and uncertainty of benefit.

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Data Access and Responsibility: Drs. Steinman and Mor had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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- Dr. Steinman: MAS is a paid consultant for iodine.com.
- Dr. Mor: VM's research is in a related area to that of several different paid activities. VM also periodically serves as a paid speaker at national conferences where he discusses trends and research findings in long term and post-acute care. VM holds stock of unknown value in PointRight, Inc. an information services company providing advice and consultation to various components of the long term care and post-acute care industry, including suppliers and insurers. PointRight sells information on the measurement of nursing home quality to nursing homes and liability insurers. VM was a founder of the company but has subsequently divested much of his equity in the company and relinquished his seat on board. In addition, VM Chairs the Independent Quality Committee for HRC Manor Care, Inc., a nursing home chain, for which he receives compensation in the $20,000-$40,000 range. VM also serves as chair of a Scientific Advisory Committee for NaviHealth, a post–acute care service organization, for which he also receives compensation in the $20,000–40,000 per year range. VM serves as a Technical Expert Panel member on several Centers for Medicare/ Medicaid quality measurement panels. VM is a member of the board of directors of Tufts Health Plan Foundation; Hospice Care of Rhode Island; and The Jewish Alliance of Rhode Island.
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Objective—We studied the impact of beta blockers after AMI on functional decline, mortality, and rehospitalization among long-stay nursing home residents age 65 and older.

Design, setting, participants, exposure—Observational study of nursing home residents with AMI in 2007–2010, using national data from the Minimum Data Set and Medicare Parts A and D. Subjects with beta blocker use prior to AMI were excluded. We used propensity score-based methods to compare outcomes in people who did vs. did not initiate a beta blocker after AMI hospitalization.

Main outcomes—Functional decline, death, and rehospitalization in the first 90 days after AMI. Functional status was measured using a validated 28-point scale that evaluates independence in activities of daily living.

Results—The study cohort included 5,496 new beta blocker users and an equal number of non-users. Mean age was 84 years. Beta blocker users were more likely than non-users to experience functional decline (OR 1.14, 95% CI 1.02–1.28), with a number need to harm of 52. Conversely, beta blocker users were less likely than non-users to die (HR 0.74, 95% CI 0.67–0.83) and had similar rates of re-hospitalization (HR 1.06, 95% CI 0.98–1.14). Nursing home residents with moderate or severe cognitive impairment or severe functional dependency were particularly likely to experience functional decline from beta blockers (OR 1.34, 95% CI 1.11–1.61 and OR 1.32, 95% CI 1.10–1.59, respectively). In contrast, there was little evidence of functional decline from beta blockers in subjects with better cognitive and functional status (ORs 0.99 to 1.05; P value for effect modification 0.03 and 0.06, respectively). Mortality benefits of beta blockers were similar across all subgroups.

Conclusions/relevance—Use of beta blockers after AMI is associated with functional decline in older nursing home residents with substantial cognitive or functional impairment, but not in those with relatively preserved mental and functional abilities. Beta blockers yielded considerable mortality benefit in all groups.

Beta blockers are a mainstay of guideline-recommended care for adults following acute myocardial infarction (AMI).[1,2] Randomized trials in middle-aged and “young-old” adults show that treatment with beta blockers after AMI reduces mortality by 25–30%.[3–5] Multiple observational studies have found a similar level of mortality reduction in adults 85 years and older and in those with functional impairment.[6–9]

Despite the benefits of beta blockers across the age span, these medications are less often prescribed to older adults, especially those with functional impairment or multimorbidity.[6,7,10,11] Although studies have suggested that beta blockers are generally well-tolerated in older adults,[12–14] there are little data on their adverse event profile in frail and highly vulnerable elders, including potential harms such as orthostasis, fatigue, and depression, which can negatively impact daily functioning and quality of life. This dilemma, where potential mortality benefits are weighed against an unclear level of harms, is common in the care of vulnerable older adults.[15–18] It is particularly important for the 1.4 million Americans who reside in nursing homes, who are at high risk of functional decline and often strongly value preserving whatever remaining functional independence they have.[19,20]

In this study, we evaluated the impact of beta blockers on functional outcomes in older nursing home residents with myocardial infarction, and compared these functional outcomes with the impact of beta blockers on death and re-hospitalization in this population.

Methods

Data Sources and Subjects

Data came from Medicare Part A and Part D (prescription drug benefit) claims; the Online Survey Certification and Reporting System (OSCAR), which provides facility-level information on nursing home characteristics, staffing, and quality indicators; and the Minimum Data Set (MDS) version 2.0, which comprises assessments made on nearly all nursing home residents in the U.S. MDS assessments occur a minimum of every 3 months, and more often for patients with a major recent change in clinical status and those receiving care under the Medicare Skilled Nursing Facility (SNF) benefit.

Our study population comprised U.S. nursing home residents age 65 and older who were hospitalized for AMI between May 1, 2007 and March 31, 2010, had resided in a nursing home for at least 30 days prior to the AMI hospitalization, were not using a beta blocker for at least four months prior to hospitalization, and returned to a nursing home after hospital discharge (see Appendix 1 and Zullo et al[21] for additional details). We defined hospitalization with AMI based on a hospital admission or discharge claim with ICD9 code 410.XX or 411.1 as a primary or secondary diagnosis. We excluded patients who died, were rehospitalized, or otherwise left the nursing home within 14 days of hospital discharge, because in such short-stay situations it is difficult to reliably ascertain beta blocker use. We also excluded patients with very poor prognosis at baseline (Changes in Health, End-Stage Disease, and Signs and Symptoms [CHESS] score of 5 or hospice),[22] patients who were not continuously enrolled in Medicare Part D during the study period or had no Part D claims following hospitalization, and patients who were enrolled in a Medicare Advantage plan at any point during this period. Finally, we excluded subjects with extremely poor functional status prior to hospitalization (Morris ADL score ≥24/28) since they had little room for further functional decline.[23]

Measures

Our exposure of interest was use of a beta blocker in the immediate post-hospital period. We defined this as a Part D claim for an oral beta blocker within 30 days of resuming Part D coverage after hospital discharge. Part D covers at least 81% of nursing home residents and in most cases is the sole source of prescription drug coverage for these patients.[24] For the subset of patients who return to the nursing home under the Medicare Skilled Nursing Facility (SNF) benefit, resumption of Part D claims is temporarily delayed. Therefore, we conducted a companion validation study to evaluate the performance of our beta blocker exposure measure in this subset. This study confirmed the validity of our measure (see Appendix 1).

Our primary outcome was functional decline. We defined this as a loss of 3 points on a validated 28-point scale of independence in activities of daily living (ADLs) between the

pre-hospital baseline and the first available assessment following hospitalization, up to 3 months after discharge.[23] A 3-point drop corresponds to a major loss of independence in 1 ADL or incremental losses in 2 or more ADLs. In a sensitivity analysis, we evaluated the outcome as a 4-point (more substantial) decline in function. We chose a 90-day outcome period because it is long enough to be clinically meaningful, but short enough that many of these highly vulnerable patients have not yet died, a competing outcome which complicates interpretation of longer-term functional outcomes.

Other key outcome measures included death and re-hospitalization within 90 days of the index hospital discharge. We used data from Medicare Part A and Medicare enrollment files to identify hospital admissions and date of death. We also explored two composite outcomes: time to hospitalization or death, and time to hospitalization, death, or functional decline.

Information on chronic conditions and characteristics of the index hospitalization were obtained from Medicare Part A data. Overall, this data source is more accurate for identifying chronic conditions than MDS 2.0.[25–28] MDS 2.0 provided data on other patient characteristics including functional and cognitive status, geriatric syndromes, and symptoms, including validated scales such as the Cognitive Performance Score (CPS) and CHESS score.[22,29]

We used the OSCAR dataset to evaluate a variety of nursing home facility characteristics such as staffing, resident mix and quality indicators.

Analyses

We used propensity score-based methods to evaluate the relationship between beta blocker exposure and our outcomes of interest. Following an intention-to-treat framework, we defined subjects as beta blocker users or non-users throughout the study period based on their exposure in the immediate post-AMI period.

We estimated the propensity score via a logistic regression model that used 93 variables to predict beta blocker use. Variables included sociodemographic characteristics, chronic medical conditions, baseline medication use, prior hospitalization history, baseline functional and cognitive status, geriatric syndromes, symptoms, characteristics of the AMI hospitalization, and nursing home characteristics (Appendix 2). To evaluate whether vital signs, laboratory test results, and measures of cardiac function could result in unmeasured confounding, we conducted a companion validation study using national VA data, which unlike Medicare claims data contains information on these parameters. We found no evidence that the absence of these factors would substantially alter our results (Appendix 3).

To match beta blocker users with non-users who had similar propensity scores, we first discarded subjects in the top and bottom 1% of the propensity score distribution so as to exclude areas of non-overlap. We then applied a 1:1 greedy 5-to-1 digit matching algorithm without replacement.[30] We evaluated the quality of resulting matches by comparing standardized differences between groups for each covariate in our model, and by using t-tests to assess differences in the distribution of propensity scores.[31,32]

Our propensity matching yielded excellent covariate balance, so we did not further adjust for baseline covariates in our models. Because we excluded people who died or were re-hospitalized during the first 14 days after hospital discharge, we did not consider outcomes that occurred during this period, thus effectively beginning our outcome analyses at day 14 after hospitalization.

We used Cox proportional hazards models to determine the impact of beta blocker use on time to death. We used the method of Fine and Gray (similar to Cox regression) to evaluate the impact of beta blocker use on time to rehospitalization while accounting for the competing outcome of death.[33] Finally, we used multinomial logit models to evaluate the impact of beta blocker use on functional decline.[28] At the end of the 90 day followup period, subjects were classified as alive without functional decline, having had functional decline documented in the first MDS assessment of that period, or having died without evidence of functional decline on the first MDS assessment.

We used both multiplicative and additive interaction terms to evaluate whether the impact of beta blockers on outcomes varied across subject characteristics. These characteristics included levels of baseline functional status, cognitive function, age, and presence or absence of an ICU or CCU stay during the AMI hospitalization. The distribution of propensity scores was very similar for beta blocker users and non-users within each subgroup, suggesting that stratifying patients into subgroups did not threaten covariate balance (Appendix 4).

The decision to exclude patients who died or were rehospitalized within 14 days after the AMI discharge has the potential to create selection bias. To evaluate this, we repeated our main analyses using inverse probability of selection weighting.[34,35] This approach weighted subjects according to their similarity to individuals who were excluded due to death (N=1,859) or re-hospitalization (N=2,444) in the first 14 days, thus estimating treatment effects as if these people had been included in the analysis. In another sensitivity analysis, we controlled for use of other cardiovascular medications post-AMI using multinomial logistic regression in our propensity-matched cohort.

We also evaluated several alternate approaches to determine if our results were stable across different analytic techniques. These included stratifying by propensity score quintile and deciles, controlling for propensity score as a covariate, using inverse probability of treatment weights, performing time-dependent analyses. In each case, results were similar to our main approach (Appendix 5).

Results

Our initial cohort included 8,953 new beta blocker users and 6,767 non-users. Before matching, beta blocker users were more likely to have been in an ICU or CCU during the hospital stay and to return to the nursing home on the Medicare SNF-benefit care pathway, and less likely to have a prior diagnosis of angina pectoris or unstable angina (Table 1 and Appendix 6).

Propensity score matching yielded a cohort of 5,496 new beta blocker users and an equal number of non-users (Table 1). Mean age was 84 years. The distribution of propensity scores was nearly identical between the matched groups (P=0.63), and all but 2 variables had standardized mean differences of 0.03 or less (Appendix 6). This is consistent with excellent covariate balance between groups.[31] Beta blocker users and non-users had equal time between nursing home readmission and their first ADL assessment (median 22 days, IQR 11–29 days, P=0.97 for difference). New beta blockers users were more likely than non-users to be prescribed other cardiovascular medications in the post-AMI period, including statins (49% vs 32%, P<.0001) and ACE inhibitors (44% vs. 31%, P<.0001), but not angiotensin receptor blockers (8% vs 7%, P=.17).

Within 3 months after hospital discharge, 1,328 of 10,992 subjects (12%) experienced functional decline, 2,782 (25%) were rehospitalized, and 1,541 (14%) died. Some patients experienced more than one outcome; e.g. were rehospitalized and then died.

Beta blocker users had a higher rate of functional decline than non-users. In the first 90 days after AMI, the odds of functional decline were 1.14 (95% CI, 1.02–1.28) times greater in patients receiving beta blockers than in those not using beta blockers (Table 2). The number needed to treat to cause one patient to have functional decline was 52 (95% CI, 32–141). Results were similar using the more stringent threshold of a 4-point decline on the Morris ADL scale: using this definition, 1,165 subjects (11%) had functional decline, and beta blocker users were more likely to decline (OR 1.16, 95% CI, 1.02–1.31).

Beta blocker users were less likely than non-users to die within 90 days of hospital discharge (hazard ratio [HR] 0.74, 95% CI, 0.67–0.83; Figure 1 and Table 2). The number needed to treat to prevent one death was 26 (95% CI, 19–39). Beta blocker use had no impact on time to re-hospitalization (HR 1.06, 95% CI 0.98–1.14).

Beta blocker use had no significant effect on a composite outcome of time to death, hospitalization, or functional decline (HR 0.98, 95% CI 0.94–1.03). Beta blocker use showed a borderline small protective effect for a composite outcome that only included time to death or hospitalization (HR 0.94, 95% CI 0.88–1.00).

The impact of beta blocker use on death was similar across a variety of patient characteristics (Figure 3). However, the impact of beta blocker use on functional decline varied according to patients' baseline cognitive and functional status (Figure 3 and Appendix 7). Among nursing home residents with moderate or severe cognitive deficits, beta blocker users were substantially more likely than non-users to experience functional decline (OR 1.34, 95% CI 1.11 – 1.61), with a number needed to harm of 36 (95% CI, 24–76). Similarly, among residents with severe functional dependence at baseline, beta blocker users had greater risk of functional decline than did non-users (OR 1.32, 95% CI 1.10–1.59), with a number needed to harm of 25 (95% CI, 16–55). In contrast, beta blocker use did not increase the risk of functional decline in people with intact cognition or mild dementia (OR 1.03, 95% CI 0.89–1.20) or in those with less impaired levels of functioning prior to their hospitalization for AMI (OR 1.05, 95% CI 0.86–1.27 and OR 0.99, 95% CI 0.77–1.26,

respectively). The P values for effect modification on the multiplicative scale were 0.03 for baseline cognitive status and 0.06 for baseline functional status.

The main results were similar after applying inverse probability of selection weights, although the point estimate for the impact of beta blockers on functional decline was slightly attenuated, with 95% confidence intervals crossing 1 (OR 1.09, 95% CI 0.96–1.24). Similar patterns held for results of subgroup analyses using selection weights (Appendix 8). Finally, results were similar after controlling for use of other cardiovascular medications in the post-AMI setting (Appendix 5).

Discussion

In this national study of older nursing home residents, using beta blockers after acute myocardial infarction resulted in a 26% relative reduction in 90-day mortality, with a number needed to treat of 26 to prevent one death. Similar levels of risk reduction were found across a wide variety of patient subgroups. However, beta blockers conferred a 14% relative increase in the odds of functional decline, with a number need to harm of 52 to cause one case of functional decline. This risk was particularly high for people with moderate or severe cognitive impairment or a high degree of functional dependence at baseline. In these groups, beta blockers increased the odds of functional decline by 32–34%, with a number needed to harm of 25 to 36. In contrast, nursing home residents with relatively preserved cognitive and functional abilities did not appear to suffer adverse functional consequences from receiving beta blockers.

Our findings of mortality benefit are consistent with the results of other observational studies of beta blocker use among the old-old, frail, and functionally impaired.[6–9,36,37] Regarding harms, little is known about the impact of beta blockers on functional status. However, these agents increase risk of fatigue (particularly first-generation agents such as propranolol)[12] and have been associated with increased rates of dizziness[38,39] and decreased subjective sense of well-being,[40,41] although no consistent effect has been found on rates of depression[12] or falls.[13,42]

Our results confirm the suspicion of many physicians that poor cognitive and functional status increase the risk of medication-induced harms in older adults. However, they call into question the more general practice whereby older adults are less likely to receive guideline-recommended medications after AMI regardless of their mental or physical abilities.[7,10,11,43] For nursing home residents with intact cognition or mild dementia, and in those with non-severe levels of functional dependency, we found substantial mortality benefit and no functional harms. So, for most such patients treatment is appropriate. In contrast, for nursing home residents with extensive functional dependency or moderate to severe dementia (roughly corresponding to a Folstein Mini Mental State Exam score of 14/30 or lower),[29] resolving the tradeoff between reduced mortality and increased risk of functional decline will depend on patient preferences, as expressed directly or through surrogate decision-makers.[44,45] For cognitively or functionally impaired nursing home residents who are more concerned about functional decline than death, avoiding treatment may be preferable. This is

a large population: more than half of nursing home residents have high levels of functional dependence, and two-thirds have moderate or severe cognitive impairment.[46]

Because this is an observational study, we cannot rule out the possibility of confounding. However, several factors support the robustness of our findings. We obtained excellent balance of baseline covariates across treatment groups and consistent results using several alternate analytic approaches. Moreover, younger and healthier patients are more likely to receive secondary prevention medications after AMI.[7,10,11,43,47] This would bias results toward better outcomes in beta blocker users. Instead, functional outcomes were in the opposite direction of this expected bias. Another important consideration is co-interventions. People who used beta blockers after AMI were also more likely to receive statins and ACE-inhibitors in the post-AMI period. Controlling for these differences slightly attenuated the observed associations between beta blocker use and our outcomes of interest, although the overall pattern remained.

To enable robust assessment of beta blocker exposure, we excluded subjects who died or were rehospitalized within the first 14 days of hospital discharge. This prevented us from evaluating the impact of beta blockers on outcomes during this period. Thus, our results should be interpreted as providing evidence about the impact of beta blocker use on outcomes starting 14 days after discharge, among people who had survived and remained in the nursing home until then. In addition, these exclusions could induce selection bias.[34,35] However, while our sensitivity analyses were consistent with the possibility of mild selection bias, we found little evidence of bias sufficiently large to invalidate our overall findings.

Use of beta blockers after myocardial infarction resulted in substantial reductions in mortality among older nursing home residents. At the same time, use of these agents resulted in worse functional outcomes among nursing home residents with substantial cognitive or functional deficits. In this highly vulnerable group, understanding the importance that individual patients place on avoiding death and on avoiding functional decline will be critical to guiding decision-making about use of these medications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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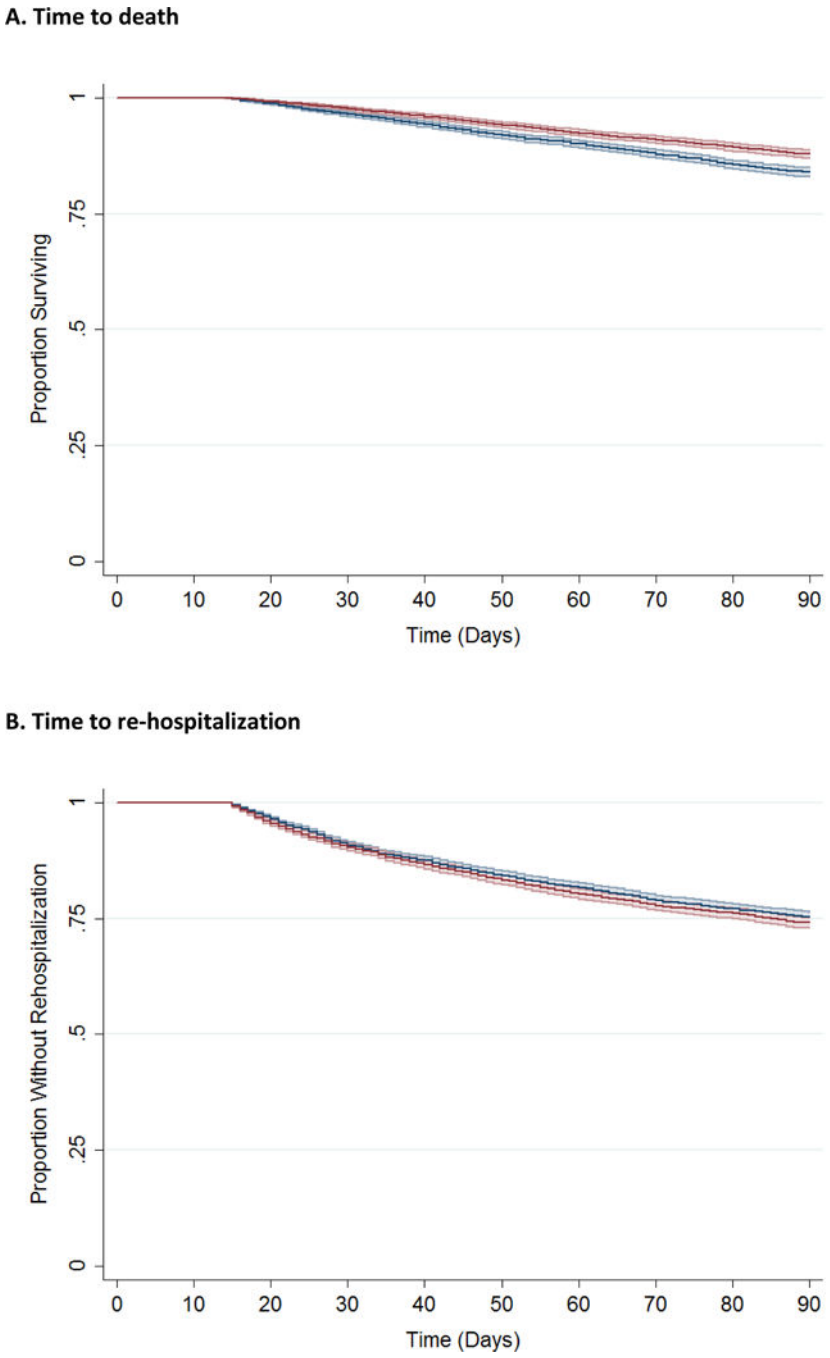

Figure 1. Association between beta-blocker use and death and re-hospitalization

Panel A shows time to death among beta blocker users and non-users. Panel B shows time to re-hospitalization in the 2 groups. There are no events in the first 14 days after hospital discharge because subjects who left the nursing home for any reason in the first 14 days after hospital discharge were excluded from analysis.

Red lines are beta blocker-users; blue lines are non-users. Shaded areas are the 95% confidence intervals around each survival curve.

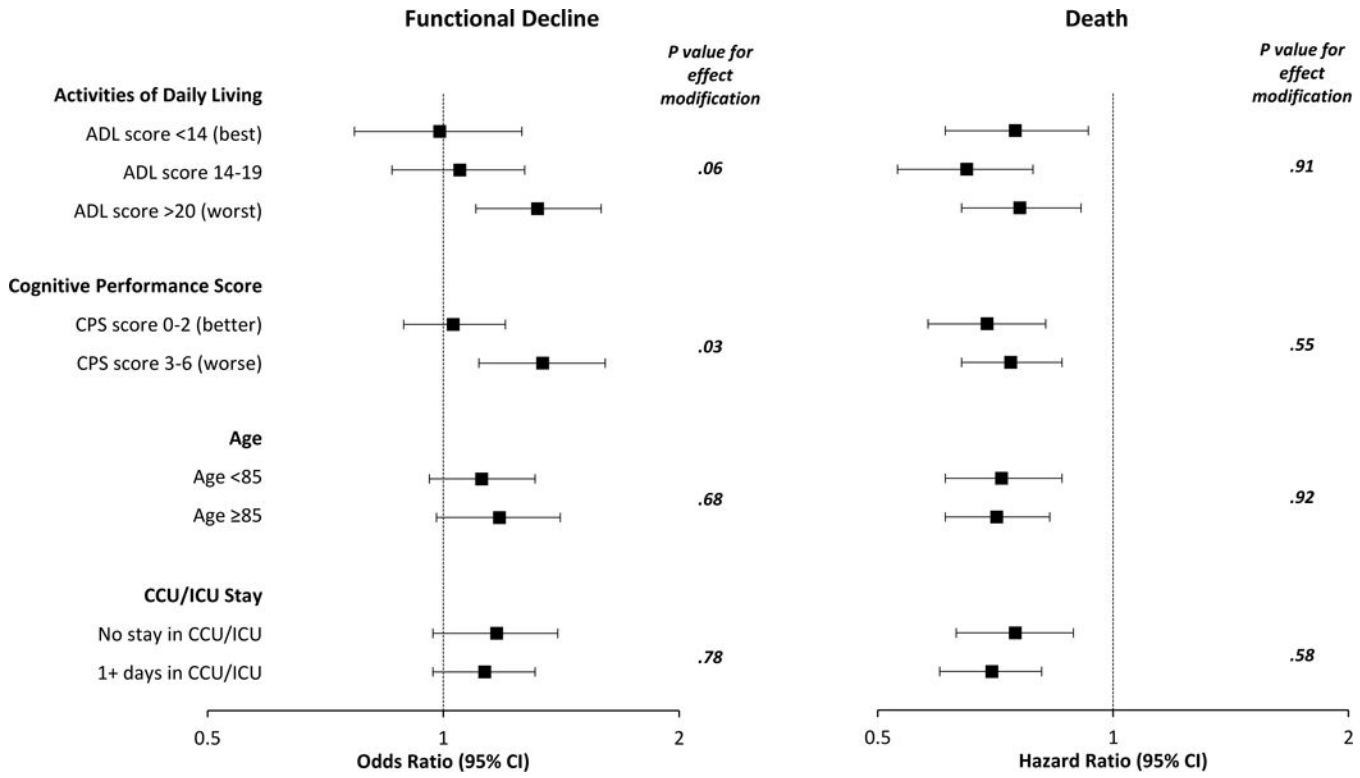

Figure 2. Impact of beta blockers on functional decline and death: subgroup analyses

P values show the significance of effect modification on the multiplicative scale. Values for additive effect modification are as follows, and are expressed as relative excess risk due to interaction (RERI). For the outcome of functional decline, RERI (95% CI) for moderate ADL dependence is 0.11 (−0.36 to 0.58), P=0.65 and for high ADL dependence is 0.66 (0.20 to 1.13), p<0.01, indicating positive additive interaction for high ADL dependence; RERI (95% CI) for worse cognitive performance score is 0.08 (−0.12 to 0.29), P=.42; RERI (95% CI) for higher age is −0.14 (−0.38 to 0.11), P=.27; RERI (95% CI) for ICU/CCU stay is −0.03 (−0.29 to 0.24), P=0.85. For the outcome of death, RERI (95% CI) for moderate ADL dependence is −0.35 (−0.70 to 0.01), P=0.05, indicating potential negative additive interaction, and for higher ADL dependence is −0.19 (−0.54 to 0.17), p=0.31; RERI (95% CI) for worse cognitive performance score is −0.15 (−0.42 to 0.12), P=.29; RERI (95% CI) for higher age is 0.00 (−0.21 to 0.22), P=.97; RERI (95% CI) for ICU/CCU stay is −0.05 (−0.26 to 0.14), P=0.60.

*ADL score <14 corresponds to independence or requiring limited assistance with ADLs; ADL score 14–19 corresponds to requiring extensive assistance; and ADL score 20 or above corresponds to extensive dependence on others to perform ADLs.

*CPS score 0–2 corresponds to normal to mildly impaired cognition including mild dementia. CPS score 3–6 corresponds to moderate or severe cognitive impairment (roughly equivalent to a Folstein Mini Mental State Exam score of 14/30 or lower).

Table 1

Characteristics of beta blocker users and non-users: before and after propensity score-based matching

Characteristic	n (%)			
	Before matching (original cohort)		After matching (analytic cohort)	
	Beta blocker users (N=8,953)	Beta blocker non-users (N= 6,767)	Beta blocker users (N=5,496)	Beta blocker non-users (N=5,496)
Age, mean (SD) years	83 (8)	84 (8)	84 (8)	84 (8)
Female sex	6,304 (70.4)	4,836 (71.5)	3,901 (71.0)	3,887 (70.7)
Race				
Caucasian	7,232 (80.8)	5,597 (82.7)	4,485 (81.6)	4,497 (81.8)
African-American	1,158 (12.9)	756 (11.2)	644 (11.7)	646 (11.8)
Other	563 (6.3)	414 (6.1)	367 (6.7)	353 (6.4)
Chronic conditions				
Diabetes	2,855 (31.9)	1,942 (28.7)	1,567 (28.5)	1,582 (28.8)
Heart failure	4,534 (50.6)	3,051 (45.1)	2,554 (46.7)	2,562 (46.6)
COPD	2,218 (24.8)	1,942 (28.7)	1,498 (27.3)	1,504 (27.4)
Depression	1,101 (12.3)	838 (12.4)	660 (12.0)	622 (11.3)
Elixhauser comorbidity score, median, (IQR)	3 (2–4)	3 (2–4)	3 (2–4)	3 (2–4)
ADL status prior to hospitalization *				
Independent to limited assistance required	3,054 (34.1)	2,347 (34.7)	1,834 (33.4)	1,866 (34.0)
Extensive assistance required	3,050 (34.1)	2,188 (32.3)	1,801 (32.8)	1,778 (32.4)
Extensive dependency	2,849 (31.8)	2,232 (33.0)	1,861 (33.9)	1,852 (33.7)
Cognitive status prior to hospitalization *				
Intact or borderline intact	2,790 (31.2)	1,961 (29.0)	1,580 (28.8)	1,585 (28.8)
Mild to moderate dementia	4,609 (51.5)	3,505 (51.8)	3,294 (59.9)	3,305 (60.1)
Moderately severe to very severe dementia	1,554 (17.4)	1,301 (19.2)	622 (11.3)	606 (11.0)
CHESS score prior to hospitalization, mean (SD)	0.6 (0.8)	0.6 (0.8)	0.6 (0.8)	0.6 (0.8)
Symptoms, geriatric prior to hospitalization				
Dizziness, vertigo, or syncope	103 (1.2)	82 (1.2)	54 (1.0)	55 (1.0)
Falls	1,843 (20.6)	1,515 (22.4)	1,193 (21.7)	1,187 (21.6)
Dyspnea	621 (6.9)	645 (9.5)	461 (8.4)	455 (8.3)
Number of medications prior to hospitalization	11 (8–15)	12 (9–15)	11 (8–15)	12 (8–15)
Medication use prior to hospitalization *				
Statins	2,584 (28.9)	1,944 (28.8)	1,559 (28.4)	1,580 (28.8)
Antiplatelets	1,453 (16.2)	1,165 (17.2)	914 (16.6)	916 (16.7)

Characteristic	n (%)			
	Before matching (original cohort)		After matching (analytic cohort)	
	Beta blocker users (N=8,953)	Beta blocker non-users (N= 6,767)	Beta blocker users (N=5,496)	Beta blocker non-users (N=5,496)
Warfarin	992 (11.1)	938 (13.9)	707 (12.9)	723 (13.2)
Psychotropics	5,400 (60.3)	4,367 (64.5)	3,547 (64.5)	3,482 (63.4)
Length of hospital stay for AMI, median (IQR) days	6 (4–9)	6 (4–9)	6 (4–9)	6 (4–9)
Number of days in ICU / CCU				
None	3,385 (37.8)	3,277 (48.4)	2,374 (43.2)	2,361 (43.0)
1 to 2	2,425 (27.1)	1,589 (23.5)	1,376 (25.0)	1,396 (25.4)
3 or more	3,143 (35.1)	1,901 (28.1)	1,746 (31.8)	1,739 (31.6)
Nursing home care pathway after hospitalization				
Skilled nursing facility (SNF) benefit	6,714 (75.0)	4,569 (67.5)	3,894 (70.9)	3,867 (70.4)
Long-term care	2,239 (25.0)	2,198 (32.5)	1,602 (29.2)	1,629 (29.6)
Nursing Home Facility Characteristics				
Ownership				
For profit	6,488 (72.5)	4,909 (72.5)	4,019 (73.1)	3,991 (72.6)
Non-profit	1,983 (22.2)	1,451 (21.4)	1,151 (20.9)	1,195 (21.7)
Government	482 (5.4)	407 (6.0)	326 (5.9)	310 (5.6)
Size				
<100 beds	1,375 (15.4)	871 (12.9)	1,535 (27.9)	1,521 (27.7)
100–200 beds	5,258 (58.7)	3,951 (58.4)	3,206 (58.3)	3,220 (58.6)
>200 beds	2,320 (25.9)	1,945 (28.7)	755 (13.7)	755 (13.7)
Quality indicators				
% of residents restrained, median (IQR)	2.8 (0–6.5)	3.1 (0.4–6.9)	2.9 (0.4–6.6)	3.0 (0.3–6.7)
No. of quality-of-life deficiencies, mean (SD)	0.73 (1.1)	0.74 (1.1)	0.73 (1.0)	0.75 (1.1)
% of residents with pressure sores, mean (SD)	7.2 (4.5)	7.0 (4.3)	7.1 (4.6)	7.0 (4.3)
Staffing				
Direct care hours/resident/day, mean (SD)	3.4 (0.8)	3.4 (0.8)	3.4 (0.7)	3.4 (0.8)

*ADL status was measured by the Morris 28-point ADL score, and categorized as 0–14 (independent to limited assistance required), 15–19 (extensive assistance required), and ≥20 (extensive dependency). Cognitive status was measured by Cognitive Performance Scale (CPS) and trichotomized as 0–1 (intact to borderline intact), 2–3 (mild to moderate dementia), and 4–6 (moderately-severe to very severe dementia). Psychotropics include antidepressants, antipsychotics, antianxiety medications, and sedative/hypnotics.

Table 2

Impact of beta blockers on functional decline, death, and rehospitalization

Outcome	Odds Ratio / Hazard Ratio for beta blocker users vs. non-users* (95% CI)	Number needed to treat (NNT) / number needed to harm (NNH) (95% CI)
Functional decline	1.14 (1.02 – 1.28)	NNH 52 (32 – 141)
Death	0.74 (0.67 – 0.83)	NNT 26 (19 – 39)
Re-hospitalization	1.06 (0.98 – 1.14)	NNH 82 (NNH 250 to ∞ to NNT 36)†

NNH = number needed to harm; NNT = number needed to treat. NNH and NNT calculated as 1/(control event rate – intervention event rate).

*Odds ratio for functional decline; hazard ratio for death and re-hospitalization

†Non-significant NNH / NNT, expressed in format recommended by Altman (1998)