Supplemental Online Content

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Supplement 2. eMethods

This supplemental material has been provided by the authors to give readers additional information about their work.

Supplement

Effects of the Million Hearts Model on Myocardial Infarctions, Strokes and Medicare Spending: Randomized Clinical Trial

eMethods 1. Minimization procedure the Centers for Medicare & Medicaid Services used to allocate organizations to the intervention and control groups

When organizations joined the Million Hearts® Cardiovascular Disease (CVD) Risk Reduction Model, they agreed to be randomly assigned to the intervention group or the control (usual care) group. The Centers for Medicare & Medicaid Services (CMS) used a minimization procedure to randomly allocate the 516 participating organizations to the intervention group (260 organizations) and the control group (256 organizations). This minimization procedure ensured (1) a roughly equal number of intervention and control organizations; and (2) balance between the two groups on organizations' region in the United States, number of sites (physical locations where beneficiaries are seen), number of practitioners, and anticipated number of Medicare fee-for-service (FFS) beneficiaries. Randomization was conducted once, in April 2016, by an independent CMS contractor (NORC at the University of Chicago). The procedure went as follows:

1. Assign all 516 organizations a random number from the uniform distribution.
2. Sort the organizations according to the random number.
3. Randomly assign the first 78 organizations (15%) to the intervention or control group.
    - 3.1. Assign organization 1 to the control group.
    - 3.2. Assign organization 2 to the intervention group.
    - 3.3. Assign organization 3 to the control group.
    - 3.4. Assign organization 4 to the intervention group.
    - …
    - 3.77. Assign organization 77 to the control group.
    - 3.78. Assign organization 78 to the intervention group.
4. Assign organization 79 to the intervention or control group, considering the organization's characteristics and previous assignments of organizations (that is, the characteristics and assignment of organizations 1 to 78).
    - 4.1. Temporarily assign organization 79 to the intervention group and calculate an χ^2 test statistic for each of four organization characteristics—the anticipated number of Medicare FFS beneficiaries, the number of service sites, U.S. Department of Health and Human Services (HHS) region, and number of practitioners. For HHS region, the test statistic measures imbalance for the characteristics for the level of the categorical variable that the 79th organization belongs to. (For example, if organization 79 is in HHS Region 1, it tests for differences between the intervention and control organizations in the number of organizations in HHS Region 1.) For other variables, the test statistic measures imbalance in the total number of anticipated beneficiaries, service sites, and practitioners.
    - 4.2. Temporarily assign organization 79 to the control group and repeat.
    - 4.3. For each characteristic, identify the group assignment—to the intervention group or to control group—that would result in less imbalance for that characteristic, as measured by the χ^2 test statistics.
    - 4.4. Assign organization 79 to the intervention group if two, three, or four of the characteristics would show less imbalance if organization 79 was assigned to the intervention group. Otherwise, assign organization 79 to the control group.
5. Repeat Step 4 sequentially for each of the remaining organizations (80 through 516).

Some organizations participating in the Million Hearts Model were large, with more than 20 practitioners and multiple sites. In those cases, CMS chose to randomly assign the whole organization—not individual sites within the organization—to the intervention versus control group out of concern of contaminating the control group. Specifically, CMS was concerned that, if a large organization made changes to its electronic health record or other shared resources and processes to allow some of its sites (those randomly assigned to the intervention group) to implement the model, those changes could then apply to all sites at the organization (including those randomly assigned to the control group). Therefore, the model could change care at the control group sites, potentially decreasing the model's apparent effect.

eMethods 2. Identifying beneficiaries to include in the study population

We used data from the Million Hearts Data Registry to identify model beneficiaries for this study. We began with all Medicare FFS beneficiaries entered into the model by the participating organizations (both intervention or control) during 2017 and 2018, the first two years of the model: 230,697 beneficiaries from 173 intervention organizations plus 157,360 beneficiaries from 172 control organizations. (See Figure 1 in the article.) *Entering the model* means the organization reported the beneficiary to the Million Hearts Data Registry and CMS validated the beneficiary's visit record. To enter a beneficiary into the model, an organization had to upload data on a model-qualifying visit for the beneficiary and the demographic and clinical data needed to determine the beneficiary's baseline CVD risk. To validate each beneficiary's model entry, CMS (through a contractor) used Medicare administrative data to confirm the beneficiary (1) did indeed have a visit with a practitioner from the organization near the time listed and (2) met model eligibility criteria. Medicare beneficiaries met *model eligibility criteria* if they were ages 40 to 79 at the time of the first model visit, had no evidence of a prior myocardial infarction or stroke or transient ischemic attack (TIA), had Medicare FFS as their primary payer, did not have end-stage renal disease (ESRD), and were not receiving hospice benefits.

For this study, we further limited the analytic population in four ways. First, we restricted the population to those who had complete and plausible clinical data needed to calculate a baseline CVD risk score (for example, dropping beneficiaries with a systolic blood pressure of 0). Second, we required beneficiaries be observable in Medicare Parts A and B claims. *Observable* beneficiaries were those enrolled in Medicare Parts A and B FFS with Medicare as the primary payer during the month of model entry. Third, we checked additional model eligibility criteria in Medicare administrative data, removing observable beneficiaries who were not ages 40 to 79 or had evidence of a prior myocardial infarction, prior stroke, prior TIA, ESRD, or receipt of hospice services. (CMS validated beneficiaries were observable and met the other eligibility criteria. However, we found a very small proportion of beneficiaries who did not, likely due to differences in when we and CMS pulled claims and Medicare enrollment data.) Finally, we limited the population to people with CVD risk scores at model entry indicating high or medium CVD risk. Beneficiaries with *high and medium CVD risk* were those who were predicted to have, on their dates of model entry, at least 15% or higher risk of a myocardial infarction or stroke in the next 10 years.

After applying these restrictions, the study's final analysis population included 218,864 beneficiaries: 130,578 beneficiaries from 172 intervention organizations and 88,286 beneficiaries from 170 control organizations.

An advantage of using Medicare data and the National Death Index (NDI) to identify outcomes was that we could measure outcomes for all beneficiaries in our analytic population for at least one day after model entry, without loss to follow-up. Beneficiaries contributed to the analysis until censoring at either

1. the study end date (December 31, 2021),
2. death,
3. losing Medicare FFS as the primary payer (for analysis of all outcomes other than death or cause of death), or
4. having a CVD event (only for analysis of first-time CVD events).

eMethods 3. Outcome definitions

We estimated effects on 11 outcomes. All outcomes were prespecified in the trial protocol registered at clinicaltrials.gov, with two exceptions:

- We added the outcome of **first-time CVD events or CVD death** because of newly available data linkages between Medicare administrative records and cause-of-death data from the NDI, which we did not anticipate having when we drafted the trial protocol. This outcome is conceptually very similar to the primary outcome of first-time CVD events (measured in Medicare claims), but addresses an important limitation. Especially during the Covid-19 pandemic,[1] the claims-based outcome is likely to undercount the true number of CVD events because some events do not generate a Medicare claim—for example, because the beneficiary dies before reaching the hospital. This outcome is broader than myocardial infarctions and strokes, however, in that it includes all coronary heart disease (CHD) deaths (not just those due to myocardial infarctions).
- We changed the outcome for **office visits**. The trial protocol specified analyzing office visits with a *Million Hearts Model practitioner*. However, this was not practical to implement due to changes in the practitioner list after random assignment. As a result, we instead analyzed all office visits.

All outcomes were constructed at the beneficiary-quarter level, except the three event measures (first-time CVD events, first-time CVD events or CVD deaths, and all-cause deaths) and one episode-level measure (per beneficiary per month [PBPM] Medicare spending for first-time CVD events). For the beneficiary-quarter-level outcomes, we defined the quarterly observations relative to each beneficiary's model entry date. For example, Quarter 1 for a beneficiary who entered the model on March 7, 2017, spanned the period from March 7, 2017, through June 6, 2017, whereas Quarter 1 for a beneficiary who entered the model on July 24, 2017, spanned July 24, 2017, through October 23, 2017. We summed total Medicare spending and service use outcomes over each intervention quarter. We quarterized outcomes for beneficiaries who were not observable for the full quarter and constructed observability weights that reflected the amount of time the beneficiary was observable in the quarter. (For example, if a beneficiary had one outpatient emergency department (ED) visit in the quarter but was observed for only 60 days of the quarter, that beneficiary's quarterized outpatient ED visit rate would be [1 visits / 60 days observed] * 90 days in the quarter = 1.5 visits per quarter.) Beneficiaries were observable if they were alive and enrolled in Medicare FFS Parts A and B with Medicare as their primary payer. Beneficiaries who were fully observable in any quarter received an observability weight of one for that quarter. Those who were observable for less than a quarter (for example, due to death or loss of Parts A and B coverage), received a weight that was the share of days in the quarter the person was actually observed.

Definitions of the outcomes follow.

1. Primary outcome: First-time CVD events, as measured in Medicare claims

We measured myocardial infarctions, strokes, and TIAs using Medicare FFS inpatient hospital claims and outpatient ED or observation stay claims. In the inpatient claims, we identified these events if the principal or any of the secondary diagnoses had a relevant diagnosis, as long as the secondary diagnosis was not present on admission. The not-present-on-admission restriction sought to exclude events previously diagnosed or treated. In the outpatient ED and observation stay claims, we identified events based on the principal diagnosis only.

Definitions were based on the Chronic Conditions Data Warehouse (CCW) definitions.[2] For myocardial infarctions, the definition included diagnoses categorized as ST elevation (STEMI), non-ST elevation (NSTEMI), and unspecified myocardial infarction (this corresponds to Type 1 myocardial infarctions, as defined by the Fourth Universal Definition of Myocardial Infarction[3]). The measure also included all five types of myocardial infarctions in the Fourth Universal Definition of Myocardial Infarction. We excluded any diagnoses for complications following STEMI and NSTEMI, as well as diagnoses for subsequent myocardial infarction from the outcome definition because the outcome aims to measure first myocardial infarctions. For stroke and TIA, the diagnoses included those categorized as ischemic and hemorrhagic stroke, transient ischemic attack, and stroke syndromes.

Based on previous validation studies, Medicare claims data capture the primary outcome of this study—myocardial infarction, stroke, and TIA—with reasonable positive predictive values (80 percent or greater for myocardial infarction and stroke and 70 percent or greater for TIAs).[4,5,6] However, sensitivity estimates were lower, especially

for fatal events (Xie et al. 2018),[7] which likely reflects a substantial portion of beneficiaries who die from these events outside of the hospital without generating a Medicare claim.

List of ICD-10 codes used to define myocardial infarction, stroke, and TIA in claims data

Definition	
Diagnosis codes	
Myocardial infarction	STEMI: I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3 NSTEMI: I21.4 Unspecified: I21.9 Type 2: I21.A1 Other types: I21.A9
Stroke and TIA[a]	Ischemic and hemorrhagic stroke, original codes: I60.00, I60.01, I60.02, I60.10, I60.11, I60.12, I60.2, I60.20, I60.21, I60.22, I60.30, I60.31, I60.32, I60.4, I60.50, I60.51, I60.52, I60.6, I60.7, I60.8, I60.9, I61.0, I61.1, I61.2, I61.3, I61.4, I61.5, I61.6, I61.8, I61.9, I63.00, I63.011, I63.012, I63.013, I63.019, I63.02, I63.031, I63.032, I63.033, I63.039, I63.09, I63.10, I63.111, I63.112, I63.113, I63.119, I63.12, I63.131, I63.132, I63.133, I63.139, I63.19, I63.20, I63.211, I63.212, I63.213, I63.219, I63.22, I63.231, I63.232, I63.233, I63.239, I63.29, I63.30, I63.311, I63.312, I63.313, I63.319, I63.321, I63.322, I63.323, I63.329, I63.331, I63.332, I63.333, I63.339, I63.341, I63.342, I63.343, I63.349, I63.39, I63.40, I63.411, I63.412, I63.413, I63.419, I63.421, I63.422, I63.423, I63.429, I63.431, I63.432, I63.433, I63.439, I63.441, I63.442, I63.443, I63.449, I63.49, I63.50, I63.511, I63.512, I63.513, I63.519, I63.521, I63.522, I63.523, I63.529, I63.531, I63.532, I63.533, I63.539, I63.541, I63.542, I63.543, I63.549, I63.59, I63.6, I63.81, I63.89, I63.9. I62.00, I62.01, I62.02, I62.9 TIA: G45.0, G45.1, G45.2, G45.8, G45.9, I67.81, I67.82, I67.841, I67.848, I67.89 Other stroke syndromes: G46.0, G46.1, G46.2, G46.3, G46.4, G46.5, G46.6, G46.7, G46.8, G97.31, G97.32, I66.01, I66.02, I66.03, I66.09, I66.11, I66.12, I66.13, I66.19, I66.21, I66.22, I66.23, I66.29, I66.3, I66.8, I66.9, I97.810, I97.811, I97.820, I97.821
Diagnosis fields	
Inpatient claims	Principal and secondary, but only those secondary diagnoses not present on admission
Outpatient ED and observation stay claims	Principal only

[a] For stroke, we applied the CCW stroke exclusions as originally defined in its 2018 specifications and added new exclusion codes from the 2022 updates. The stroke exclusion codes, including the original 2018 codes, are S01.90XA, S02.0XXA, S02.0XXB, S02.10XA, S02.10XB, S02.101A, S02.101B, S02.102A, S02.102B, S02.109A, S02.109B, S02.11GA, S02.11GB, S02.11HA, S02.11HB, S02.110A,S02.111A, S02.112A, S02.113A, S02.110B, S02.111B, S02.112B, S02.113B, S02.118A, S02.118B, S02.119A, S02.119B, S02.19XA, S02.19XB, S02.2XXA, S02.2XXB, S02.3XXA, S02.30XA, S02.3XXB, S02.30XB, S02.31XA, S02.31XB, S02.32XA, S02.32XB, S02.40AA, S02.40AB, S02.40BA, S02.40BB, S02.40CA, S02.40CB, S02.40DA, S02.40DB, S02.40EA, S02.40EB, S02.40FA, S02.40FB, S02.400A, S02.400B, S02.401A, S02.401B, S02.402A, S02.402B, S02.411A, S02.411B, S02.412A, S02.412B, S02.413A, S02.413B, S02.42XA, S02.42XB, S02.600A, S02.600B, S02.601A, S02.601B, S02.602A, S02.602B, S02.609A, S02.609B, S02.61XA, S02.610A, S02.610B, S02.611A, S02.611B, S02.612A, S02.612B, S02.62XA, S02.620A, S02.62XB, S02.620B, S02.621A, S02.621B, S02.622A, S02.622B, S02.63XA, S02.630A, S02.63XB, S02.630B, S02.631A, S02.631B, S02.632A, S02.632B, S02.64XA, S02.640A, S02.64XB, S02.640B, S02.641A, S02.641B, S02.642A, S02.642B, S02.65XA, S02.650A, S02.65XB, S02.650B, S02.651A, S02.651B, S02.652A, S02.652B, S02.66XA, S02.66XB, S02.67XA, S02.670A, S02.670B, S02.671A, S02.671B, S02.672A, S02.672B, S02.69XA, S02.61XB, S02.62XA, S02.63XA, S02.64XA, S02.65XA, S02.66XA, S02.67XB, S02.69XB, S02.8XXA, S02.80XA, S02.8XXB, S02.80XB, S02.81XA, S02.81XB, S02.82XA, S02.82XB, S02.91XA, S02.91XB, S02.92XA, S02.92XB, S06.0X0A, S06.0X1A, S06.0X2A, S06.0X3A, S06.0X4A, S06.0X5A, S06.0X6A, S06.0X7A, S06.0X8A, S06.0X9A, S06.1X0A, S06.1X1A, S06.1X2A, S06.1X3A, S06.1X4A, S06.1X5A, S06.1X6A, S06.1X7A, S06.1X8A, S06.1X9A, S06.2X0A, S06.2X1A, S06.2X2A, S06.2X3A, S06.2X4A, S06.2X5A,

S06.2X6A, S06.2X7A, S06.2X8A, S06.2X9A, S06.2X0B, S06.2X1B, S06.2X2B, S06.2X3B, S06.2X4B, S06.2X5B, S06.2X6B, S06.2X7B, S06.2X8B, S06.2X9B, S06.300A, S06.301A, S06.302A, S06.303A, S06.304A, S06.305A, S06.306A, S06.307A, S06.308A, S06.309A, S06.310A, S06.311A, S06.312A, S06.313A, S06.314A, S06.315A, S06.316A, S06.317A, S06.318A, S06.319A, S06.320A, S06.321A, S06.322A, S06.323A, S06.324A, S06.325A, S06.326A, S06.327A, S06.328A, S06.329A, S06.330A, S06.331A, S06.332A, S06.333A, S06.334A, S06.335A, S06.336A, S06.337A, S06.338A, S06.339A, S06.340A, S06.341A, S06.342A, S06.343A, S06.344A, S06.345A, S06.346A, S06.347A, S06.348A, S06.349A, S06.350A, S06.351A, S06.352A, S06.353A, S06.354A, S06.355A, S06.356A, S06.357A, S06.358A, S06.359A, S06.360A, S06.361A, S06.362A, S06.363A, S06.364A, S06.365A, S06.366A, S06.367A, S06.368A, S06.369A, S06.370A, S06.371A, S06.372A, S06.373A, S06.374A, S06.375A, S06.376A, S06.377A, S06.378A, S06.379A, S06.380A, S06.381A, S06.382A, S06.383A, S06.384A, S06.385A, S06.386A, S06.387A, S06.388A, S06.389A, S06.4X0A, S06.4X1A, S06.4X2A, S06.4X3A, S06.4X4A, S06.4X5A, S06.4X6A, S06.4X7A, S06.4X8A, S06.4X9A, S06.5X0A, S06.5X1A, S06.5X2A, S06.5X3A, S06.5X4A, S06.5X5A, S06.5X6A, S06.5X7A, S06.5X8A, S06.5X9A, S06.6X0A, S06.6X1A, S06.6X2A, S06.6X3A, S06.6X4A, S06.6X5A, S06.6X6A, S06.6X7A, S06.6X8A, S06.6X9A, S06.810A, S06.811A, S06.812A, S06.813A, S06.814A, S06.815A, S06.816A, S06.817A, S06.818A, S06.819A, S06.820A, S06.821A, S06.822A, S06.823A, S06.824A, S06.825A, S06.826A, S06.827A, S06.828A, S06.829A, S06.890A, S06.891A, S06.892A, S06.893A, S06.894A, S06.895A, S06.896A, S06.897A, S06.898A, S06.899A, S06.9X0A, S06.9X1A, S06.9X2A, S06.9X3A, S06.9X4A, S06.9X5A, S06.9X6A, S06.9X7A, S06.9X8A, S06.9X9A, OR Z51.89 as the principal diagnosis code. Exclusion codes newly included 2022 are S02.121A, S02.121B, S02.122A, S02.122B, S02.129A, S02.129B, S02.831A, S02.831B, S02.832A, S02.832B, S02.839A, S02.839B, S02.841A, S02.841B, S02.842A, S02.842B, S02.849A, S02.849B, S02.85XA, and S02.85XB.

Abbreviations: ED = emergency department; CCW = Chronic Conditions Data Warehouse; ICD-10 = *International Classification of Diseases,* 10th edition; NSTEMI = non-ST elevation; STEMI = ST elevation; TIA = transient ischemic attack.

2. First-time CVD events or CVD deaths

This outcome includes first-time CVD events measured in claims, as described previously, and adds deaths due to CHD or cerebrovascular disease without a Medicare claim.

For this outcome and the breakdown of deaths by cause, we identified cause-specific mortality based on the underlying cause of death codes obtained from the NDI. The World Health Organization defines the underlying cause of death as "the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury." We classified underlying causes of death into circulatory system-related deaths, and further classified circulatory system-related deaths as CHD or cerebrovascular disease-related deaths using the same *International Classification of Diseases,* 10th edition (ICD-10) diagnosis-based definitions used by the American Heart Association and the Reasons for Geographic and Racial Differences in Stroke (REGARDS) project.[8,9]

NDI-based definitions of CHD, cerebrovascular disease, and circulatory-system-related conditions (ICD-10 codes only)

Cause of death	ICD-10 diagnosis codes
All circulatory system-related deaths	I00–I99
CHD or cerebrovascular deaths	CHD: I20–I25, I46, I49 Cerebrovascular: I60 to I69
All other deaths	All other ICD-10 codes

Abbreviations: CHD = coronary heart disease; ICD-10 = *International Classification of Diseases,* 10th edition; NDI = National Death Index.

According to REGARDS, NDI-derived cause-specific mortality based on these definitions had good specificity and modest sensitivity (specificity of 85 percent for all circulatory-system conditions, 90 percent for CHD, and 99 percent for cerebrovascular deaths; sensitivity: 73 percent for all circulatory system-related conditions, 54 percent for CHD, and 52 percent for cerebrovascular deaths).[8,9] The top ICD-10 diagnosis codes in each cause-of-death category were as follows.

Top ICD-10 diagnosis codes, by cause-of-death category

Cause of death	Top 5 ICD-10 diagnosis codes
CHD deaths	I25.1, Atherosclerotic heart disease of native coronary artery I21.9, Acute myocardial infarction, unspecified I25.0, Atherosclerotic cardiovascular disease, so described I46.9, Cardiac arrest, cause unspecified I25.5, Ischemic cardiomyopathy
Cerebrovascular deaths	I64, Stroke, not specified as hemorrhage or infarction I61.9, Nontraumatic intracerebral hemorrhage, unspecified I63.9, Cerebral infarction, unspecified I62.9, Nontraumatic intracranial hemorrhage, unspecified I67.9, Cerebrovascular disease, unspecified
Other circulatory-system-related deaths	I50.0, Congestive heart failure I11.9, Hypertensive heart disease without heart failure I48, Atrial fibrillation and flutter I42.9, Cardiomyopathy, unspecified I50.9, Heart failure, unspecified

Abbreviations: CHD = coronary heart disease; ICD-10 = *International Classification of Diseases,* 10th edition.

We extracted the date of death from the Medicare Enrollment Database (EDB). Among 26,403 beneficiaries who died by the end of 2021 based on EDB, 98.7 percent had a corresponding NDI record. For deceased beneficiaries without a corresponding NDI record, we coded their cause of death as unknown.

3. Primary outcome: PBPM Medicare spending on first-time CVD events

We constructed a measure of spending (before model payments) for first-time CVD events, including spending during the acute event and 90 days following the event. This measure included all Medicare FFS payments made to hospitals for the acute event (an inpatient stay, an outpatient ED visit, or observation stay) as well as all payments made to individual practitioners for care provided during the acute event. Further, this measure included all Medicare payments in the 90 days after discharge for all services delivered during this window, even if they were unrelated to the acute event. We chose a 90-day window, following other studies,[10,11,12] to capture relevant services such as rehabilitation that often last several months after an event. This outcome included Medicare payments for services found in each of the FFS claims files: inpatient, skilled nursing facility, hospice, home health, outpatient, carrier (also called Part B), and durable medical equipment. If a claim was partially contained within the 90-day window—for example, an inpatient hospital claim spanning days 86 to 95 post-discharge—we calculated the average daily payment for the claim and estimated Medicare payments contained within the 90-day episode window by multiplying the average daily payment rate by the number of days that fell in the 90-day window. We did not measure 90-day episode spending for acute events if (1) the beneficiary was not observable for the full 90-day window for any reason other than death (for example, if they moved into Medicare Advantage during the 90-day window [n = 217 events excluded]); or (2) if the acute event occurred too late in the analysis period to measure 90-day spending (for example, an event for which the 90-day window ended on or after January 1, 2022 [n = 6 events excluded]). The n = 223 excluded events represented 3 percent of the acute events otherwise eligible for the event spending analyses.

4. PBPM Medicare Parts A and B spending, before model payments

We calculated Medicare spending for claims for inpatient, carrier (Part B), outpatient, home health services, skilled nursing facility, hospice services, and durable medical equipment. We summed payments across all claims with a from or admission date in each relevant quarter to create the measure of total Parts A and B Medicare spending. This measure does not include Part D spending.

5. PBPM Medicare Parts A and B spending, including model payments

We added estimated PBPM model payments to the measure of Medicare Parts A and B spending, described previously.

Total Million Hearts Model payments for the intervention group beneficiaries were an estimated $7.2 million. This figure included (1) all payments for risk assessment in 2017 and 2018, given that organizations needed to the perform risk assessments (for beneficiaries in all risk groups) to identify the high- and medium-risk beneficiaries included in the study population; (2) all cardiovascular management payments, which were paid in 2017 only for high-risk beneficiaries; and (3) risk reduction payments in 2018–2021 which we estimated were for high-risk beneficiaries entering the model in 2017–2018. We divided this $7.2 million total by the number of beneficiary-months among the high- and medium-risk beneficiaries who entered the model through December 2018. Note this outcome does not include costs of implementing the model, such as maintaining the Million Hearts Data Registry or calculating semiannual performance (for risk reduction payments).

6. All-cause hospitalizations

We counted the number of acute inpatient admissions using the inpatient claims.

7. All-cause ED visits

We counted the number of outpatient ED visits or observation stays that did not end in admission using outpatient claims file. We identified ED visits using revenue center codes (0450, 0451, 0452, 0456, 0459, and 0981). We identified observation stays using revenue center codes (0760 or 0762), combined with Healthcare Common Procedure Coding System (HCPCS) code G0378 and a unit count of eight or more. We only allowed for one ED visit or observation stay per day so as not to count multiple claims from the stay as multiple visits.

8. and 9. Circulatory system-related hospitalizations or ED visits

To measure hospitalizations or outpatient ED visits (including observation stays) for circulatory system-related conditions, we developed a list of more than 300 ICD-10 relevant diagnosis codes, including those related to heart failure, hypertension, and angina, as well as the diagnoses for myocardial infarction, stroke, or TIA listed in in the description of the measure of first-time CVD events.[i] We then added diagnoses for subsequent myocardial infarction (I220, I221, I222, I228, and I229, all included in the CCW definition of myocardial infarction) to the definition of circulatory system-related conditions because we did not include these diagnoses in our definition of *first-time* CVD events, described previously.

[i] Of the ICD-10 diagnoses included in our list, the following appeared most frequently on inpatient or outpatient claims during the baseline period in our study population: A5201, B3322, C380, D151, G454, G9340, G9341, G9349, G9389, G939, G968, G969, G980, G988, I011, I018, I019, I050, I051, I052, I058, I059, I060, I061, I062, I068, I069, I071, I078, I079, I080, I081, I082, I083, I088, I089, I0981, I0989, I099, I10, I110, I119, I130, I1310, I132, I150, I151, I152, I158, I159, I160, I161, I169, I200, I201, I208, I209, I236, I240, I241, I248, I249, I2510, I25110, I25111, I25118, I25119, I252, I253, I2541, I255, I256, I25700, I25701, I25708, I25709, I25710, I25718, I25719, I25720, I25721, I25728, I25729, I25739, I25750, I25758, I25759, I25790, I25791, I25798, I25799, I25810, I25811, I25812, I2582, I2583, I2584, I2589, I259, I270, I271, I2720, I2721, I2781, I2789, I279, I281, I288, I289, I300, I301, I308, I309, I311, I312, I313, I314, I318, I319, I32, I330, I339, I340, I341, I342, I348, I349, I350, I351, I352, I358, I359, I360, I361, I362, I368, I369, I370, I371, I372, I379, I38, I39, I400, I401, I41, I420, I421, I422, I423, I425, I426, I427, I428, I429, I43, I440, I441, I442, I4430, I4439, I444, I447, I450, I4510, I4519, I452, I453, I454, I455, I456, I4581, I4589, I459, I462, I468, I469, I470, I471, I472, I479, I480, I481, I482, I483, I484, I4891, I4892, I4901, I4902, I491, I492, I493, I4940, I4901, I4902, I491, I493, I4949, I495, I498, I499, I501, I5020, I5021, I5022, I5023, I5030, I5031, I5032, I5033, I5040, I5041, I5042, I5043, I50810, I509, I510, I511, I513, I514, I515, I517, I5181, I5189, I519, I52, I6200, I6201, I6202, I6203, I621, I629, I6501, I6502, I6503, I6509, I651, I6521, I6522, I6523, I6529, I658, I659, I672, I6781, I6782, I6783, I679, I680, and I700.29.

10. Office visits

To identify outpatient office visits, we flagged all claims in the carrier file with both (1) a specialty code indicating a claim from a physician, physician assistant, nurse practitioner, or certified clinical nurse specialist; and (2) a Current Procedural Terminology (CPT®) or HCPCs code for evaluation and management services that indicated the claim was for an outpatient office[ii] or telehealth[iii] visit. We further used the outpatient file to identify all outpatient visits to federally qualified health centers, rural health clinics, and critical access hospitals. To avoid double-counting visits across outpatient and carrier claims—for example, for beneficiaries with an office visit at a critical access hospital outpatient facility and for whom we would observe both an outpatient and carrier claim—we counted only one visit per beneficiary per day.

11. All-cause deaths

We measured death based on date of death in the Medicare EDB.

[ii] Outpatient office or clinic codes include 99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99487, 99489, 99495, 99496, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99315, 99316, 99324, 99325, 99326, 99327, 99328, 99334, 99335, 99336, 99337, 99339, 99340, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, 99318, 99490, 99497, G0402, G0438, G0439, G0181, 99492, 99493, 99494, 99484, G0502, G0503, G0504, G0507, 99354, 99355, 99358, 99359, 99406, 99407, 97802, 97803, 96152, 96153, 96154, 96160, G0101, G0102, G0108, G0109, G0270, G0271, G0442, G0443, G0444, G0445, G0446, G0447, 99401, 99402, 99403, 99404, 99408, 99409, 99411, 99412, 99420, 99429, 99381, 99382, 99383, 99384, 99385, 99386, 99387, 99391, 99392, 99393, 99394, 99395, 99396, 99397, G0473, G0466, G0467, G0468, G0469, G0470, G2064, G2065, G0076, G0077, G0078, G0079, G0080, G0081, G0082, G0083, G0084, G0085, G0086, G0087, G2011, G2076, G2212, G2214, G9987, G0296, G0396, G0397, Q0091, G0511, G0512, G0463, 99488, G0505, G0506, and 99483.

[iii] Telehealth-specific codes include 98966, 98967, 98968, 99441, 99442, 99443, 98969, 99444, 98970, 98971, 98972, 99421, 99422, 99423, 99453, 99454, 99457, 99474, G2010, G2012, G2061, G2062, G2063, G2250, G2251, G2252, G9978, G9979, G9980, G9981, G9982, G9983, G9984, G9985, G9986, and G0071.

eMethods 4. Additional restrictions when identifying the population used to analyze Medicare spending for first-time CVD events

For the analyses of one outcome measure—Medicare spending on first-time CVD events—we restricted the main analysis population (defined in eMethods 2) to beneficiaries entering the Million Hearts Model on or before August 31, 2017. Among these beneficiaries, we could measure spending during a triggering CVD event (of up to one month) with 90 days of follow-up for all CVD events happening within four years of model entry. (Among the first-time CVD events included in this analysis, more than 95 percent had a hospital stay shorter than one month.) After applying this restriction, the analysis population comprised 92,104 high- and medium-risk beneficiaries from 170 intervention organizations and 56,023 beneficiaries from 160 control organizations. This represented 71 percent of the intervention beneficiaries and 63 percent of control beneficiaries included in analysis of CVD events and other long-term outcomes.

eMethods 5. Covariates included in regression models

To improve precision of the effect estimates and to account for any observed differences between the intervention and control beneficiaries, we adjusted for a wide range of beneficiary-, organization-, and region-level variables:

Covariate, measured at date of model entry or attribution	Included in regression models with the population of: Model beneficiaries	Attributed beneficiaries
Clinical indicators of beneficiary's cardiovascular risk		
CVD risk score[a, b, c]	■	
Predicted CVD risk score (see eMethods 6)		■
Predicted probabilities of belonging to the high- or medium-, high-, medium-, and low-CVD risk groups (four variables; see eMethods 6)[c]		■
Estimated modifiable risk[a, b, c, d, e]	■	
Claims-based CVD risk score (assuming optimal values for clinical values)		■
Evidence of diabetes in claims (yes/no)	■	■
Systolic blood pressure (mm Hg)[a]	■	
Evidence of hypertension in claims over previous 24 months (yes/no)	■	■
Total cholesterol (mg/dL)[a]	■	
HDL cholesterol (mg/dL)[a]	■	
LDL cholesterol (mg/dL)[a, e]	■	
Evidence of hyperlipidemia in claims over previous 12 months (yes/no)	■	■
Is current smoker (yes/no)[a]	■	
Evidence of tobacco use in claims over previous 24 months (yes/no)		■
Beneficiary's medication use in the year before model entry[f]		
Uses antihypertensive medications (yes/no/without Part D enrollment)	■	■
Uses statins (no/low/moderate/high/without Part D enrollment)	■	■
Uses aspirin (yes/no)[a]	■	
Evidence of aspirin use in claims over previous 24 months (yes/no)		■
Beneficiary's demographic and Medicare enrollment characteristics		
Age (separately by categorical age group)[b]	■	■
Race and ethnicity predicted probabilities: non-Hispanic Black, non-Hispanic White, Hispanic (3 variables)[g]	■	■
Male (yes/no)	■	■
Dually enrolled in Medicare and Medicaid (yes/no)	■	■
Originally entitled to Medicare due to disability (yes/no)	■	■
Received Part D low-income subsidy for at least one month over previous year	■	■
Beneficiary's health and comorbid conditions from claims		
HCC score[b]	■	■
Count of chronic conditions	■	■
Has chronic kidney disease (yes/no)	■	■
Has ischemic heart disease (yes/no)	■	■

Covariate, measured at date of model entry or attribution	Included in regression models with the population of: Model beneficiaries	Attributed beneficiaries
Has heart failure (yes/no)	■	■
Has atrial fibrillation (yes/no)	■	■
Has morbid obesity (yes/no)	■	■
Has dementia (yes/no)	■	■
Has diabetes with complications (yes/no)	■	■
Has dialysis status, acute renal failure, or stage 5 chronic kidney disease (yes/no)	■	■
Has cancer (yes/no)	■	■
Has unstable angina (yes/no)	■	■
Has chronic obstructive pulmonary disease (yes/no)	■	■
Has vascular disease with complications (yes/no)	■	■
Has drug or alcohol dependence (yes/no)	■	■
Has heart failure *and* diabetes (yes/no)	■	■
Has heart failure *and* chronic kidney disease (yes/no)	■	■
Has heart failure *and* atrial fibrillation (yes/no)	■	■
Has heart failure *and* ischemic heart disease (yes/no)	■	■
Has ischemic heart disease *and* chronic kidney disease (yes/no)	■	■
Has ischemic heart disease *and* diabetes (yes/no)	■	■
Has ischemic heart disease *and* chronic obstructive pulmonary disease (yes/no)	■	■
Beneficiary's medical service use and spending in year before model entry[f]		
Total Medicare Parts A and B annualized expenditures[b, h]	■	■
Total inpatient annualized expenditures[h]	■	■
Number of hospital admissions[h]	■	■
Number of circulatory system-related hospital admissions [h]	■	■
Number of outpatient ED visits or observation stays[h]	■	■
Number of circulatory system-related ED visits or observation stays[h]	■	■
Number of office visits[h]	■	■
Number of office visits with model-aligned practitioners[h]	■	■
Number of cardiologist office visits[h]	■	■
Beneficiary's CVD-related procedures in year before model entry[f]		
Received echocardiogram (yes/no)	■	■
Received electrocardiogram (yes/no)	■	■
Received cardiac stress test (yes/no)	■	■
Beneficiary's other preventive-care procedures in year before model entry[f]		
Received prophylactic vaccination or inoculation (yes/no)	■	■
Received colonoscopy or biopsy (yes/no)	■	■
Characteristics of organization entering the beneficiary in the Million Hearts Model[i]		
Total number of practitioners (1 to 5, 6 to 19, or 20 or more)[d]	■	■
Total number of service sites (1, 2 to 5, or 6 or more)	■	■

Covariate, measured at date of model entry or attribution	Included in regression models with the population of: Model beneficiaries	Attributed beneficiaries
Organization type (primary care, specialty or multispecialty, FQHC, RHC, or other health center; CAH, rural hospital, acute care hospital, or other)	■	■
Organization participated in or had application pending for another CMS model at random assignment (yes/no)	■	■
Organizational-level mean Parts A and B Medicare spending[h, j]	■	■
Organizational-level mean hospital admissions (per 1,000 beneficiaries)[h, j]	■	■
Organizational-level mean outpatient ED visits or observation stays (per 1,000 beneficiaries)[h, j]	■	■
Characteristics of practitioner entering the beneficiary in the Million Hearts Model[i]		
Practitioner specialty (cardiovascular-related physician/primary care physician [noncardiovascular]/other physician/other practitioner type [nonphysician])	■	■
Characteristics of beneficiary's region		
Rural (yes/no)	■	■
HHS Region (1: CT, ME, MA, NH, RI, and VT, 2: NY, NJ, PR, and VI, 3: DC, DE, MD, PA, VA, and WV, 4: AL, FL, GA, KY, MS, NC, SC, and TN, 5: IL, IN, MI, MN, OH, and WI, 6: AR, LA, NM, OK, and TX, 7: IA, KS, MO, and NE, 8: CO, MT, ND, SD, UT, and WY, 9: AZ, CA, HI, and NV, or 10: AK, ID, OR, and WA)	■	■
SVI (low vulnerability [summary SVI score deciles 1–4 or SVI unknown], medium vulnerability [summary SVI score deciles 5–8], or high vulnerability [summary SVI score deciles 9 and 10])	■	■
County-level AMI hospitalizations per 1,000 Medicare beneficiaries ages 65 and older in 2014–2016[h]	■	■
County-level stroke hospitalizations per 1,000 Medicare beneficiaries ages 65 and older in 2014–2016[h]	■	■
County-level age-adjusted mortality per 100,000 for residents ages 65 and older in 2014–2016[h]	■	■
County-level per capital total Medicare Parts A and B spending in 2016[h]	■	■
County-level hospital admissions per 1,000 Medicare FFS beneficiaries in 2016[h]	■	■
County-level outpatient ED visits per 1,000 Medicare FFS beneficiaries in 2016[h]	■	■
Characteristics of beneficiary's Million Hearts Model entry[f]		
Calendar month of the model entry/attribution date (24 variables, each corresponding to 1 of the 24 months in 2017 and 2018)	■	■
Fewer than 12 months observable in Medicare claims in the year before model entry/attribution (yes/no)	■	■
Data submitted to the Million Hearts Data Registry using bulk upload options (yes/no)[a, e]	■	

[a] We constructed this variable using data from the Million Hearts Data Registry.

[b] For the model population, we included an interaction term between this variable and the high-risk group indicator, in addition to the high-risk group indicator itself, in models that included both high- and medium-risk beneficiaries. For the attributed population, we interacted this variable with the probability of belonging to the high-risk group.

[c] For each model beneficiary, we estimated the amount of CVD risk that could be eliminated within one year of model entry if all modifiable risk factors were addressed. Modifiable risk factors were based on the ABCS of heart health— taking **a**spirin, controlling systolic **b**lood pressure, managing LDL **c**holesterol, and not **s**moking. Estimates of risk reduction were based on the novel longitudinal risk calculator created for the Million Hearts Model.

[d] For the model population, we interacted CVD risk group and modifiable CVD risk by three organization size categories: 1 to 5 practitioners, 6 to 19 practitioners, or 20 or more practitioners. For the attributed population, we interacted predicted CVD risk by organization size using the same three categories.

[e] To account for missing values, we included an indicator for missing data in the regression model.

[f] For the population of attributed beneficiaries, we defined these variables according to the date of the visit that led to the beneficiary being attributed to the participating organization (in place of the date of model entry).

[g] The distribution of beneficiaries by race and ethnicity is based on their predicted probabilities of falling into each category. The RAND Corporation developed the predicted probabilities from its Medicare Bayesian Improved Surname Geocoding (MBISG 2.0) algorithm,[13] which used information from CMS administrative data and beneficiaries' names and characteristics of their Census blocks to assign each beneficiary probabilities of being non-Hispanic White, non-Hispanic Black, Hispanic, Asian/Pacific Islander, American Indian/Alaska Native, and multiracial.

[h] Before including these variables in the regression models, we standardized each variable to have mean 0 and standard deviation 1.

[i] For the population of attributed beneficiaries, we defined these variables according to characteristics of the organization or practitioner the beneficiary was attributed to (in place of the organization or practitioner that entered the beneficiary into the model).

[j] To estimate organizational-level mean Medicare spending and use per beneficiary, we used only baseline data from the beneficiaries entering the model in 2017. Because many of the 2017 intervention group beneficiaries entered the model within the first few months of the year, their baseline period is more likely to span the period before the intervention started and, importantly, before the model might have affected the use and expenditures for the Medicare beneficiaries associated with organizations participating in the model. The organization-level means included in the regression models are the variance-shrunken means for each organization.

Abbreviations: AMI = acute myocardial infarction; CAH = critical access hospital; CMS = Centers for Medicare & Medicaid Services; CVD = cardiovascular disease; ED = emergency department; FFS = fee-for-service; FQHC = federally qualified health center; HCC = hierarchical condition category; HDL= high-density lipoprotein; HHS = U.S. Department of Health and Human Services; LDL = low-density lipoprotein; mg/dL = milligrams per deciliter; mmHg = millimeters of mercury; RHC = rural health center; SVI = Social Vulnerability Index.

eMethods 6. Identifying and analyzing outcomes among beneficiaries attributed to intervention and control organizations

In sensitivity analyses, we estimated intervention–control differences in outcomes among a population we defined by attributing Medicare FFS beneficiaries to the participating organizations using Medicare claims and enrollment data. This approach limited potential biases that could stem from differences in the types of beneficiaries whom the organizations chose to enter into the model, because the analysis included all eligible beneficiaries (to the extent we could replicate eligibility in Medicare data)—whether or not they actually entered the model.

In brief, the process for defining the population of attributed beneficiaries and analyzing their outcomes had three major components.

1. We used claims data to attribute Medicare FFS beneficiaries to participating organizations based on visits to those organizations. Specifically, we identified all Medicare FFS beneficiaries who, according to Medicare claims data, had office or clinic visits with one of the practitioners at an intervention or control organization that entered at least one beneficiary in the Million Hearts Model in 2017 or 2018. (Participating practitioners covered a range of specialties: 58% of high- and medium-risk beneficiaries were entered into the model by a primary care physician; 27% by a cardiologist; 3% by a physician with another specialty; and 11% by a non-physician [for example, a nurse practitioner or physician's assistant].) Visits had to occur during the period the practitioner actively participated in the model. Then we limited the attributed population to beneficiaries who met Million Hearts Model eligibility criteria, to the extent we could replicate those criteria in Medicare claims or enrollment data (for example, ages 40 to 79, with no previous myocardial infarction or stroke or TIA, no ESRD, and not in hospice) on the date of their first visit with the practitioner and organization they were attributed to. To assess previous myocardial infarction or stroke, we used data from the CMS Medicare Beneficiary Summary File chronic conditions segment about the first date, if any, that a beneficiary met the criteria for having a myocardial infarction or stroke based on Medicare FFS claims history going back as far as 1999. eFigure 1 provides sample sizes at different stages in this process.
2. Using an algorithm we developed, we used a person's claims-based characteristics at baseline to predict his or her (1) baseline CVD risk score; and (2) probabilities of being in the high-, medium-, and low-risk groups. We made these predictions because many of the beneficiaries in the attribution-based study population did not have data submitted to the Million Hearts Data Registry, so we could not observe clinical data to construct a true CVD risk score. We developed the risk prediction algorithm using data from the 2017 and 2018 model beneficiaries, for whom we had both clinical and claims data. We considered a range of candidate models and chose the model that performed best on relevant cross-validated metrics. (Random forest regression and gradient boosting classifier algorithms performed best at predicting baseline risk scores and risk groups, respectively.)
3. We estimated the mean difference in average outcomes (or hazard ratios) between beneficiaries attributed to intervention and control organizations. Because the population of attributed beneficiaries included beneficiaries of any risk level, we applied weights to the data for the attribution-based population to reflect either high- and medium-risk or high-risk beneficiaries, depending on the analysis. (The weight equaled, respectively, [1] the predicted probability the beneficiary was in the high-risk group plus the predicted probability the beneficiary was in the medium-risk group or [2] the predicted probability the beneficiary was in the high-risk group). Besides using weights, the regression models we used for these analyses were largely the same as those in the main analysis. The main difference in the model specification was that we had to substitute a few registry-based covariates (for example, clinical values such as blood pressure) with proxies available in claims data. See eMethods 5 for a complete list of the regression covariates.

The intervention and control group organizations entered roughly half the beneficiaries who visited the organizations in 2017 and 2018 and appeared to be eligible for the Million Hearts Model, based on their age and clinical characteristics observed in Medicare claims and enrollment data.

To compare our estimates obtained with the attributed beneficiaries to those obtained in our main analysis, we adjusted the output to account for the fact that not all beneficiaries in the attribution-based intervention group were entered into the model. Specifically, we divided the estimated regression-adjusted intervention–control difference by

the model entry rate. The validity of this adjustment relies heavily on the assumption that the model had no spillover effects to beneficiaries attributed to the organization but not entered in the model.

Although we used the attribution-based results primarily as a check for the main results, some might be interested in the attribution-based results in their own right. These estimates reflected our best estimate of the effects of the model among all Medicare beneficiaries eligible for the model who had office or clinic visits with participating practitioners, regardless of whether the practitioners' organization entered them into the model.

eTable 1. Characteristics of organizations that entered at least one beneficiary in the Million Hearts Model (2017–2018) versus those that were randomized but did not enter beneficiaries into the model

Characteristic	Intervention organizations		Control organizations	
	Entered beneficiaries (N = 173)	Did not enter beneficiaries (N = 87)	Entered beneficiaries (N = 172)	Did not enter beneficiaries (N = 84)
Organization size (reported on Million Hearts Model application)				
Total practitioners, median (q1, q3)	10 (3, 30)	10 (3, 31)	11 (4, 30)	8 (2, 29)
Total sites, median (q1, q3)	3 (1, 7)	3 (1, 6)	3 (1, 7)	2 (1, 6)
Location				
No. (%) rural	79 (46)	51 (59)	80 (47)	31 (37)
No. (%) in each Census region				
South	65 (38)	27 (31)	68 (40)	27 (32)
Northeast	52 (30)	17 (20)	41 (24)	26 (31)
Midwest	29 (17)	28 (32)	35 (20)	16 (19)
West	26 (15)	15 (17)	28 (16)	14 (17)
U.S. Territory	1 (1)	0 (0)	0 (0)	1 (1)
Organization type[a]				
No. (%) primary care	90 (52)	32 (37)	95 (55)	31 (37)
No. (%) specialty or multispecialty	39 (23)	22 (25)	35 (20)	23 (27)
No. (%) of federally qualified health centers, rural health clinics, or other health centers[b]	26 (15)	11 (13)	25 (15)	12 (14)
No. (%) hospital	18 (10)	20 (23)	17 (10)	13 (15)
No. (%) other/unknown	0 (0)	2 (2)	0 (0)	5 (6)
Participating in other CMS models or programs when applied for the Million Hearts Model				
No. (%) in one or more CMS initiative (or application pending at random assignment)	88 (51)	35 (40)	84 (49)	28 (33)
No. (%) participating in the Medicare Shared Savings Program	51 (29)	18 (21)	37 (22)	11 (13)

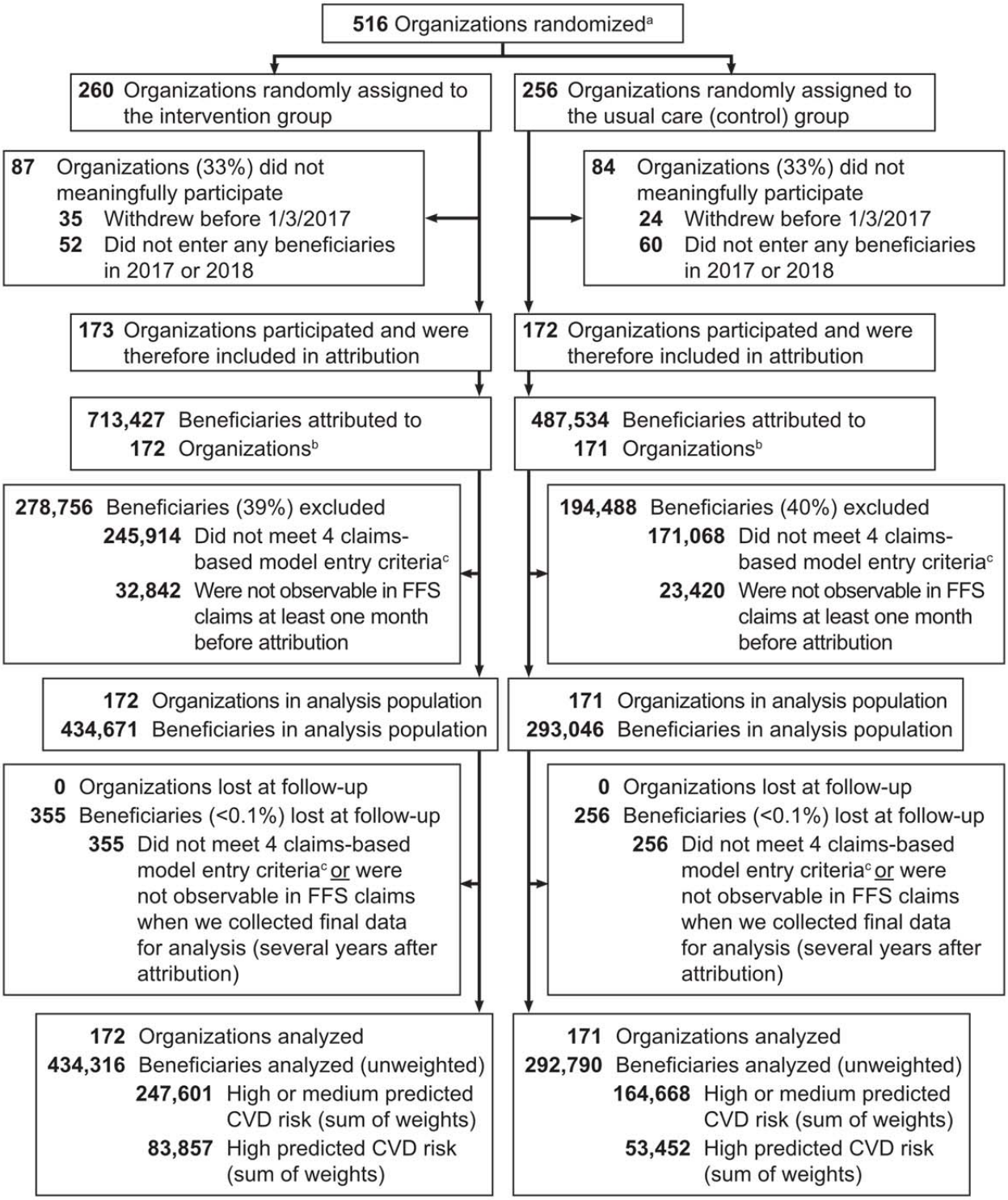
[a] Organization type is based on data from the organizations' Million Hearts Model applications linked to the CMS National Plan & Provider Enumeration System.

[b] "Other health centers" include Indian health and migrant health centers.

[c] Hospital sites were outpatient clinics within hospitals. The National Provider Identifier Type 2 organization taxonomy codes that we used to categorize the organizations does not distinguish hospitals' primary care clinics from their specialty care clinics.

Abbreviations: CMS = Centers for Medicare & Medicaid Services; q1 = quartile 1 (25th percentile) value; q3 = quartile 3 (75th percentile) value; SD = standard deviation.

eFigure 1. Flow of organizations and attributed beneficiaries from randomization through analysis



[a] CMS received 762 applications, but 246 organizations were not eligible or did not sign a participation agreement.

[b] One intervention organization and one control organization did not have any beneficiaries attributed to them. In the control group, the number of participating practitioners per organization was capped at 20. This resulted in fewer beneficiaries per organization, on average, in the control group versus the intervention group.

[c] The criteria are ages 40 to 79, no prior acute myocardial infarction, no prior stroke, no end-stage renal disease, and no hospice.
Abbreviations: CMS = Centers for Medicare & Medicaid Services; CVD = cardiovascular disease; FFS = fee-for-service.

eTable 2. Baseline characteristics of Medicare beneficiaries entered into the model in 2017 or 2018 (with high, medium, or low CVD risk) versus beneficiaries attributed but not entered into the model[a]

Characteristic	Intervention group		Control group	
	Entered the model (N = 228,020)	Attributed but did not enter (N = 206,590)	Entered the model (N = 154,101)	Attributed but not did not enter (N = 138,915)
Demographics and socioeconomic status				
Age,[b] median (q1, q3), years	69 (66, 73)	69 (65, 73)	69 (66, 73)	69 (65, 73)
No. (%) with Black race[c]	18,000 (8)	18,490 (9)	10,569 (7)	13,631 (10)
No. (%) female[b]	127,998 (56)	112,084 (54)	85,037 (55)	75,599 (54)
No. (%) male[b]	100,022 (44)	94,506 (46)	69,064 (45)	63,316 (46)
No. (%) dually eligible for Medicaid[b]	32,211 (14)	33,909 (16)	22,949 (15)	25,620 (18)
Risk factors for myocardial infarction and stroke[d]				
No. (%) with diabetes	62,979 (28)	55,961 (27)	43,059 (28)	37,640 (27)
No. (%) with ischemic heart disease	56,100 (25)	61,715 (30)	40,453 (26)	39,409 (28)
No. (%) with hypertension	150,050 (66)	129,237 (63)	101,293 (66)	87,113 (63)
No. (%) with hyperlipidemia	102,840 (45)	85,784 (42)	70,981 (46)	56,411 (41)
Medication use[e]				
No. (%) with Medicare Part D prescription drug coverage	149,223 (65)	129,838 (63)	100,666 (65)	86,446 (62)
No. (% among those with Part D coverage) with antihypertensive use	108,262 (73)	92,353 (71)	72,814 (72)	61,578 (71)
No. (% among those with Part D coverage) with statin use	84,328 (57)	69,319 (53)	57,565 (57)	44,651 (52)
Low intensity	8,940 (6)	6,787 (5)	6,062 (6)	4,463 (5)
Medium intensity	52,508 (35)	41,737 (32)	35,146 (35)	26,332 (30)
High intensity	22,880 (15)	20,795 (16)	16,357 (16)	13,856 (16)
Model-qualifying visits[f]				
No. (%) whose first model-qualifying visit was with a primary care physician	142,593 (63)	91,055 (44)	99,977 (65)	75,309 (54)
No. (%) whose first model-qualifying visit was with a cardiologist	53,252 (23)	81,798 (40)	35,366 (23)	46,061 (33)
Health care service use in the year before attribution[d]				
Total Medicare Parts A and B spending, median (q1, q3), dollars per beneficiary per month	192 (70, 506)	229 (75, 668)	186 (68, 493)	212 (69, 631)
All-cause hospitalizations, mean (SD), per 1,000 people per year[g]	181 (959)	273 (2,036)	183 (1,135)	271 (1,653)
Circulatory system-related hospitalizations, mean (SD), per 1,000 people per year[g]	35 (335)	58 (985)	38 (747)	58 (642)
All-cause ED visits, mean (SD), per	435 (1,608)	582 (2,534)	424 (1,701)	614 (3,193)

Characteristic	Intervention group		Control group	
	Entered the model (N = 228,020)	Attributed but did not enter (N = 206,590)	Entered the model (N = 154,101)	Attributed but not did not enter (N = 138,915)
1,000 people per year[g]				
Circulatory system-related ED visits, mean (SD), per 1,000 people per year[g]	25 (466)	39 (437)	25 (245)	42 (1,085)
Office visits, median (q1, q3), per person per year	7 (3, 12)	7 (3, 13)	6 (3, 12)	7 (3, 13)
Office visits with a practitioner listed on the organization's Million Hearts Model application, median (q1, q3), per person per year	1 (0, 3)	0 (0, 2)	1 (0, 3)	0 (0, 2)

[a] We limited this analysis to attributed beneficiaries—that is, beneficiaries who, in 2017 or 2018, visited a practitioner participating in the Million Hearts Model, and who met model eligibility criteria we could replicate in Medicare claims and enrollment data. We described those eligibility criteria and the methods used to attribute beneficiaries earlier in this supplement (eMethods 6). We excluded CVD risk factors from this table if we could not observe those risk factors using Medicare claims or enrollment data; we do not have clinical data from the Million Hearts Data Registry for beneficiaries not in the model.

[b] Based on data from the Medicare enrollment database.

[c] Based on probabilities of Black race from the RAND Medicare Bayesian Improved Surname Geocoding race and ethnicity file.

[d] Based on Medicare Parts A and B claims.

[e] Based on Medicare Part D claims.

[f] Based on Medicare claims data linked to specialty information in the National Plan & Provider Enumeration System.

[g] We show means per 1,000 people rather than medians per person because the median, q1, and q3 values per person were all 0.

Abbreviations: CVD = cardiovascular disease; ED = emergency department; q1 = quartile 1 (25th percentile) value; q3 = quartile 3 (75th percentile) value; SD = standard deviation.

eTable 3. Effects of the Million Hearts Model on deaths, by cause, within four years of model entry

Percentage of people who died within 4 years after model entry, by cause of death	Unadjusted means		Difference			
	Intervention group	Control group	Unadjusted	Adjusted (90% CI)	Percent-age effect	p-value
High- and medium-risk beneficiaries						
All cause[a]	10.1	10.7	-0.65	-0.48 (-0.77 to -0.18)	-4.5%	0.009
Circulatory system conditions[b]	2.8	3.0	-0.24	-0.19 (-0.35 to -0.03)	-6.4%	0.05
CHD or cerebrovascular	1.6	1.9	-0.22	-0.19 (-0.32 to -0.07)	-10.6%	0.009
CHD	1.3	1.5	-0.18	-0.18 (-0.29 to -0.06)	-11.9%	0.01
Cerebrovascular	0.3	0.4	-0.04	-0.02 (-0.06 to +0.03)	-4.8%	0.58
Other circulatory system conditions	1.2	1.2	-0.02	+0.00 (-0.09 to +0.10)	+0.4%	0.95
Noncirculatory or unknown cause	7.3	7.7	-0.41	-0.29 (-0.53 to -0.04)	-3.8%	0.06
High-risk beneficiaries						
All cause[a]	13.5	13.7	-0.24	+0.02 (-0.51 to +0.55)	+0.1%	0.95
Circulatory-system conditions[b]	3.9	4.2	-0.26	-0.26 (-0.59 to +0.07)	-6.3%	0.19
CHD or cerebrovascular	2.4	2.6	-0.26	-0.24 (-0.50 to +0.03)	-9.1%	0.14
CHD	1.9	2.2	-0.27	-0.32 (-0.57 to -0.07)	-14.4%	0.03
Cerebrovascular	0.5	0.5	+0.01	+0.08 (-0.01 to +0.17)	+21.0%	0.12
Other circulatory system conditions	1.5	1.5	+0.00	-0.03 (-0.21 to +0.16)	-1.6%	0.82
Noncirculatory or unknown cause	9.6	9.6	+0.02	+0.28 (-0.16 to +0.72)	+3.0%	0.29

[a] All-cause mortality results presented in this table are from the same multinomial logistic regression model as the cause-specific results.

[b] See eMethods 3 for classifications of cause of death, based on the underlying cause of death information listed in the National Death Index.

Abbreviations: CHD = coronary heart disease; CI = confidence interval.

eTable 4. Effects of the Million Hearts Model on first-time myocardial infarctions and strokes using alternative claims-based definitions

	High- and medium-risk group						High-risk group					
	Unadjusted rate		Hazard ratio				Unadjusted rate		Hazard ratio			
Outcome	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[a]	*p*-value	Inter-vention	Control	Un-adjusted HR	Adjusted HR (90% CI)	Percentage effect[a]	*p*-value
Primary outcome: first-time myocardial infarctions, strokes, and TIAs[b]	15.8	17.0	HR = 0.925	HR = 0.967 (0.935 to 0.999)	-3.3%	0.09	21.3	22.7	HR = 0.937	HR = 0.987 (0.943 to 1.033)	-1.3%	0.63
First-time myocardial infarctions and strokes using narrower definition[c]	13.0	14.2	HR = 0.918	HR = 0.961 (0.926 to 0.997)	-3.9%	0.07	17.9	19.2	HR = 0.932	HR = 0.990 (0.943 to 1.039)	-1.0%	0.72
First-time myocardial infarctions and strokes using narrowest definition[d]	12.0	13.1	HR = 0.918	HR = 0.964 (0.927 to 1.002)	-3.6%	0.12	16.4	17.7	HR = 0.928	HR = 0.989 (0.939 to 1.042)	-1.1%	0.73

[a] The percent effect is $(HR - 1)x100\%$

[b] Myocardial infarctions, strokes, TIAs, or stroke symptoms, using primary diagnoses on outpatient ED claims or primary and secondary diagnoses on inpatient claims. For myocardial infarctions, we include all five types of acute myocardial infarctions described in the Fourth Universal Definition of Myocardial Infarction.[3]

[c] Myocardial infarctions and strokes only (excludes TIAs or stroke syndromes), using primary diagnoses on outpatient ED claims or primary and secondary diagnoses on inpatient claims. For myocardial infarctions, we include only the first type of acute myocardial infarctions described in the Fourth Universal Definition of Myocardial Infarction.[3]

[d] Myocardial infarctions and strokes only (excludes TIAs or stroke syndromes) listed as primary diagnosis on ED or inpatient claim. For myocardial infarctions, we include only the first type of acute myocardial infarctions described in the Fourth Universal Definition of Myocardial Infarction.[3]

Abbreviations: CI = confidence interval; ED = emergency department; HR = hazard ratio; TIA = transient ischemic attack.

452 **eTable 5. Effects of the Million Hearts Model on binary measures of health events (logistic regression results)**

	High- and medium-risk group						High-risk group					
	Unadjusted means		Difference				Unadjusted means		Difference			
Outcome	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[a]	*p*-value	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[a]	*p*-value
Percentage with first-time myocardial infarction, stroke, or TIA (from Medicare claims only)												
Within one year of model entry	1.4	1.4	-0.0	+0.0 (-0.1 to +0.1)	+1.6%	0.69	1.9	1.9	+0.0	+0.1 (-0.1 to +0.3)	+5.5%	0.34
Within two years of model entry	2.8	3.0	-0.2	-0.0 (-0.1 to +0.1)	-0.5%	0.86	3.8	4.0	-0.2	-0.0 (-0.3 to +0.2)	-0.6%	0.87
Within three years of model entry	4.1	4.4	-0.3	-0.1 (-0.3 to +0.1)	-2.2%	0.38	5.5	5.9	-0.4	-0.1 (-0.4 to +0.2)	-2.0%	0.52
Within four years of model entry	5.3	5.8	-0.4	-0.2 (-0.4 to -0.0)	-4.1%	0.07	7.0	7.5	-0.5	-0.3 (-0.7 to +0.1)	-4.0%	0.18
Percentage with first-time myocardial infarction, stroke, or TIA, including deaths due to CHD or cerebrovascular disease												
Within one year of model entry	1.6	1.7	-0.1	-0.0 (-0.1 to +0.1)	-0.9%	0.80	2.2	2.2	-0.0	+0.1 (-0.1 to +0.3)	+3.1%	0.57
Within two years of model entry	3.3	3.5	-0.2	-0.1 (-0.2 to +0.1	-1.5%	0.57	4.6	4.8	-0.2	-0.0 (-0.3 to +0.2)	-0.6%	0.87
Within three years of model entry	5.0	5.3	-0.3	-0.1 (-0.3 to -0.0)	-2.6%	0.23	6.7	7.1	-0.4	-0.1 (-0.5 to +0.2)	-2.1%	0.44
Within four years of model entry	6.5	7.1	-0.6	-0.4 (-0.6 to -0.1)	-5.3%	0.01	8.6	9.3	-0.7	-0.5 (-0.9 to -0.1)	-5.6%	0.04
Percentage who died												
Within one year of model entry	1.7	1.8	-0.2	-0.2 (-0.3 to -0.0)	-8.4%	0.03	2.1	2.2	-0.1	-0.1 (-0.3 to +0.1)	-4.1%	0.47
Within two years of model entry	3.9	4.2	-0.3	-0.2 (-0.4 to -0.1)	-5.2%	0.02	5.2	5.3	-0.1	+0.0 (-0.3 to +0.3)	+0.5%	0.89

	High- and medium-risk group						High-risk group					
	Unadjusted means		Difference				Unadjusted means		Difference			
Outcome	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[a]	*p*-value	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[a]	*p*-value
Within three years of model entry	6.7	7.1	-0.4	-0.2 (-0.5 to -0.0)	-3.6%	0.06	8.9	9.2	-0.3	+0.1 (-0.3 to +0.5)	+0.9%	0.74
Within four years of model entry	10.1	10.7	-0.6	-0.5 (-0.8 to -0.2)	-4.4%	0.01	13.5	13.7	-0.2	+0.1 (-0.5 to +0.6)	+0.4%	0.88

[a] The percentage effect is relative to the regression-adjusted control group mean.

Abbreviations: CHD = coronary heart disease; CI = confidence interval; TIA = transient ischemic attack.

eTable 6. Effects of the Million Hearts Model on primary and secondary study outcomes for the trimmed population,[a] mimicking the control group's 20-practitioner cap in the intervention group

	High- and medium-risk group						High-risk group					
	Unadjusted rate or mean			HR or difference (Δ)			Unadjusted rate or mean			HR or difference (Δ)		
Outcome (unit), by domain	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value
Health events (number per 1,000 person-years)												
Primary outcome: first-time myocardial infarctions, strokes, and TIAs (from Medicare claims only)	16.1	17.0	HR = 0.946	HR = 0.966 (0.933 to 1.000)	-3.4%	0.10	21.7	22.7	HR = 0.952	HR = 0.982 (0.934 to 1.033)	-1.8%	0.56
First-time myocardial infarctions, strokes, and TIAs, including deaths due to CHD or cerebrovascular disease	19.1	20.3	HR = 0.939	HR = 0.953 (0.923 to 0.985)	-4.7%	0.02	26.0	27.4	HR = 0.948	HR = 0.970 (0.925 to 1.017)	-3.0%	0.28
All-cause deaths	28.5	29.6	HR = 0.957	HR = 0.962 (0.933 to 0.991)	-3.8%	0.03	38.6	39.3	HR = 0.977	HR = 0.995 (0.953 to 1.038)	-0.5%	0.84

Outcome (unit), by domain	High- and medium-risk group						High-risk group					
	Unadjusted rate or mean			HR or difference (Δ)			Unadjusted rate or mean			HR or difference (Δ)		
	Intervention	Control	Unadjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value	Intervention	Control	Unadjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value
Medicare spending ($ per beneficiary per month)												
Primary outcome: Medicare spending on first-time myocardial infarctions, strokes, and TIAs and 90-day follow-up	$38.56	$40.74	Δ = -$2.18	Δ = -$1.57 (-$3.93 to +$0.79)	-3.9%	0.27	$51.28	$55.82	Δ = -$4.54	Δ = -$3.20 (-$7.93 to +$1.53)	-5.9%	0.27
Total Medicare Parts A and B spending, before model payments	$972.33	$954.61	Δ = +$17.72	Δ = +$3.73 (-$15.11 to +$22.56)	+0.4%	0.74	$1,111.66	$1,088.05	Δ = +$23.61	Δ = +$13.58 (-$15.58 to +$42.75)	+1.2%	0.44
Health care service use (number per 1,000 beneficiaries per year)												
All-cause hospitalizations	256.8	251.8	Δ = +5.0	Δ = +9.1 (+3.7 to +14.5)	+3.7%	0.006	77.3	75.6	Δ = +1.7	Δ = +3.1 (+0.8 to +5.3)	+4.1%	0.03
Circulatory system-related hospitalizations	57.2	57.0	Δ = +0.1	Δ = +0.7 (-1.2 to +2.5)	+1.2%	0.55	76.4	75.6	Δ = +0.8	Δ = +2.3 (-0.9 to +5.4)	+3.0%	0.23
All-cause ED visits	393.1	383.0	Δ = +10.1	Δ = +8.3 (-1.4 to +18.1)	+2.2%	0.16	430.3	416.6	Δ = +13.7	Δ = +14.6 (+2.5 to +26.8)	+3.5%	0.05
Circulatory-system-related ED visits	33.7	33.0	Δ = +0.7	Δ = +0.5 (-1.4 to +2.3)	+1.4%	0.68	40.4	39.3	Δ = +1.0	Δ = +1.2 (-1.3 to +3.7)	+3.2%	0.42

Outcome (unit), by domain	High- and medium-risk group						High-risk group					
	Unadjusted rate or mean			HR or difference (Δ)			Unadjusted rate or mean			HR or difference (Δ)		
	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percentage effect[b]	*p*-value
Office visits	10,699.1	10,176.0	Δ = +523.1	Δ = +101.6 (-57.3 to +260.4)	+1.0%	0.29	11,425.1	10,879.1	Δ = +546.1	Δ = +148.2 (-53.4 to +349.9)	+1.3%	0.23

[a] We trimmed the intervention group to mimic the 20-practitioner cap applied to the control group. Patterns of model entry in the control group suggest that control organizations—faced with the cap—strategically selected their participating practitioners to be those who could enter the most beneficiaries. We replicated this in the intervention group by (1) identifying each practitioner who entered a beneficiary at a large intervention organization (with large organizations defined as those with more than 20 practitioners entering beneficiaries into the model), (2) ranking those practitioners by the number of beneficiaries they entered into the model in 2017 or 2018, (3) selecting the top 20, and (4) removing from the intervention group any beneficiaries entered by practitioners not ranked in the top 20.

[b] For effects on the hazard ratio scale, the percent effect is $(HR - 1)x100\%$. For effects on the difference scale, the percent effect is relative to the regression-adjusted control group mean.

Abbreviations: CHD = coronary heart disease; CI = confidence interval; ED = emergency department; HR = hazard ratio.

467 **eTable 7. Effects of the Million Hearts Model on primary and secondary study outcomes among attributed**
468 **beneficiaries**

	Unadjusted rate or mean		HR or difference (Δ)				Implied effect for model population[a] (90% CI)
	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percent effect[b]	*p*-value	
Predicted high- and medium-risk group							
Health events (number per 1,000 person-years)							
Primary outcome: first-time myocardial infarctions, strokes, and TIAs (from Medicare claims only)	17.6	18.4	HR = 0.955	HR = 0.989 (0.960 to 1.018)	-1.1%	0.53	HR = 0.979 (0.926 to 1.035)
First-time myocardial infarctions, strokes, and TIAs, including deaths due to CHD or cerebrovascular disease	21.3	22.2	HR = 0.959	HR = 0.987 (0.959 to 1.015)	-1.3%	0.44	HR = 0.975 (0.925 to 1.029)
All-cause deaths	33.0	34.1	HR = 0.965	HR = 0.985 (0.961 to 1.009)	-1.5%	0.01	HR = 0.972 (0.928 to 1.017)
Medicare spending ($ per beneficiary per month)							
Primary outcome: Medicare spending on first-time myocardial infarctions, strokes, and TIAs and 90-day follow-up	$42.01	$43.42	Δ = -$1.41	Δ = -$1.04 (-$3.19 to +$1.10)	-2.4%	0.42	Δ = -$1.71 (-$5.20 to +$1.79)
Total Medicare Parts A and B spending, before model payments	$1,056.09	$1,029.80	Δ = +$26.28	Δ = +$3.21 (-$16.63 to +$23.05)	+0.3%	0.79	Δ = +$5.76 (-$29.72 to +$41.24)
Health care service use (number per 1,000 beneficiaries per year)							
All-cause hospitalizations	284.6	281.8	Δ = +2.8	Δ = +6.8 (+1.7 to +12.0)	+2.5%	0.03	Δ = +12.2 (+3.1 to +21.4)
Circulatory system-related hospitalizations	63.9	64.3	Δ = -0.4	Δ = +1.4 (-0.2 to +2.9)	+2.2%	0.15	Δ = +2.4 (-0.3 to +5.2)
All-cause ED visits	423.2	430.5	Δ = -7.4	Δ = +8.5 (-0.9 to +17.9)	+2.0%	0.13	Δ = +15.2 (-1.5 to +32.0)
Circulatory system-related ED visits	36.0	36.7	Δ = -0.7	Δ = +1.6 (-0.3 to +3.5)	+4.6%	0.17	Δ = +2.8 (-0.5 to +6.2)
Office visits	10,881.4	10,545.4	Δ = +336.0	Δ = +21.3 (-133.0 to	+0.2%	0.82	Δ = +38.3 (-237.7 to +314.2)

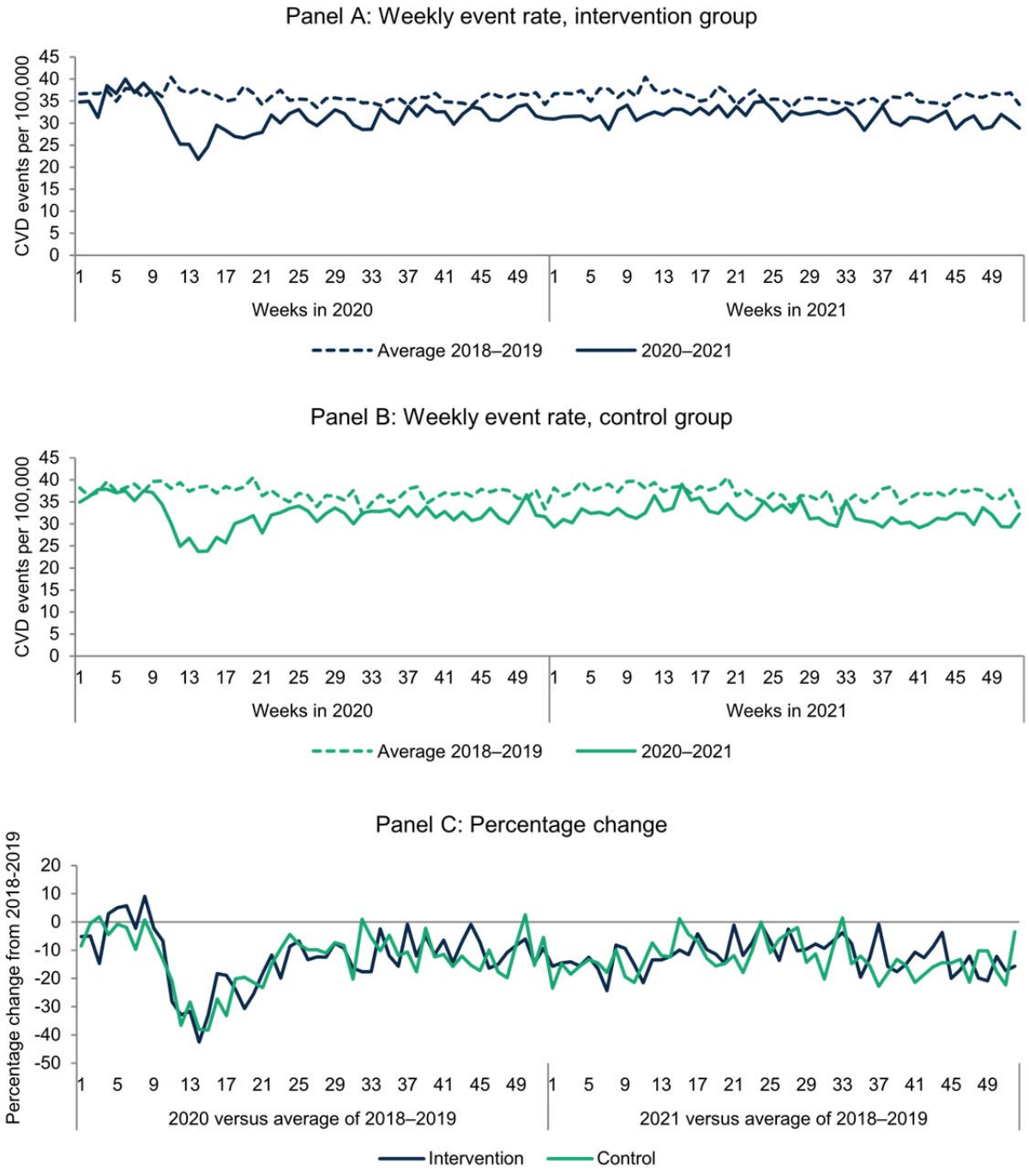
	Unadjusted rate or mean		HR or difference (Δ)				Implied effect for model population[a] (90% CI)
	Inter-vention	Control	Un-adjusted	Adjusted (90% CI)	Percent effect[b]	*p*-value	
				+175.7)			
Predicted high-risk group							
Health events (number per 1,000 person-years)							
Primary outcome: first-time myocardial infarctions and strokes (from Medicare claims only)	21.9	23.2	HR = 0.945	HR = 0.992 (0.959 to 1.027)	-0.8%	0.70	HR = 0.985 (0.923 to 1.051)
First-time myocardial infarctions or strokes, including deaths due to CHD or cerebrovascular disease	27.1	28.4	HR = 0.953	HR = 0.989 (0.957 to 1.022)	-1.1%	0.58	HR = 0.979 (0.920 to 1.043)
All-cause deaths	42.9	44.6	HR = 0.960	HR = 0.978 (0.951 to 1.006)	-2.2%	0.02	HR = 0.959 (0.910 to 1.011)
Medicare spending ($ per beneficiary per month)							
Primary outcome: Medicare spending on first-time myocardial infarctions and strokes and immediate follow-up	$51.69	$55.46	Δ = -$3.77	Δ = -$2.09 (-$5.19 to +$1.00)	-3.9%	0.27	Δ = -$3.47 (-$8.58 to +$1.64)
Total Medicare Parts A and B spending, before model payments	$1,178.07	$1,159.50	Δ = +$18.57	Δ = +$0.46 (-$24.48 to +$25.41)	+0.0%	0.98	Δ = +$0.83 (-$43.71 to +$45.38)
Health care service use (number per 1,000 beneficiaries per year)							
All-cause hospitalizations	333.0	333.2	Δ = -0.1	Δ = +6.6 (-0.6 to +13.8)	+2.0%	0.13	Δ = +11.8 (-1.0 to +24.6)
Circulatory system-related hospitalizations	81.2	81.9	Δ = -0.7	Δ = +2.4 (+0.3 to +4.6)	+3.1%	0.06	Δ = +4.4 (+0.6 to +8.2)
All-cause ED visits	454.6	464.6	Δ = -10.0	Δ = +6.6 (-4.0 to +17.3)	+1.5%	0.30	Δ = +11.9 (-7.1 to +30.9)
Circulatory system-related ED visits	41.1	41.7	Δ = -0.6	Δ = +2.5 (+0.1 to +4.8)	+6.4%	0.08	Δ = +4.4 (+0.2 to +8.6)
Office visits	11,603.1	11,210.8	Δ = +392.4	Δ = +29.6 (-155.7 to +214.9)	+0.3%	0.79	Δ = +53.0 (-278.0 to +383.9)

[a] These columns present the implied effect for model beneficiaries assuming overall impacts among attributed beneficiaries come solely through the subset of beneficiaries entered into the model. We obtained this estimate by dividing the regression model coefficient corresponding to the impact estimate by the percentage of attributed beneficiaries who were entered into the model. For effects on the hazard ratio scale, we expressed this scaled regression coefficient as a hazard ratio.

[b] For effects on the hazard ratio scale, the percent effect is $(HR - 1)x100\%$. For effects on the difference scale, the percent effect is relative to the regression-adjusted control group mean.

Abbreviations: CHD = coronary heart disease; CI = confidence interval; ED = emergency department; HR = hazard ratio.

eFigure 2. Assessment of the influence of Covid-19 on CVD events:[a] County-level CVD event rates declined similarly in 2020–2021 across the intervention and control group beneficiaries' counties, relative to the average rates in 2018 and 2019 (beneficiaries ages 40 to 79)



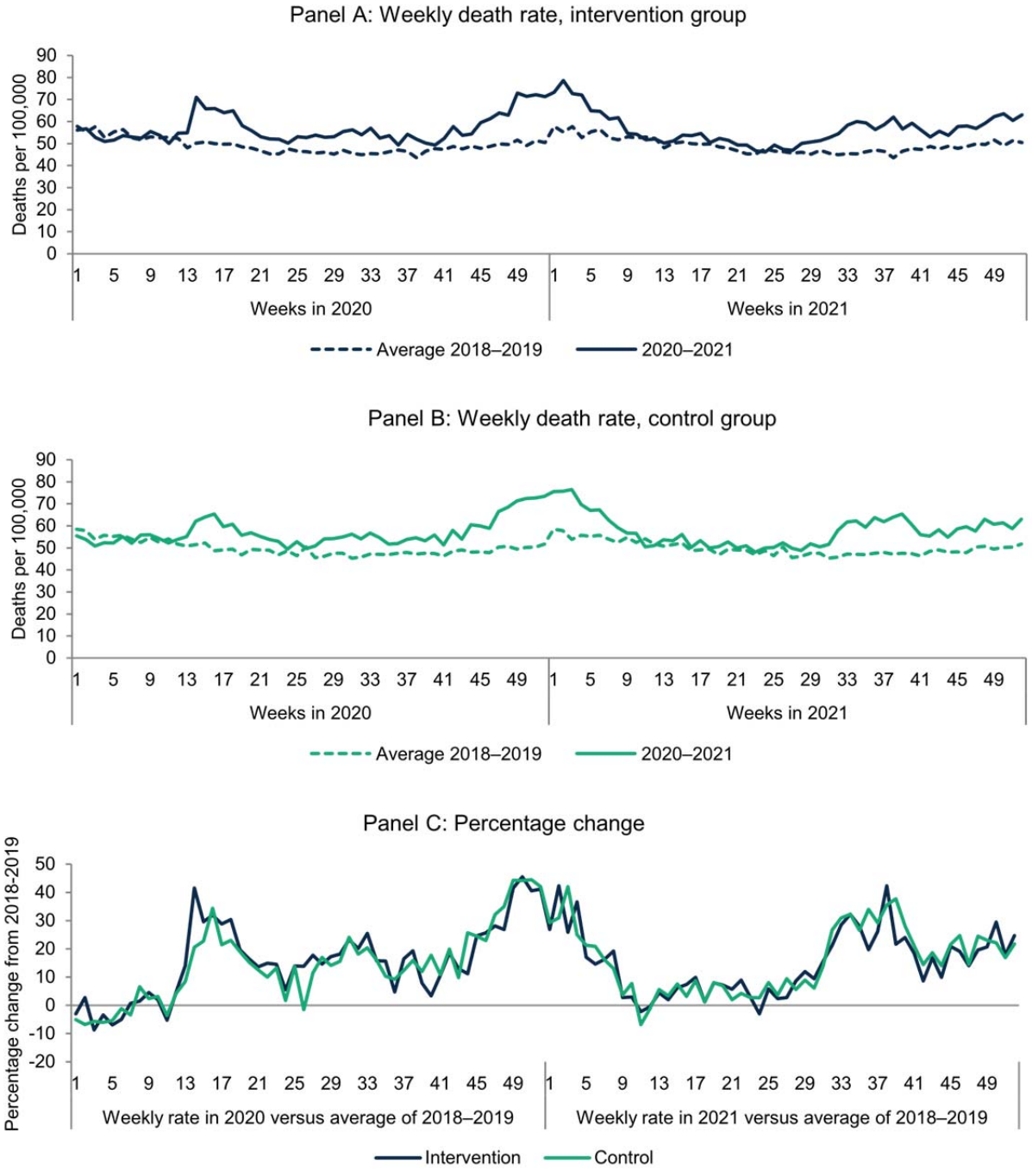
[a] Because the distribution of intervention and control group beneficiaries across U.S. counties is not identical, regional differences in Covid-19 infection rates or responses to Covid-19 could lead to differences in outcomes between the intervention and control groups. To assess the potential for such differences due to Covid-19, we calculated the *county-level* differences in outcome rates in each week in 2020 and 2021 versus the average rates for the same week in 2018–2019 among Medicare FFS beneficiaries ages 40 to 79, with each county weighted by the number of intervention or control group beneficiaries living in that county. The 2018–2019

rates are repeated along the x-axis, so that, for example, CVD event rates in Week 1 of 2020 and in Week of 2021 are both shown relative to the same 2018–2019 Week 1 average. The rationale for using weighted county-level rates is to approximate the likely effects of Covid-19 on outcomes for the actual intervention and control groups based on the counties where intervention and control beneficiaries live.

This figure reflects all CVD events, not only first-time CVD events, due to feasibility challenges identifying first-time events for the full FFS population. For the rates in Panels A and B, the denominator in each week is the number of Medicare FFS beneficiaries in each county between the ages of 40 and 79 who were alive and enrolled in Medicare Parts A and B FFS with Medicare as primary payer at the start of that week. The numerator is the number (among the denominator population) of acute inpatient hospitalizations, outpatient ED visits, and outpatient observation stays for a myocardial infarction or stroke (excluding diagnosis codes indicating care only for an earlier myocardial infarction or stroke), based on a relevant claim. The rates in Panel A are weighted by the number of intervention group beneficiaries in each county. (This figure effectively drops counties with no intervention group beneficiaries.) Similarly, the rates in Panel B are weighted by the number of control group beneficiaries in each county. (This figure effectively drops counties with no control group beneficiaries.) Panel C reports the percentage change in weighted rates for each week in 2020 and 2021 versus the average rate for 2018 and 2019 for the same week for each group. Although outcome levels changed substantially between 2018–2019 and 2020–2021, those changes were extremely similar in regions inhabited by intervention versus control group beneficiaries. eTable 8 shows that observed intervention–control differences would have only a trivial influence on estimates of the model's effects.

Abbreviations: CVD = cardiovascular disease; ED = emergency department; FFS = fee-for-service.

eFigure 3. Assessment of the influence of Covid-19 on the death rate:[a] The county-level death rate declined similarly in 2020–2021 across the intervention and control group beneficiaries' counties, relative to the average rates in 2018 and 2019 (beneficiaries ages 40 to 79)

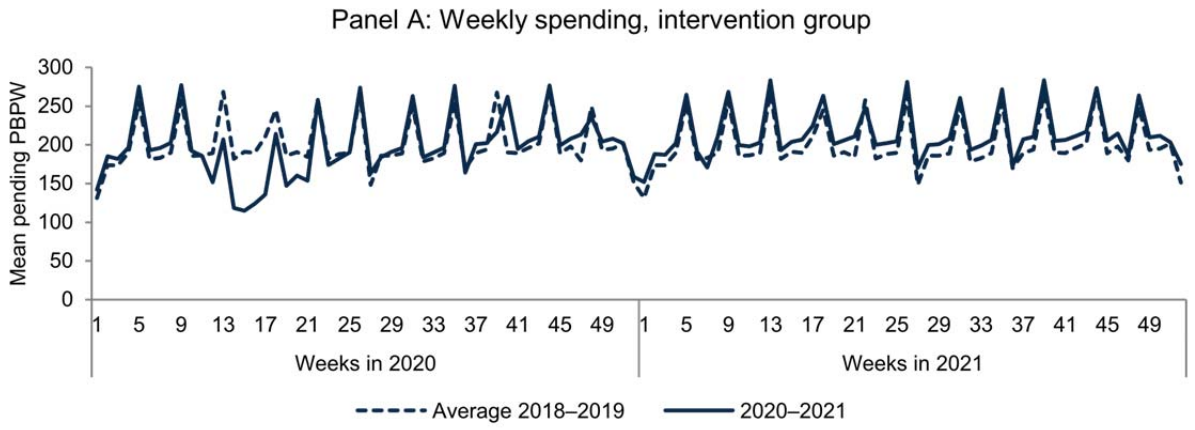


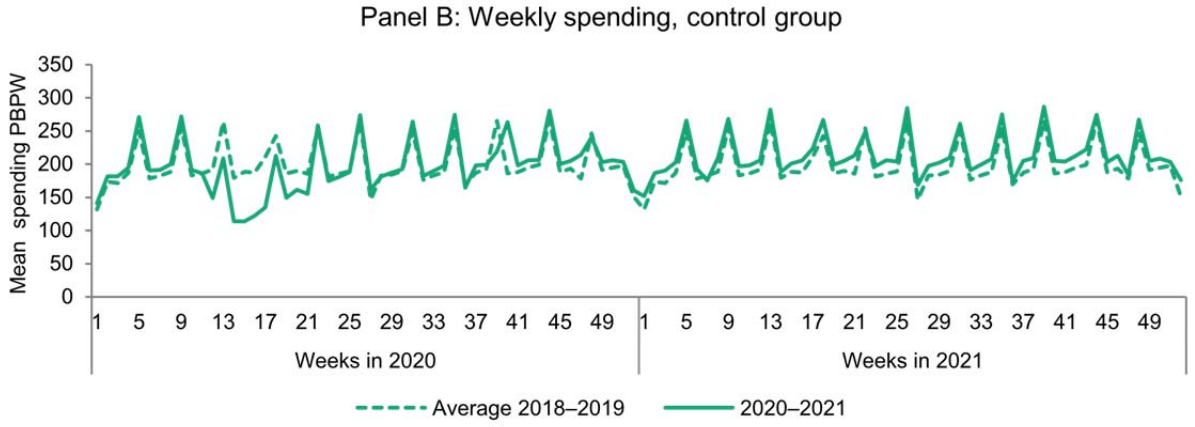
[a] As in eFigure 2, this figure reports the percentage change in weighted rates in 2020 and 2021 versus the average rate for 2018 and 2019 for the same week for each group (intervention versus control). To calculate the death rate for each county, the denominator for each week is the number of Medicare FFS beneficiaries in the county between the ages of 40 and 79 who were alive and enrolled in Medicare Parts A and B FFS with Medicare as primary payer at the start of that week. The numerator is the number of beneficiaries who died during that week among the denominator population. Intervention group weekly rates are weighted

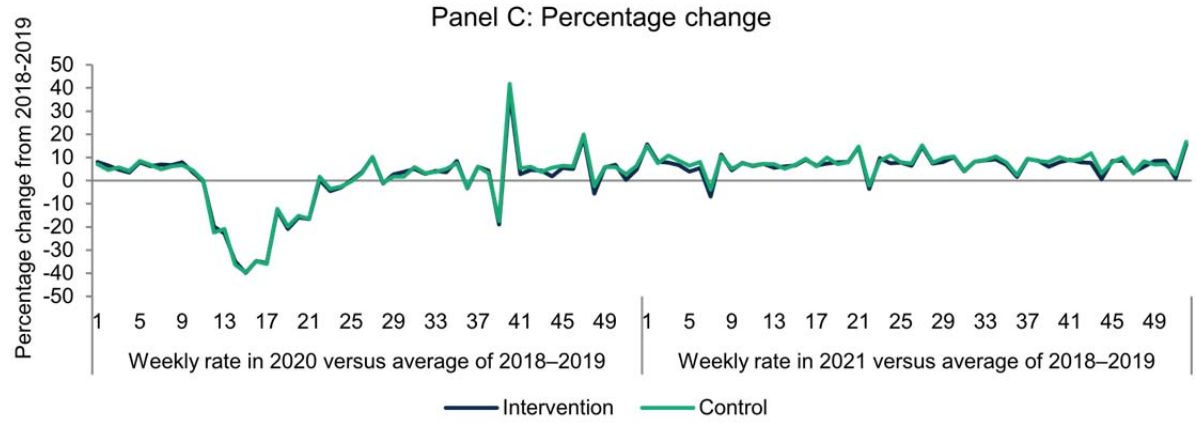
by the number of intervention group beneficiaries in each county. (This figure effectively drops counties with no intervention group beneficiaries.) Similarly, control group weekly rates are weighted by the number of control group beneficiaries in each county. (This figure effectively drops counties with no control group beneficiaries.) Although outcome levels changed substantially between 2018–2019 and 2020–2021, those changes were extremely similar in regions inhabited by intervention versus control group beneficiaries. eTable 8 shows that observed intervention–control differences would have only a trivial influence on estimates of the model's effects.

Abbreviations: FFS = fee-for-service.

eFigure 4. Assessment of the influence of Covid-19 on Medicare spending:[a] County-level Parts A and B spending (per capita) declined similarly in 2020–2021 across the intervention and control group beneficiaries' counties, relative to the average rates in 2018 and 2019 (beneficiaries ages 40 to 79)







[a] As in eFigures 2 and 3, the figure reports the percentage change in weighted spending per person per week in 2020 and 2021 versus the average rate for 2018 and 2019 for the same week for each group. To calculate each county's per-person per-week spending, the denominator for each week is the number of Medicare FFS beneficiaries in each county between the ages of 40 and 79 who were alive and enrolled in Medicare Parts A and B FFS with Medicare as primary payer at the start of that week. The numerator is the total Medicare Parts A and B FFS spending during that week among the denominator population. Intervention group weekly spending rates are weighted by the number of intervention group beneficiaries in each county. (This figure effectively drops counties with no intervention group beneficiaries.) Similarly, control group weekly rates are weighted by the number of control group beneficiaries in each county. (This figure effectively drops counties with no control group beneficiaries.) Although outcome levels changed substantially between 2018–2019 and 2020–2021, those changes were extremely similar in regions inhabited by intervention versus control group beneficiaries. eTable 8 shows that observed intervention–control differences would have only a trivial influence on estimates of the model's effects.

We binned spending by week based on the claim through date, so claims paid monthly (for example, skilled nursing facility and hospice for beneficiaries using services all month) get binned on the last date of each month. This explains the monthly spikes in spending in Panels A and B of the figure.

The spike in Panel C in Week 40 of 2020 occurs because 2020 was a leap year; Week 40 of 2020 starts on September 30, 2020, whereas Week 40 starts on October 1 in 2018–2019. Together, these two factors lead to an artificial reduction in spending in Week 39 in 2020, relative to 2018–2019, followed by an increase in spending in Week 40 in 2020 relative to 2018–2019, as the end-of-month expenditures for September are counted in Week 40 in 2020 rather than Week 39.

Abbreviations: FFS = fee-for-service; PBPW = per beneficiary per week.

eTable 8. Projected influence of Covid-19 on Million Hearts Model effect estimates

Outcomes	Estimated change in outcome due to Covid-19			Potential bias on effect estimates from Covid-19		Conclusions about model effects, after accounting for potential bias from Covid-19
	Intervention group	Control group	Difference	Observed effect estimate from main study [90% CI]	Projected effect estimate, subtracting difference in outcomes that may be due to Covid-19[a], [90% CI]	
Health events (no. per 1,000 person-years)						
First-time myocardial infarctions, strokes, and TIAs (from Medicare claims only)	-1.24	-1.33	+0.09	0.967 (0.935 to 0.999)	0.961 (0.930 to 0.992)	No change
All-cause deaths (events per 1,000 beneficiaries per year	1.89	1.91	-0.02	0.957 (0.930 to 0.984)	0.957 (0.932 to 0.983)	No change
Medicare spending ($ per beneficiary per month)						
Total Medicare Parts A and B spending, before model payments	$7.87	$10.56	-$2.70	+$0.87 (-$17.91 to +$19.64)	+$3.56 (-$15.16 to +22.29)	No change

[a] We took the differences in outcomes due to Covid-19 from eFigures 2–4 and subtracted them from the observed effect estimates from this study of Million Hearts Model effects, converting to the hazard ratio scale for health events. This approximates the influence of Covid-19 on effect estimates, assuming the Million Hearts Model intervention and control groups experienced the same changes in outcomes in 2020 and 2021 as all Medicare FFS beneficiaries ages 40 to 79 in the county.

Abbreviations: CI = confidence interval; FFS = fee-for-service.

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