ORIGINAL RESEARCH

Healthcare Utilization and Statin Re-Initiation Among Medicare Beneficiaries With a History of Myocardial Infarction

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Background—Contact with the healthcare system represents an opportunity for individuals who discontinue statins to re-initiate treatment. To help identify opportunities for healthcare providers to emphasize the risk-lowering benefits accrued through restarting statins, we determined the types of healthcare utilization associated with statin re-initiation among patients with history of a myocardial infarction.

Methods and Results—Medicare beneficiaries with a statin pharmacy fill claim within 30 days of hospital discharge for a myocardial infarction in 2007 to 2012 (n=158 795) were followed for 182 days postdischarge to identify treatment discontinuation, defined as 60 continuous days without statins (n=24 461). Re-initiation was defined as a statin fill within 365 days of the discontinuation date (n=13 136). Using a case-crossover study design and each beneficiary as their own control, healthcare utilization during 0 to 14 days before statin re-initiation (case period) was compared with healthcare utilization 30 to 44 days before statin re-initiation (control period). The mean age of beneficiaries was 75.4 years; 52.8% were women and 81.9% were white. For routine healthcare utilization, the odds ratio (95% confidence interval) for statin re-initiation associated with lipid panel testing was 2.65 (1.93–3.65), outpatient primary care was 1.31 (1.23–1.40), and outpatient cardiologist care was 1.38 (1.28–1.50). For acute healthcare utilization, the odds ratio (95% confidence interval) for statin re-initiation associated with emergency department visits was 1.77 (1.31–2.40), coronary heart disease (CHD) hospitalizations was 3.16 (2.41–4.14) and non–coronary heart disease hospitalizations was 1.73 (1.49–2.01).

Conclusions—The weaker association of routine versus acute healthcare utilization with statin re-initiation suggests missed opportunities to reinforce the importance of statin therapy for secondary prevention. **(*J Am Heart Assoc*. 2018;7:e008462. DOI: 10.1161/JAHA.117.008462.)**

Key Words: case-crossover • discontinuation • re-initiation • statin • statin discontinuation • statin re-initiation

Randomized controlled trials have demonstrated that statins reduce the risk of recurrent coronary heart disease (CHD). This has led to guidelines that recommend statin therapy for patients with a history of CHD.[1–4] While statin use for secondary prevention of CHD among adults aged ≥65 years old increased between 2002 and 2003 and 2012 and 2013,[5] it is commonly reported that >25% of patients discontinue this treatment within 1 year.[6–8] However, many patients who discontinue statins frequently re-initiate therapy.[9–11] Among Medicare beneficiaries who discontinued statin treatment following a myocardial infarction, 53.7% re-initiated therapy within 1 year.[12]

Data from patients in Canada in the late 1990s and early 2000s indicate that healthcare utilization including lipid panel

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Accompanying Data S1 and Tables S1 through S9 are available at http://jaha.ahajournals.org/content/7/10/e008462/DC1/embed/inline-supplementary-material-1.pdf

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Clinical Perspective

What Is New?

- Among Medicare beneficiaries who had a history of myocardial infarction and who discontinued statins, recent healthcare utilization was associated with statin re-initiation.
- The types of healthcare utilization most strongly associated with statin re-initiation were coronary heart disease hospitalizations followed by lipid panel testing, emergency department visits, and noncoronary heart disease hospitalizations.
- Outpatient primary care and cardiology office visits were also associated with statin re-initiation, but associations of office visits with statin re-initiation were weaker than associations with acute care.

What Are the Clinical Implications?

- Among patients who discontinue treatment, contact with the health system and healthcare professionals may increase the likelihood that a patient re-initiates statin therapy.
- Opportunities exist to emphasize the importance of continued statin treatment at routine healthcare encounters.

testing and visiting the physician who initially prescribed their statin was associated with treatment re-initiation.[10] Contemporary US-based data on healthcare encounters associated with re-initiating statins are limited. Determining whether statins are re-initiated following specific types of healthcare encounters may identify opportunities to reinforce the importance of statin therapy for secondary prevention. In the current study, we identified healthcare utilization associated with statin re-initiation among Medicare beneficiaries who were hospitalized for a myocardial infarction (MI) and had discontinued treatment.[13,14]

Methods

Data used in this study are available from the Centers for Medicare and Medicaid Services. Other study information is available from the corresponding author.

Study Population

We conducted a case-crossover study of Medicare beneficiaries with a history of MI who discontinued and subsequently re-initiated statin therapy. Medicare is a federal health insurance program that covers adults aged 65 years and older as well as younger adults with disabilities or end-stage renal disease in the United States. We identified all beneficiaries with a hospitalization claim for a MI between January 1, 2007 and December 31, 2012 (n=918 464). MI hospitalizations were identified using the *International Classification of Disease, Ninth Revision* (*ICD-9*) coding system (410.xx in any discharge diagnosis position except 410.x2, which indicates a subsequent episode of care) from Medicare Part A in-hospital claims.[15] We restricted analyses to beneficiaries who had consistent demographic information, were ≥66 and <110 years of age, had Medicare Part A (in-hospital), Part B (outpatient), and Part D (pharmacy) coverage without Part C (Medicare Advantage) coverage and were alive at least 730 days following hospital discharge for a MI (Figure 1). We excluded beneficiaries <66 years of age because Medicare beneficiaries <65 years of age represent a select population with disabilities or end-stage renal disease and we used a 1-year baseline period to assess covariates. We excluded beneficiaries with inconsistent demographic data because this suggests that multiple individuals were linked to the same beneficiary identification number. Additionally, beneficiaries were required to live in the United States from 365 days before admission for their MI through 730 days postdischarge, not to have hospice care from 365 days before their MI hospitalization through 730 days postdischarge, and not to have skilled nursing facility care from MI discharge through 730 days postdischarge. We excluded beneficiaries who received hospice or skilled nursing facility care because there are gaps in the prescription claims during these periods. We also excluded beneficiaries who did not fill a statin prescription within 30 days following hospital discharge for MI. Each patient's first eligible inpatient MI hospitalization claim was defined as their index MI. After these criteria were applied, the study population included 158 795 beneficiaries.[12]

Beneficiaries were followed to identify statin discontinuation within 182 days postdischarge for their index MI hospitalization. Discontinuation of statin therapy was defined as having a 60-day continuous period with no statin supply. The date that a beneficiary had 60 continuous days with no days of supply for statins was assigned as their discontinuation date. Statin pills remaining from prescriptions filled before the MI hospital admission were included in a beneficiary's statin supply following hospital discharge. Additionally, if a beneficiary had statin pills remaining from a prescription when a refill occurred, the existing statin supply was added to the new statin fill. Statin re-initiation was evaluated during the 365 days following the discontinuation date. Beneficiaries who had a Part D claim for a statin during this period were categorized as having re-initiated statins. Of the 158 795 Medicare beneficiaries who met the inclusion criteria and filled a statin prescription within 30 days of discharge for their index MI, 24 461 (15.4%) beneficiaries discontinued treatment for at least 60 continuous days in the 182 days

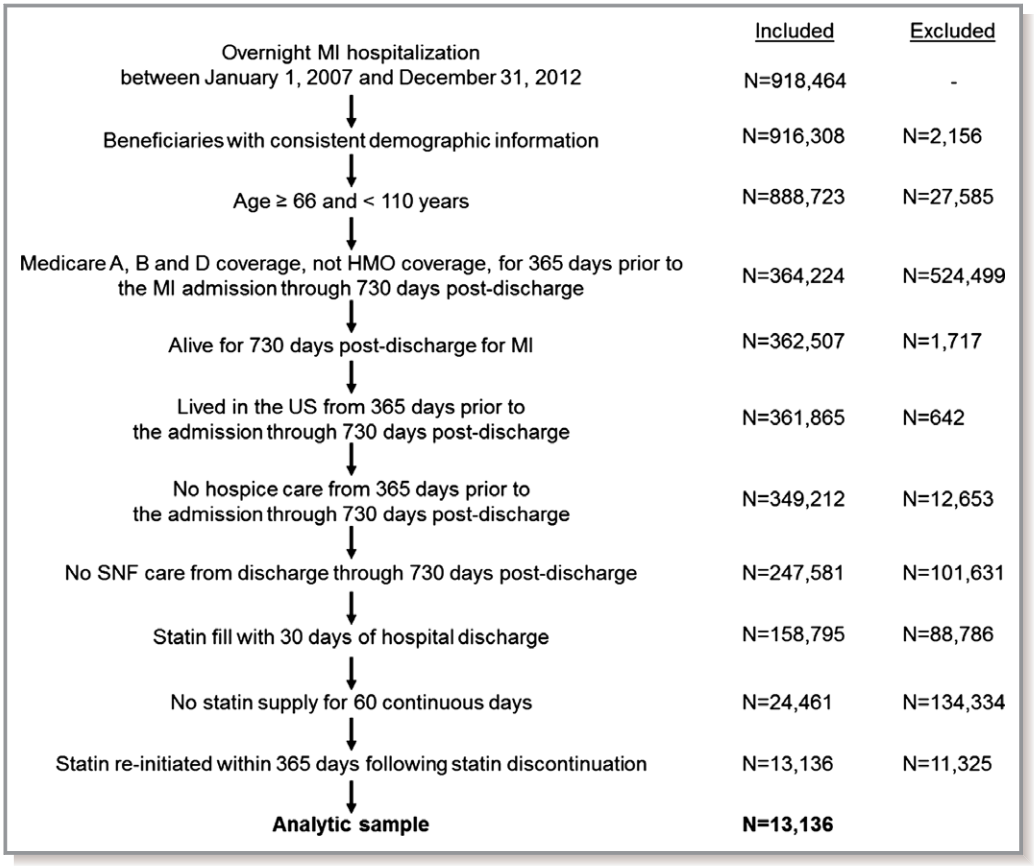

Figure 1. Flow chart describing identification of Medicare beneficiaries with a MI hospitalization and who re-initiated statins. HMO indicates Medicare Part C; MI, myocardial infarction; SNF, skilled nursing facility; US, United States.

postdischarge (Figure 2). Analyses included the 13 136 (53.7%) beneficiaries who re-initiated statins in the 365 days following their date of discontinuation. The University of Alabama at Birmingham Institutional Review Board governing human subject research and the Centers for Medicare and Medicaid Services Privacy Board approved the study. The requirement for informed consent was waived.

Case-Crossover Study Design

A case-crossover study design is an efficient and effective method for evaluating whether a transient exposure is associated with an acute outcome (Figure 2).[16] The current analysis assessed the exposures of lipid panel testing, outpatient care visits, and acute care visits with the outcome

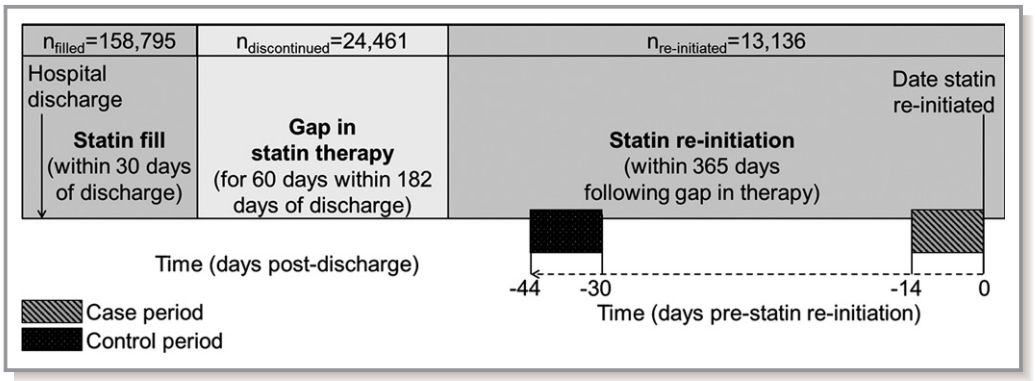

Figure 2. Study design schematic. Using the case-crossover study design, each beneficiary who re-initiated statin therapy within 365 days of discontinuation was their own control. For the primary analysis, healthcare utilization (exposure) during the 0 to 14 days before statin re-initiation (case period) was compared with healthcare utilization 30 to 44 days before statin re-initiation (control period).

of statin re-initiation. Because exposure information for each beneficiary at the time of statin re-initiation is compared with his/her own prior exposure experience, each person is their own control. This self-matching eliminates confounding by risk factors that do not change over the study period within individuals but differ between individuals (eg, sex, obesity, socioeconomic status).[17] In the primary analysis, the case and control periods included the 14 days and 30 to 44 days before statin re-initiation, respectively. A sensitivity analysis was performed using the 7 days and 30 to 37 days before statin re-initiation for the case and control periods, respectively.

Beneficiary Characteristics

Medicare beneficiaries' demographics (age, race/ethnicity, sex, low-income subsidy, area-level median income), characteristics before the index MI hospitalization (cardiologist care, diabetes mellitus, stroke, chronic kidney disease, heart failure, CHD, statin use and nonstatin lipid-lowering medication use), characteristics during the MI hospitalization (length of hospitalization, coronary stent insertion, newly diagnosed heart failure, diabetes mellitus, or chronic kidney disease), characteristics following the MI hospitalization (initial statin intensity filled, last intensity filled before discontinuation) and the index hospitalization admission and discharge dates were assessed using enrollment and claims data.

Age at the time of index MI hospitalization, discharge was categorized as 66 to 69, 70 to 74, 75 to 79, 80 to 84, and ≥85 years old. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, Asian, and Other. Low-income status was defined by receipt of a low-income subsidy for Part D or dual Medicare/Medicaid eligibility in the 365-day baseline period or 182 days following hospital discharge. Area-level median income, derived from zip codes linked to US Census data, was categorized into quartiles. Diabetes mellitus, stroke, chronic kidney disease, heart failure, CHD, statin use, and nonstatin lipid-lowering medication use before the MI hospitalization were defined as having diagnosis codes for these health problems or a claim filed in the 365 days before the admission date. New diagnoses of diabetes mellitus, chronic kidney disease, and heart failure, defined as having a diagnosis code for these health problems on the same claim as the index MI hospitalization, were determined among beneficiaries without prior evidence of each specified condition. Detailed definitions are provided in Data S1. Length of hospitalization was calculated as the difference in days between the hospital discharge and admission dates.

Statin intensity was categorized as low, moderate, and high consistent with the 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults.[1] We categorized statin intensity using the first statin filled within 30 days of hospital discharge and, separately, the last statin filled before discontinuation.

Primary Exposures

We assessed claims for lipid panel testing, outpatient primary care visits, outpatient cardiologist care, and emergency department visits during the case and control periods for each beneficiary. We also assessed claims for non-CHD and CHD hospitalizations with discharge dates during these periods. We grouped the lipid panel testing, outpatient primary care visits, and outpatient cardiologist care visits as routine healthcare utilization and emergency department visits and CHD and non-CHD hospitalizations as acute healthcare utilization. The diagnosis and procedure codes used to define these types of healthcare utilization are provided in Data S1.

Statistical Analysis

Summary statistics comparing demographic factors among Medicare beneficiaries with MI and included and excluded from the current study were calculated as frequencies and percentages for categorical variables and mean and SD for continuous variables. Beneficiary characteristics before, during, and after the MI hospitalization were also described using frequencies and percentages for categorical variables and mean and SD or median with 25th and 75th percentiles for continuous variables among those included in the study population. Conditional logistic regression was used to calculate the odds ratio (OR) and 95% confidence interval (CI) for statin re-initiation associated with the occurrence of each exposure, including lipid panel testing, outpatient primary care visits, outpatient cardiologist care visits, emergency department visits, non-CHD hospitalization, and CHD hospitalization, during the 14 days (case period) compared with 30 to 44 days (control period) before statin re-initiation. This is the standard approach for matched case–control studies, except instead of case participants matched to control participants, the case and control periods were paired within the same Medicare beneficiary.[17] ORs were calculated for the overall population and within subgroups defined by history of statin use before the index MI hospitalization, race/ethnicity, age (<75 and ≥75 years old), sex, and statin intensity discontinued. For assessing the statistical significance of differences in associations between healthcare utilization and statin re-initiation across subgroups, models were conducted using a main effects indicator variable for the healthcare utilization factors (eg, lipid panel) and a product term between the healthcare utilization factor and subgroup (eg, lipid panel*age group). The main effect term for the subgroup (eg, age group) was not included because it did not

vary between the case and control periods. In a sensitivity analysis, the models described above were repeated for healthcare utilization during the 7 days (case period) compared with 30 to 37 days (control period) before statin re-initiation. $P \leq 0.05$ were considered statistically significant. Analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Characteristics of Medicare Beneficiaries Who Re-Initiated Statins

Beneficiaries who met all study inclusion criteria were younger and less likely to have low-income Part D subsidy than those who were excluded (Table S1). Beneficiaries who re-initiated statins had an average age of 75.4 years, 52.8% were women, and 81.9% were non-Hispanic white (Table 1). Before the MI hospitalization, 37.2% of beneficiaries had a history of diabetes mellitus and 52.6% had a history of CHD. Statin and nonstatin lipid-lowering medications were being used before the index MI hospitalization by 50.9% and 15.0% of beneficiaries, respectively. The median length of MI hospitalization was 5 days. Overall, 60.2% of beneficiaries initially filled a moderate-intensity statin within 30 days postdischarge, and 32.9% initially filled a high-intensity statin. Also, 7.1%, 60.5%, and 32.4% of beneficiaries' last fill before discontinuation was for a low-, moderate-, and high-intensity dosage, respectively.

Healthcare Utilization and Statin Re-Initiation

In the 2 weeks before statin re-initiation, 1.1% of beneficiaries had claims for lipid panel testing, 21.9% had claims for outpatient primary care visits, 13.4% had claims for outpatient cardiology visits, 0.9% had claims for emergency department visits, 1.7% had claims for CHD hospitalizations, and 3.9% had claims for non-CHD hospitalizations. Comparing routine healthcare utilization during the 0 to 14 days (case period) with 30 to 44 days (control period) before statin re-initiation, the odds ratio (95% CI) for statin re-initiation associated with lipid panel testing was 2.65 (1.93–3.65), outpatient primary care was 1.31 (1.23–1.40), and outpatient cardiologist care was 1.38 (1.28–1.50). The OR (95% CI) for statin re-initiation associated with emergency department visits was 1.77 (1.31–2.40), CHD hospitalization was 3.16 (2.41–4.14), and non-CHD hospitalization was 1.73 (1.49–2.01) comparing these acute healthcare utilization during the 0 to 14 days (case period) with 30 to 44 days (control period) before statin re-initiation (Table 2, top panel). These healthcare utilization factors were associated with statin re-initiation among those who were not taking (Table 2, middle panel) and taking (Table 2, bottom panel) a statin before their index MI hospitalization. Associations of statin re-initiation with outpatient cardiologist care visits (P-interaction=0.012) and emergency department visits (P-interaction=0.035) were stronger for beneficiaries who were not taking a statin compared with beneficiaries taking a statin before their index MI hospitalization. Also, the OR between non-CHD hospitalization and statin re-initiation varied by race/ethnicity (OR [95% CI]: non-Hispanic white: 1.53 [1.29–1.82], non-Hispanic black: 2.72 [1.81–4.08], Asian: 1.46 [0.72–2.96], Hispanic: 2.33 [0.90–6.07], Other: 4.20 [1.58–11.14]; P-interaction=0.033; Table S2). The ORs for the association between healthcare utilization and statin re-initiation were not statistically significantly different across strata of age, sex, and statin intensity discontinued (all P-interactions>0.05; Tables S3 through S5, respectively).

In the sensitivity analysis, lipid panel testing comparing 0 to 7 days (case period) with 30 to 37 days (control period), outpatient primary care visits, outpatient cardiologist care visits, emergency department visits, and CHD and non-CHD hospitalizations were associated with statin re-initiation (Table 3, top panel). Outpatient cardiologist visit (P-interaction=0.008) and CHD hospitalization (P-interaction=0.046) had stronger associations with statin re-initiation in beneficiaries without compared with prior statin use (Table 3, middle and bottom panels). The association between non-CHD hospitalization and statin re-initiation was the only healthcare utilization factor that differed by race/ethnicity (OR [95% CI]: non-Hispanic white: 2.24 [1.78–2.82], non-Hispanic black: 4.79 [2.69–8.51], Asian: 1.20 [0.52–2.78], Hispanic: not reported since the exposure was not present in the control period, Other: 8.00 [1.84–34.79]; P-interaction=0.026; Table S6). There were no statistically significant differences in healthcare utilization associated with statin re-initiation among beneficiaries grouped by age, sex, and statin intensity discontinued (all P-interactions>0.05; Tables S7 through S9, respectively).

Discussion

Recent healthcare utilization including lipid panel testing, outpatient primary care visits, outpatient cardiologist care visits, emergency department visits, and CHD and non-CHD hospitalizations were each associated with statin re-initiation. The strongest associations for statin re-initiation were with CHD hospitalizations followed by lipid panel testing, emergency department visits, and non-CHD hospitalizations; outpatient primary care and cardiology office visits were the most common healthcare encounters and had weaker associations with statin re-initiation. However, among those who re-initiated statin therapy, less than half had a claim for any healthcare encounters during the 2 weeks preceding statin re-initiation.

Table 1. Characteristics of Medicare Beneficiaries With a MI Hospitalization in 2007–2012 Who Filled a Statin Following Discharge, Discontinued Therapy for 60 Continuous Days, and Re-Initiated Statin Medication Within 365 Days Following Discontinuation

Characteristic	N=13 136
Demographic information	
Age at admission, mean (SD) (y)	75.4 (6.8)
66–69	3120 (23.8%)
70–74	3594 (27.4%)
75–79	2813 (21.4%)
80–84	2122 (16.2%)
≥85	1487 (11.3%)
Female	6942 (52.8%)
Race/ethnicity	
Non-Hispanic white	10 764 (81.9%)
Non-Hispanic black	1271 (9.7%)
Asian	309 (2.4%)
Hispanic	461 (3.5%)
Other	331 (2.5%)
Low-income Part D subsidy	4994 (38.0%)
Area-level median income (quartiles)	
<$28 606	2935 (22.3%)
≥$28 606 and <$37 257	3026 (23.0%)
≥$37 257 and <$50 326	3125 (23.8%)
≥$50 326	3201 (24.4%)
No information	849 (6.5%)
Characteristics before the MI hospitalization	
Cardiologist care	5112 (38.9%)
Diabetes mellitus	4892 (37.2%)
Stroke	604 (4.6%)
Chronic kidney disease	2234 (17.0%)
Heart failure	2489 (18.9%)
Coronary heart disease	6906 (52.6%)
Statin use	6687 (50.9%)
Statin intensity	
None	6449 (49.1%)
Low	619 (4.7%)
Moderate	4467 (34.0%)
High	1601 (12.2%)
Nonstatin lipid-lowering medication use	
Any	1976 (15.0%)
Ezetimibe	1033 (7.9%)
Bile acid sequestrant	188 (1.4%)
Niacin	228 (1.7%)
Fibrate	722 (5.5%)
Characteristics during the MI hospitalization	
Length of hospitalization (d)	5.0 (3.0, 8.0)
Coronary stent insertion	6017 (45.8%)
Newly diagnosed heart failure	1962 (14.9%)
Newly diagnosed diabetes mellitus	506 (3.9%)
Newly diagnosed chronic kidney disease	938 (7.1%)
Characteristics following the MI hospitalization	
Intensity of first statin filled postdischarge	
Low	902 (6.9%)
Moderate	7907 (60.2%)
High	4327 (32.9%)
Intensity of last statin filled before discontinuation	
Low	930 (7.1%)
Moderate	7950 (60.5%)
High	4256 (32.4%)

Numbers in the table are number (percentage) or mean (SD), except length of hospitalization, which is median (25th percentile, 75th percentile). MI indicates myocardial infarction.

Statin treatment is a highly effective secondary prevention approach for reducing cardiovascular disease risk. A systematic review of 92 randomized controlled trials reported 23% to 38% lower odds of a major coronary event and 10% to 25% reduction in the odds of all-cause mortality among participants with history of cardiovascular disease who were randomized to statin therapy versus placebo.[18] However, statin discontinuation is common, with >25% of patients stopping treatment within 1 year of initiation.[8,10] Identifying factors that are associated with re-initiation in patients who discontinue therapy can help in developing approaches for increasing re-initiation rates. In turn, individuals who re-initiate treatment will continue to accrue risk reduction benefits over time. Results from the current study suggest that contact with the health system and healthcare professionals may increase the rates of statin re-initiation in those who discontinue therapy. These associations were observed for cardiovascular care (ie, outpatient cardiology visits and CHD hospitalizations) and other health system encounters (ie, outpatient primary care visits and non-CHD hospitalizations). Opportunities to emphasize the importance of continued statin treatment at routine healthcare encounters may be missed since statin re-initiation was more strongly associated with acute versus more common routine healthcare encounters, including emergency department visits and CHD and

Table 2. OR for Statin Re-Initiation Associated With Healthcare Utilization During the 0 to 14 Days Before Statin Re-Initiation (Case Period) Compared With 30 to 44 Days (Control Period) Before Statin Re-Initiation Overall (Top Panel) and by History of Statin Use Before the Index MI Hospitalization (Middle and Bottom Panels)

Type of Healthcare Utilization	Case Period N (%)	Control Period N (%)	OR (95% CI)
Overall (N=13 136)			
Lipid panel testing	138 (1.1)	52 (0.4)	2.65 (1.93, 3.65)
Outpatient primary care visit	2873 (21.9)	2378 (18.1)	1.31 (1.23, 1.40)
Outpatient cardiologist visit	1759 (13.4)	1344 (10.2)	1.38 (1.28, 1.50)
Emergency department visit	118 (0.9)	67 (0.5)	1.77 (1.31, 2.40)
CHD hospitalization	220 (1.7)	71 (0.5)	3.16 (2.41, 4.14)
Non-CHD hospitalization	514 (3.9)	312 (2.4)	1.73 (1.49, 2.01)
No history of statin use before the MI hospitalization (N=6449)			
Lipid panel testing	73 (1.1)	26 (0.4)	2.81 (1.79, 4.39)
Outpatient primary care visit	1362 (21.1)	1136 (17.6)	1.29 (1.17, 1.41)
Outpatient cardiologist visit	894 (13.9)	626 (9.7)	1.53 (1.37, 1.71)*
Emergency department visit	67 (1.0)	27 (0.4)	2.48 (1.59, 3.88)†
CHD hospitalization	126 (2.0)	32 (0.5)	4.03 (2.72, 5.97)
Non-CHD hospitalization	219 (3.4)	122 (1.9)	1.86 (1.48, 2.34)
History of statin use before the MI hospitalization (N=6687)			
Lipid panel testing	65 (1.0)	26 (0.4)	2.50 (1.59, 3.94)
Outpatient primary care visit	1511 (22.6)	1242 (18.6)	1.33 (1.22, 1.46)
Outpatient cardiologist visit	865 (12.9)	718 (10.7)	1.25 (1.12, 1.40)*
Emergency department visit	51 (0.8)	40 (0.6)	1.28 (0.84, 1.95)†
CHD hospitalization	94 (1.4)	39 (0.6)	2.45 (1.68, 3.57)
Non-CHD hospitalization	295 (4.4)	190 (2.8)	1.64 (1.35, 2.00)

CHD indicates coronary heart disease; CI, confidence interval; MI, myocardial infarction; OR, odds ratio.
†Indicates that the association of emergency department visit (exposure) with statin re-initiation (outcome) differs by history of statin use before the MI hospitalization (P=0.035).

non-CHD hospitalizations. Future studies should investigate approaches for incorporating patient counseling during routine care visits on the accrual of risk reduction benefits with statins.

Statin re-initiation following discontinuation was common in this population of Medicare beneficiaries. In those who had a MI between 2007 and 2012 and filled a statin within 30 days of their hospital discharge (n=158 795), 15.4% discontinue treatment within 6 months.[12] Among this group who discontinue treatment, 53.7% re-initiated statins within 1 year,[12] suggesting that many individuals who discontinue will re-initiate statins following discontinuation. However, for many individuals it remains unclear why statins were re-initiated, since fewer than half of beneficiaries in the current study had a healthcare encounter in the 14 days before re-initiation.

Several studies have characterized the problem of statin discontinuation by identifying subgroups of patients who are at high risk for discontinuing treatment.[14,19–22] Few studies have described opportunities to re-initiate statins. Brookhart et al conducted a case-crossover study using data from 1997 through 2004 to investigate healthcare utilization associated with statin re-initiation in 129 167 new statin users from British Columbia, Canada who discontinued treatment for at least 90 days. Treatment was re-initiated in 48.0% of these individuals within 365 days of discontinuation.[10] Visiting the physician who wrote the patient's first statin prescription or another physician, lipid panel testing, and incident MI and other cardiovascular disease–related hospitalizations were strongly associated with statin re-initiation.[10] The current results are consistent with these previous findings and extend them by presenting contemporary data in a secondary prevention population and in subgroups defined by history of statin use before the MI hospitalization, race/ethnicity, age, sex, and statin intensity discontinued. The differences in statin re-initiation by history of statin use before the MI

Table 3. OR for Statin Re-Initiation Associated With Healthcare Utilization During the 0 to 7 Days Before Statin Re-Initiation (Case Period) Compared With Healthcare Utilization 30 to 37 Days (Control Period) Before Statin Re-Initiation Overall (Top Panel) and by History of Statin Use Before the Index MI Hospitalization (Middle and Bottom Panels)

Type of Healthcare Utilization	Case Period N (%)	Control Period N (%)	OR (95% CI)
Overall (N=13 136)			
Lipid panel testing	106 (0.8)	31 (0.2)	3.42 (2.29, 5.10)
Outpatient primary care visit	1731 (13.2)	1296 (9.9)	1.43 (1.32, 1.55)
Outpatient cardiologist visit	1075 (8.2)	668 (5.1)	1.68 (1.52, 1.86)
Emergency department visit	106 (0.8)	44 (0.3)	2.44 (1.71, 3.48)
CHD hospitalization	168 (1.3)	36 (0.3)	4.77 (3.31, 6.87)
Non-CHD hospitalization	351 (2.7)	143 (1.1)	2.60 (2.12, 3.18)
No history of statin use before the MI hospitalization (N=6449)			
Lipid panel testing	54 (0.8)	13 (0.2)	4.15 (2.27, 7.61)
Outpatient primary care visit	819 (12.7)	620 (9.6)	1.39 (1.24, 1.56)
Outpatient cardiologist visit	574 (8.9)	313 (4.9)	1.93 (1.67, 2.22)*
Emergency department visit	58 (0.9)	18 (0.3)	3.22 (1.90, 5.47)
CHD hospitalization	99 (1.5)	15 (0.2)	7.00 (4.00, 12.25)†
Non-CHD hospitalization	151 (2.3)	53 (0.8)	2.96 (2.15, 4.08)
History of statin use before the MI hospitalization (N=6687)			
Lipid panel testing	52 (0.8)	18 (0.3)	2.89 (1.69, 4.94)
Outpatient primary care visit	912 (13.6)	676 (10.1)	1.46 (1.31, 1.64)
Outpatient cardiologist visit	501 (7.5)	355 (5.3)	1.46 (1.27, 1.68)*
Emergency department visit	48 (0.7)	26 (0.4)	1.88 (1.16, 3.05)
CHD hospitalization	69 (1.0)	21 (0.3)	3.29 (2.02, 5.36)†
Non-CHD hospitalization	200 (3.0)	90 (1.4)	2.37 (1.83, 3.08)

CHD indicates coronary heart disease; CI, confidence interval; MI, myocardial infarction; OR, odds ratio.
*Indicates that the association of outpatient cardiologist care visit (exposure) with statin re-initiation (outcome) differs by history of statin use before the MI hospitalization (P=0.008).
†Indicates that the association of coronary heart disease hospitalization (exposure) with statin re-initiation (outcome) differs by history of statin use before the MI hospitalization (P=0.050).

hospitalization and race/ethnicity help to identify specific populations to direct resources for increasing statin re-initiation.

The national sample of older US adults provides sufficient sample size to examine important subgroups (ie, history of statin use before a MI hospitalization, race/ethnicity, age, sex, statin intensity discontinued). Medicare beneficiaries who did not have full fee-for-service coverage and were less healthy (eg, those who died following MI and those in skilled nursing care) were excluded from the current analyses. Although the inclusion criteria resulted in a selected population, this allowed us to focus on the individuals likely to benefit from statin re-initiation. The case-crossover design permitted assessment of exposures that precipitated statin re-initiation. Confounding by unmeasured patient-level characteristics that do not change over time was accounted for using the self-controlled case-crossover design. However, unmeasured time-varying factors may have confounded the results. For example, changing perception of disease risk and statin benefits may cause a person to schedule a healthcare visit, or an event that occurs outside a physician's office may lead to lipid panel testing. Other time-varying exposures, such as cognitive, behavioral, and psychosocial factors, which could motivate individuals to re-initiate statins and might confound the association between healthcare utilization and statin re-initiation, were unavailable. In addition, we could not uniquely link lipid panel testing to ambulatory or inpatient visits or types of providers. The administrative database used in the current study did not permit the assessment of reasons that a patient discontinued statins or physician involvement in the decision. Additionally, beneficiaries might have had healthcare system contact that was not reimbursable and did not result in a claim submitted to Medicare (eg, prescription refills may have been requested through a telephone call to the physician's office or through an electronic messaging system). Last, prescription refills for

which a reimbursement claim was not submitted are not present in Medicare claims.

Conclusions

Healthcare system encounters related to CHD as well as other conditions were associated with statin re-initiation among Medicare beneficiaries with history of MI. There was a weaker association of routine versus acute healthcare utilization with statin re-initiation. The current study indicates there are missed opportunities to reinforce the importance of statin therapy for secondary prevention in routine healthcare encounters.

Author Contributions

Study conception and design: Booth, Colantonio, Rosenson, Safford, Kilgore, Taylor, Dent, Monda, Muntner, Levitan; Acquisition, analysis or interpretation of data: Booth, Colantonio, Rosenson, Safford, Chen, Kilgore, Brown, Taylor, Dent, Monda, Muntner, Levitan; Statistical analysis: Booth, Chen, Levitan; Drafting of the article: Booth, Levitan; Critical revision of the article: Booth, Colantonio, Rosenson, Safford, Chen, Kilgore, Brown, Taylor, Dent, Monda, Muntner, Levitan; Chen had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Disclosures

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SUPPLEMENTAL MATERIAL

Data S1.

Supplemental Methods

Definitions for beneficiary characteristics

- History of coronary heart disease (CHD) was defined as being present if claim codes have any of the following:
  (a) Myocardial infarction (MI): ≥1 inpatient or physician evaluation and management outpatient claims containing ICD-9 diagnoses 410.x or 412.x
  (b) Revascularization: ≥1 inpatient or outpatient claim containing ICD-9 procedure codes (00.66, 36.01-36.09, 36.10-36.19 or 362) or CPT codes (92980-92982, 92984, 92995, 92996, 33510-33536 or ≥1 inpatient or outpatient claim containing ICD-9 diagnosis codes (V45.81 or V45.82)
  (c) Other CHD-related ICD-9 codes: ≥1 inpatient or physician evaluation and management outpatient claims with ICD-9 codes 411.xx, 413.xx, or 414.xx
- History of Stroke was defined as having any one of the following:
  (a) At least 1 inpatient ICD-9 diagnosis (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x
  (b) At least 1 carrier claim, carrier line or outpatient claims with ICD-9 diagnoses (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x, linked by CLAIM_ID to an ambulatory physician evaluation and management claim
  (c) At least 1 claim with ICD-9 diagnoses (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x in other file types (home health aide, durable medical equipment, hospice, skilled nursing facility)
- Diabetes was defined as having claim codes (250.xx, 357.2, 362.0x, or 366.41) with any of the following:
  (a) ≥1 inpatient file record with a discharge diagnosis of diabetes or
  (b) ≥2 outpatient claim file records with a diagnosis of diabetes, linked by beneficiary claim ID to a physician evaluation and management claim with the 2 claims occurring at least 7 days apart
  (c) ≥1 prescription drug event record for oral antidiabetic drug fills

- Newly diagnosed diabetes was defined as having a diagnosis code for diabetes on the same claim as the index MI hospitalization. Only beneficiaries without diabetes were eligible to have newly diagnosed diabetes.
- Chronic kidney disease (CKD) was defined as the presence of any of the following ICD-9 codes associated with an inpatient, skilled nursing facility or home health aide claim or an outpatient claim linked to a physician evaluation and management claim:
    (a) 250.4, Diabetes with renal manifestations
    (b) 403.x1, Hypertensive CKD
    (c) 403.x0 (after October 1, 2006), hypertensive CKD (subtypes)
    (d) 404.x2, Hypertensive heart and CKD
    (e) 404.x3, Hypertensive heart and CKD (subtypes)
    (f) 404.x0, Hypertensive heart and CKD (subtypes)
    (g) 404.x1, Benign hypertension and renal disease (after October 1, 2006)
    (h) 582.xx, Chronic glomerulonephritis
    (i) 585.1, CKD disease, Stage I
    (j) 585.2, CKD, Stage II (mild)
    (k) 585.3, CKD, Stage III (moderate)
    (l) 585.4, CKD, Stage IV (severe)
    (m) 585.5, CKD, Stage V
    (n) 585.6, End stage renal disease (ESRD)
    (o) 585.9, CKD, unspecified
    (p) 586, Renal failure, unspecified
    (q) 791.0, Proteinuria
- Newly diagnosed chronic kidney disease was defined as having a diagnosis code for CKD on the same claim as the index MI hospitalization. Only beneficiaries without CKD at the MI hospitalization were eligible to have newly diagnosed CKD.
- Heart failure (HF) was defined as ≥1 inpatient or outpatient physician evaluation an management claim with ICD-9 diagnoses (any position) of 398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, or 428.9.

- Newly diagnosed HF was defined as having a diagnosis code for HF on the same claim as the index MI hospitalization among beneficiaries without heart failure were eligible to have newly diagnosed heart failure.

Definitions for the primary exposures

Among Medicare beneficiaries hospitalized for a MI who discontinued statins for 60 continuous days, we estimated the association between six types of healthcare utilization and statin re-initiation: lipid panel testing, outpatient primary care visits, outpatient cardiologist care, emergency department visits, non-CHD hospitalization and CHD hospitalization.

Lipid panel testing was defined as an outpatient claim with Healthcare Common Procedure Coding System (HCPCS) codes 80061, 82465, 83718 or 84478.

Outpatient primary care was defined as having a claim for visiting a primary care physician (provider specialty codes 08, 11, 38, or 50, linked with a physician evaluation and management code including HCPCS codes 99024, 99058, 99429, 99499, 99201-99215, 99241-99245, 99271-99275, 99301-99337, 99341-99355, 99385-99387 or 99395-99404).

Outpatient cardiologist care was defined by having a claim for visiting a cardiologist (provider specialty code 06 linked to a physician evaluation and management code including HCPCS codes 99024, 99058, 99429, 99499, 99201-99215, 99241-99245, 99271-99275, 99301-99337, 99341-99355, 99385-99387 or 99395-99404).

Emergency department visit was defined as an outpatient claim with revenue center codes 0450-0452, 0456, 0459 or 0981 or HCPCS codes 99281-99285 or carrier line place of service code 23.

Non-CHD hospitalization was defined as having an inpatient claim with any primary ICD-9 diagnosis code other than 410, 411, 412, 413 or 414. The discharge date was required to have occurred during the case and control periods, respectively, since a statin was required to be filled post-discharge.

CHD hospitalization was defined as having an inpatient claim with primary ICD-9 diagnosis code 410, 411, 412, 413 or 414. The discharge date was required to have occurred during the case and control periods, respectively, since a statin was required to be filled post-discharge.

Table S1. Characteristics of Medicare beneficiaries included and excluded from the current analysis.

Characteristic	Analytic Sample (n=13,136)	Excluded Sample* (n=903,172)
Demographic information		
Age at admission, mean (standard deviation) years	75.4 (6.8)	79.2 (8.6)
<66	0 (0.0%)	32,062 (3.5%)
66-69	3,120 (23.8%)	118,216 (13.1%)
70-74	3,594 (27.4%)	152,681 (16.9%)
75-79	2,813 (21.4%)	160,271 (17.7%)
80-84	2,122 (16.2%)	172,334 (19.1%)
≥ 85	1,487 (11.3%)	267,608 (29.6%)
Female	6,942 (52.8%)	524,714 (58.1%)
Race/ethnicity		
Non-Hispanic White	10,764 (81.9%)	759,326 (84.1%)
Non-Hispanic Black	1,271 (9.7%)	86,829 (9.6%)
Asian	309 (2.4%)	17,275 (1.9%)
Hispanic	461 (3.5%)	23,471 (2.6%)
Other	331 (2.5%)	16,271 (1.8%)
Low income Part D subsidy	4,994 (38.0%)	432,394 (47.9%)
Area-level median income (quartiles)		
< $28,606	2,935 (22.3%)	191,237 (21.2%)
≥ $28,606 and < $37,257	3,026 (23.0%)	201,708 (22.3%)
≥ $37,257 and < $50,326	3,125 (23.8%)	217,165 (24.0%)
≥ $50,326	3,201 (24.4%)	232,007 (25.7%)
No information	849 (6.5%)	61,055 (6.8%)

Numbers in the table are number (percentage) or mean (standard deviation).

*An additional 2,156 beneficiaries were excluded because of inconsistent demographic information.

Table S2. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 14 days before statin re-initiation (case period) compared with 30 to 44 days (control period) before statin re-initiation by race / ethnicity.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Non-Hispanic White (N=10,764)	
Lipid panel testing	110 (1.0%)	46 (0.4%)	2.39 (1.70, 3.37)
Outpatient primary care visit	2,367 (22.0%)	1,933 (18.0%)	1.33 (1.24, 1.43)
Outpatient cardiologist visit	1,469 (13.7%)	1,124 (10.4%)	1.38 (1.27, 1.50)
Emergency department visit	84 (0.8%)	52 (0.5%)	1.62 (1.14, 2.28)
CHD hospitalization	171 (1.6%)	60 (0.6%)	2.88 (2.14, 3.87)
Non-CHD hospitalization	361 (3.4%)	244 (2.3%)	1.53 (1.29, 1.82)†
		Non-Hispanic Black (N=1,271)	
Lipid panel testing	*	*	3.33 (0.92, 12.11)
Outpatient primary care visit	269 (21.2%)	235 (18.5%)	1.21 (0.98, 1.48)
Outpatient cardiologist visit	134 (10.5%)	120 (9.4%)	1.14 (0.87, 1.49)
Emergency department visit	19 (1.5%)	*	6.33 (1.87, 21.4)
CHD hospitalization	26 (2.1%)	*	2.89 (1.35, 6.16)
Non-CHD hospitalization	96 (7.6%)	41 (3.2%)	2.72 (1.81, 4.08)†
		Asian (N=461)	
Lipid panel testing	*	*	4.00 (0.85, 18.84)
Outpatient primary care visit	96 (20.8%)	92 (20.0%)	1.06 (0.75, 1.51)
Outpatient cardiologist visit	68 (14.8%)	46 (10.0%)	1.56 (1.05, 2.34)
Emergency department visit	11 (2.4%)	*	1.38 (0.55, 3.42)
CHD hospitalization	*	*	-
Non-CHD hospitalization	20 (4.3%)	14 (3.0%)	1.46 (0.72, 2.96)†
		Hispanic (N=331)	
Lipid panel testing	*	*	-
Outpatient primary care visit	66 (19.9%)	57 (17.2%)	1.24 (0.81, 1.92)
Outpatient cardiologist visit	39 (11.8%)	24 (7.3%)	1.71 (1.00, 2.94)
Emergency department visit	*	*	3.00 (0.31, 28.84)
CHD hospitalization	*	*	-
Non-CHD hospitalization	14 (4.2%)	*	2.33 (0.90, 6.07)†
		Other (N=309)	
Lipid panel testing	*	*	7.00 (0.86, 56.89)
Outpatient primary care visit	75 (24.3%)	61 (19.7%)	1.37 (0.90, 2.08)
Outpatient cardiologist visit	49 (15.9%)	30 (9.7%)	2.06 (1.17, 3.61)
Emergency department visit	*	*	-
CHD hospitalization	*	*	4.00 (0.45, 35.79)
Non-CHD hospitalization	23 (7.4%)	*	4.20 (1.58, 11.14)†

CHD: coronary heart disease. *The Centers for Medicare and Medicaid Services requires cell counts of < 11 to be suppressed. †Indicates the association of the health utilization factor (exposure) with statin re-initiation (outcome) differs across race/ethnicities (p=0.033).

Table S3. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 14 days before statin re-initiation (case period) compared with 30 to 44 days (control period) before statin re-initiation by age.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Age < 75 years (N=6,714)	
Lipid panel testing	68 (1.0%)	27 (0.4%)	2.52 (1.61, 3.93)
Outpatient primary care visit	1,393 (20.8%)	1,201 (17.9%)	1.23 (1.12, 1.35)
Outpatient cardiologist visit	916 (13.6%)	680 (10.1%)	1.43 (1.28, 1.60)
Emergency department visit	57 (0.9%)	42 (0.6%)	1.36 (0.91, 2.02)
CHD hospitalization	113 (1.7%)	38 (0.6%)	2.97 (2.06, 4.29)
Non-CHD hospitalization	250 (3.7%)	167 (2.5%)	1.57 (1.27, 1.93)
		Age ≥ 75 years (N=6,422)	
Lipid panel testing	70 (1.1%)	25 (0.4%)	2.80 (1.77, 4.42)
Outpatient primary care visit	1,480 (23.1%)	1,177 (18.3%)	1.39 (1.27, 1.53)
Outpatient cardiologist visit	843 (13.1%)	664 (10.3%)	1.33 (1.19, 1.49)
Emergency department visit	61 (1.0%)	25 (0.4%)	2.50 (1.56, 4.01)
CHD hospitalization	107 (1.7%)	33 (0.5%)	3.39 (2.27, 5.06)
Non-CHD hospitalization	264 (4.1%)	145 (2.3%)	1.92 (1.55, 2.37)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by age.

Table S4. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 14 days before statin re-initiation (case period) compared with 30 to 44 days (control period) before statin re-initiation by sex.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Female (N=6,942)	
Lipid panel testing	73 (1.1%)	25 (0.4%)	2.92 (1.85, 4.60)
Outpatient primary care visit	1,667 (24.1%)	1,360 (19.6%)	1.34 (1.23, 1.46)
Outpatient cardiologist visit	876 (12.6%)	662 (9.5%)	1.40 (1.25, 1.56)
Emergency department visit	60 (0.9%)	39 (0.6%)	1.55 (1.03, 2.33)
CHD hospitalization	111 (1.6%)	39 (0.6%)	2.89 (2.00, 4.19)
Non-CHD hospitalization	297 (4.3%)	186 (2.7%)	1.69 (1.39, 2.06)
		Male (N=6,194)	
Lipid panel testing	65 (1.1%)	27 (0.4%)	2.41 (1.54, 3.77)
Outpatient primary care visit	1,206 (19.5%)	1,018 (16.4%)	1.27 (1.15, 1.40)
Outpatient cardiologist visit	883 (14.3%)	682 (11.0%)	1.37 (1.23, 1.53)
Emergency department visit	58 (0.9%)	28 (0.5%)	2.07 (1.32, 3.25)
CHD hospitalization	109 (1.8%)	32 (0.5%)	3.48 (2.34, 5.19)
Non-CHD hospitalization	217 (3.5%)	126 (2.0%)	1.78 (1.42, 2.24)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by sex.

Table S5. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 14 days before statin re-initiation (case period) compared with 30 to 44 days (control period) before statin re-initiation by the statin intensity discontinued.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
	Low statin intensity discontinued (N=930)		
Lipid panel testing	*	*	1.67 (0.61, 4.59)
Outpatient primary care visit	221 (23.8%)	197 (21.2%)	1.18 (0.94, 1.49)
Outpatient cardiologist visit	117 (12.6%)	85 (9.1%)	1.46 (1.08, 1.99)
Emergency department visit	*	*	1.67 (0.61, 4.59)
CHD hospitalization	16 (1.7%)	*	4.00 (1.34, 11.96)
Non-CHD hospitalization	34 (3.7%)	18 (1.9%)	2.00 (1.10, 3.64)
	Intermediate statin intensity discontinued (N=7,950)		
Lipid panel testing	81 (1.0%)	28 (0.4%)	2.89 (1.88, 4.45)
Outpatient primary care visit	1,767 (22.2%)	1,418 (17.8%)	1.37 (1.26, 1.49)
Outpatient cardiologist visit	1,051 (13.2%)	803 (10.1%)	1.38 (1.25, 1.53)
Emergency department visit	81 (1.0%)	40 (0.5%)	2.05 (1.40, 3.01)
CHD hospitalization	133 (1.7%)	40 (0.5%)	3.38 (2.37, 4.84)
Non-CHD hospitalization	325 (4.1%)	207 (2.6%)	1.63 (1.36, 1.96)
	High statin intensity discontinued (N=4,256)		
Lipid panel testing	47 (1.1%)	18 (0.4%)	2.61 (1.52, 4.50)
Outpatient primary care visit	885 (20.8%)	763 (17.9%)	1.23 (1.10, 1.38)
Outpatient cardiologist visit	591 (13.9%)	456 (10.7%)	1.36 (1.19, 1.56)
Emergency department visit	27 (0.6%)	21 (0.5%)	1.29 (0.73, 2.27)
CHD hospitalization	71 (1.7%)	27 (0.6%)	2.69 (1.72, 4.22)
Non-CHD hospitalization	155 (3.6%)	87 (2.0%)	1.92 (1.45, 2.54)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by statin intensity discontinued.

*The Centers for Medicare and Medicaid Services requires cell counts of < 11 to be suppressed.

Table S6. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 7 days before statin re-initiation (case period) compared with 30 to 37 days (control period) before statin re-initiation by race / ethnicity.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Non-Hispanic White (N=10,764)	
Lipid panel testing	86 (0.8%)	26 (0.2%)	3.31 (2.13, 5.13)
Outpatient primary care visit	1,407 (13.1%)	1,042 (9.1%)	1.44 (1.32, 1.58)
Outpatient cardiologist visit	885 (8.2%)	557 (5.2%)	1.66 (1.48, 1.85)
Emergency department visit	71 (0.7%)	34 (0.3%)	2.09 (1.39, 3.14)
CHD hospitalization	129 (1.2%)	29 (0.3%)	4.57 (3.04, 6.88)
Non-CHD hospitalization	242 (2.3%)	113 (1.1%)	2.24 (1.78, 2.82)†
		Non-Hispanic Black (N=1,271)	
Lipid panel testing	*	*	4.5 (0.97, 20.83)
Outpatient primary care visit	178 (14.0%)	130 (10.2%)	1.51 (1.16, 1.95)
Outpatient cardiologist visit	78 (6.1%)	56 (4.4%)	1.42 (1.00, 2.03)
Emergency department visit	22 (1.7%)	*	7.33 (2.19, 24.5)
CHD hospitalization	20 (1.6%)	*	2.86 (1.21, 6.76)
Non-CHD hospitalization	71 (5.6%)	18 (1.4%)	4.79 (2.69, 8.51)†
		Asian (N=461)	
Lipid panel testing	*	*	2.00 (0.37, 10.92)
Outpatient primary care visit	65 (14.1%)	51 (11.1%)	1.38 (0.90, 2.10)
Outpatient cardiologist visit	50 (10.9%)	22 (4.8%)	2.40 (1.42, 4.04)
Emergency department visit	11 (2.4%)	*	2.00 (0.68, 5.85)
CHD hospitalization	*	*	-
Non-CHD hospitalization	12 (2.6%)	*	1.20 (0.52, 2.78)†
		Hispanic (N=331)	
Lipid panel testing	*	0 (0.0%)	-
Outpatient primary care visit	32 (9.7%)	34 (10.3%)	0.93 (0.55, 1.57)
Outpatient cardiologist visit	24 (7.3%)	13 (3.9%)	1.85 (0.94, 3.63)
Emergency department visit	*	*	2.00 (0.18, 22.06)
CHD hospitalization	*	*	-
Non-CHD hospitalization	*	*	-
		Other (N=309)	
Lipid panel testing	*	*	4.00 (0.45, 35.79)
Outpatient primary care visit	49 (15.9%)	39 (12.6%)	1.36 (0.83, 2.21)
Outpatient cardiologist visit	38 (12.3%)	20 (6.5%)	2.20 (1.19, 4.05)
Emergency department visit	*	*	7.33 (2.19, 24.5)
CHD hospitalization	*	*	-
Non-CHD hospitalization	16 (5.2%)	*	8.00 (1.84, 34.79)†

CHD: coronary heart disease.

[*]The Centers for Medicare and Medicaid Services requires cell counts of < 11 to be suppressed.
[†]Indicates the association of the health utilization factor (exposure) with statin re-initiation (outcome) differs across race/ethnicities (p=0.026).

Table S7. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 7 days before statin re-initiation (case period) compared with 30 to 37 days (control period) before statin re-initiation by age.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Age < 75 years (N=6,714)	
Lipid panel testing	49 (0.7%)	15 (0.2%)	3.27 (1.83, 5.82)
Outpatient primary care visit	848 (12.6%)	656 (9.8%)	1.36 (1.22, 1.53)
Outpatient cardiologist visit	561 (8.4%)	354 (5.3%)	1.65 (1.44, 1.90)
Emergency department visit	52 (0.8%)	29 (0.4%)	1.82 (1.15, 2.89)
CHD hospitalization	89 (1.3%)	23 (0.3%)	3.87 (2.45, 6.12)
Non-CHD hospitalization	167 (2.5%)	81 (1.2%)	2.18 (1.65, 2.87)
		Age ≥ 75 years (N=6,422)	
Lipid panel testing	57 (0.9%)	16 (0.3%)	3.56 (2.05, 6.20)
Outpatient primary care visit	883 (13.8%)	640 (10.0%)	1.50 (1.34, 1.68)
Outpatient cardiologist visit	514 (8.0%)	314 (4.9%)	1.71 (1.48, 1.98)
Emergency department visit	54 (0.8%)	15 (0.2%)	3.60 (2.03, 6.38)
CHD hospitalization	79 (1.2%)	13 (0.2%)	6.50 (3.54, 11.94)
Non-CHD hospitalization	184 (2.9%)	62 (1.0%)	3.14 (2.33, 4.23)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by age.

Table S8. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 7 days before statin re-initiation (case period) compared with 30 to 37 days (control period) before statin re-initiation by sex.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
		Female (N=6,942)	
Lipid panel testing	57 (0.8%)	11 (0.2%)	5.18 (2.72, 9.88)
Outpatient primary care visit	1,026 (14.8%)	737 (10.6%)	1.50 (1.35, 1.67)
Outpatient cardiologist visit	540 (7.8%)	324 (4.7%)	1.75 (1.51, 2.02)
Emergency department visit	54 (0.8%)	23 (0.3%)	2.35 (1.44, 3.82)
CHD hospitalization	84 (1.2%)	23 (0.3%)	3.77 (2.36, 6.04)
Non-CHD hospitalization	200 (2.9%)	90 (1.3%)	2.36 (1.82, 3.06)
		Male (N=6,194)	
Lipid panel testing	49 (0.8%)	20 (0.3%)	2.45 (1.46, 4.12)
Outpatient primary care visit	705 (11.4%)	559 (9.0%)	1.33 (1.18, 1.51)
Outpatient cardiologist visit	535 (8.6%)	344 (5.6%)	1.62 (1.40, 1.86)
Emergency department visit	52 (0.8%)	21 (0.3%)	2.55 (1.52, 4.28)
CHD hospitalization	84 (1.4%)	13 (0.2%)	6.46 (3.60, 11.59)
Non-CHD hospitalization	151 (2.4%)	53 (0.9%)	3.00 (2.17, 4.15)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by sex.

Table S9. Odds ratio for statin re-initiation associated with healthcare utilization during the 0 to 7 days before statin re-initiation (case period) compared with 30 to 37 days (control period) before statin re-initiation by the statin intensity discontinued.

Type of healthcare utilization	Case period N (%)	Control period N (%)	Odds ratio (95% confidence interval)
	Low statin intensity discontinued (N=930)		
Lipid panel testing	*	*	2.00 (0.50, 8.00)
Outpatient primary care visit	134 (14.4%)	112 (12.0%)	1.25 (0.94, 1.65)
Outpatient cardiologist visit	62 (6.7%)	34 (3.7%)	1.90 (1.23, 2.94)
Emergency department visit	*	*	9.00 (1.14, 71.04)
CHD hospitalization	14 (1.5%)	*	7.00 (1.59, 30.80)
Non-CHD hospitalization	26 (2.8%)	*	2.60 (1.25, 5.39)
	Intermediate statin intensity discontinued (N=7,950)		
Lipid panel testing	65 (0.8%)	18 (0.2%)	3.61 (2.14, 6.09)
Outpatient primary care visit	1,070 (13.5%)	768 (9.7%)	1.51 (1.36, 1.68)
Outpatient cardiologist visit	664 (8.4%)	400 (5.0%)	1.75 (1.53, 1.99)
Emergency department visit	75 (0.9%)	29 (0.4%)	2.59 (1.68, 3.97)
CHD hospitalization	107 (1.4%)	19 (0.2%)	5.89 (3.57, 9.71)
Non-CHD hospitalization	223 (2.8%)	87 (1.1%)	2.70 (2.09, 3.49)
	High statin intensity discontinued (N=4,256)		
Lipid panel testing	35 (0.8%)	*	3.50 (1.73, 7.07)
Outpatient primary care visit	527 (12.4%)	416 (9.8%)	1.33 (1.15, 1.53)
Outpatient cardiologist visit	349 (8.2%)	234 (5.5%)	1.54 (1.29, 1.83)
Emergency department visit	21 (0.5%)	13 (0.3%)	1.62 (0.81, 3.23)
CHD hospitalization	47 (1.1%)	15 (0.4%)	3.13 (1.75, 5.60)
Non-CHD hospitalization	102 (2.4%)	46 (1.1%)	2.40 (1.66, 3.47)

CHD: coronary heart disease.

The association of the health utilization factors (exposure) with statin re-initiation (outcome) did not differ by statin intensity discontinued.

*The Centers for Medicare and Medicaid Services requires cell counts of < 11 to be suppressed.