

Use of Diabetes Medications in Traditional Medicare and Medicare Advantage

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Enrollment in Medicare Advantage (MA), Medicare's managed care program, continues to expand, with more than one-third of Medicare beneficiaries currently enrolled in an MA plan.¹ Relative to traditional Medicare (TM), care management by MA plans may enable them to treat patients at lower costs while attaining equal or superior quality through their control of enrollee benefits, network contracting, and coordination of care.² This may be of particular relevance for patients with chronic medical conditions, for whom plans may employ a variety of care management approaches and financial incentives to promote the delivery of appropriate services and influence the quantity of services delivered.^{3,4} Prior research has demonstrated higher quality of ambulatory care for those enrolled in MA for process measures such as preventive care and monitoring of chronic diseases, as well as lower utilization of emergency department and inpatient services and of some elective services such as joint replacements.^{5,6} Differences in choices of medication might be another method by which MA plans achieve savings compared with TM. Most MA enrollment is in plans that include Part D coverage in an integrated product. TM enrollees generally enroll in stand-alone Part D prescription drug plans, although some have non-CMS coverage (retiree or other private plans) or none. However, no prior research that we are aware of has compared patterns of medication management in the 2 programs.

Diabetes is a prototypical example of a chronic and often progressive medical condition that may be affected by managed care approaches. Diabetes currently affects more than one-fourth of Medicare beneficiaries and is among the most common and costly chronic medical conditions affecting elderly Medicare enrollees.⁷ The principal medical treatment for diabetes is pharmacologic therapy aimed at controlling blood glucose levels and thereby preventing downstream cardiovascular, renal, and retinal complications that may arise from poorly controlled diabetes. The American Diabetes Association estimated that in 2017, almost \$50 billion was spent on prescription diabetes medications and testing.⁸ Consensus recommendations uniformly support lifestyle modification plus metformin as the preferred initial treatment strategy for type 2 diabetes, but many classes of medication compete for use as second- or third-line therapy,

ABSTRACT

OBJECTIVES: To compare use of diabetes medications between beneficiaries enrolled in Medicare Advantage (MA) and traditional Medicare (TM).

STUDY DESIGN: Retrospective cohort analysis of Medicare enrollment and Part D event claims during 2015-2016.

METHODS: Data came from 1,027,884 TM and 838,420 MA beneficiaries who received at least 1 prescription for an oral or injectable diabetes medication. After matching MA and TM enrollees by demographic characteristics and geography, we analyzed use of medication overall, choices of first diabetes medication for those new to medication, and patterns of adding medications.

RESULTS: Overall and for patients on 1, 2, or 3 diabetes medications, use of metformin was higher in MA by about 3 percentage points, but use of newer medication classes was 5.1 percentage points higher in TM overall (21.3% vs 16.2%). Use of guideline-recommended first-line agents was higher in MA. For those who started metformin first, use of a sulfonylurea as a second medication was 7.8 percentage points higher in MA than TM (61.5% vs 53.7%), whereas use of medications from newer classes was 7.7 percentage points lower (22.0% vs 29.7%). Mean total spending was \$149 higher in TM for those taking 1 medication and \$298 higher for those taking 2 medications. Differences in spending among MA plans were of similar magnitude to the MA-TM differences.

CONCLUSIONS: MA enrollees are more likely to be treated with metformin and sulfonylureas and less likely to receive costly newer medications than those in TM, but there also is substantial variation within MA. A limitation of the study is that we could not assess glucose control using glycated hemoglobin levels.

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including those new in the past decade.⁹⁻¹⁶ More recently, some emerging data suggest improved outcomes with several new agents in high-risk populations with cardiovascular or chronic kidney disease, but health plans and patients who use these newer medications, which have no generic alternatives, also face higher plan and out-of-pocket costs, respectively.¹⁷⁻²³ For instance, according to GoodRx.com, mean monthly costs of glucagon-like peptide-1 (GLP-1) receptor agonists are approximately \$800/month or higher compared with less than \$100 for even the most costly dose of metformin. In

addition, recommendations specifically for elderly patients include avoidance of long-acting sulfonylureas, which are associated with increased rates of hypoglycemia, and application of less stringent treatment goals for glucose control, particularly for those with limited life expectancy or multiple coexisting comorbid conditions.¹¹ The large number of treatment options and potential intensity of treatment, as well as the wide range in prices of medications used to treat diabetes, present an opportunity for MA plans to improve the care of diabetes using approaches that are less expensive but similarly effective. Moreover, lower out-of-pocket costs to patients are associated with improved adherence to treatment recommendations, which ultimately can influence patient outcomes, as well.

Previous research indicates that diabetes is among the clinical areas in which MA plans achieve their highest rates of savings for medical services,³ but little research has examined how choices of medications for enrollees with diabetes differ for those enrolled in MA vs TM. Given the high cost of medical treatment of diabetes, we therefore used comprehensive data on beneficiaries being treated for diabetes in TM and MA to compare patterns of drug use in the 2 programs, as well as total pharmaceutical spending and adherence. We hypothesized that, relative to TM, MA plans would promote higher rates of use of medications that are recommended by consensus guidelines and that they also would promote use of less expensive generic medications when more expensive alternatives have not demonstrated clear benefits.

METHODS

Data

We analyzed Medicare claims and enrollment data provided by CMS for the period 2015-2016, the 2 most recent years available to us. Demographic and enrollment characteristics drawn from the Beneficiary Summary File were available for all enrollees. Data on prescription medication use from the Part D prescription drug event files were available for the subset (more than 67.8% in the study years) of the 20% random sample of TM beneficiaries enrolled in a Part D plan, and for a substantially higher percentage (94.6%) of those enrolled in MA plans, which typically are bundled with Part D coverage.

TAKEAWAY POINTS

Medicare Advantage (MA) is associated with decreased utilization and higher quality relative to traditional Medicare (TM), but little is known about differences in medication management of chronic medical conditions such as diabetes. Using retrospective analyses of Medicare claims, we find that:

- ▶ MA enrollees were more likely to use metformin and sulfonylureas and less likely to receive newer medications.
- ▶ Mean plan and patient out-of-pocket spending for patients on 1, 2, or 3 medications was substantially higher for patients in TM.
- ▶ There is substantial variation in the approaches to medication management across MA health plans.

Our sample included all persons who were continuously enrolled in Medicare parts A and B throughout the year and were at least 65 years old on January 1. We excluded residents of long-stay nursing homes, whom we identified using a validated algorithm,²⁴ because these beneficiaries rarely enroll in MA plans other than the dedicated special needs plans aimed at this population,²⁵ and Medicare beneficiaries with end-stage renal disease. We also excluded MA enrollees in special needs plans that most commonly are restricted to low-income enrollees and have different rules related to enrollee cost sharing. We restricted some analyses focused on initiation or up-titration of prescription drugs to beneficiaries 66 years or older who had at least 1 year of continuous Part D enrollment prior to the respective study year.

Identifying Enrollees With Diabetes

Because medical claims data are not available for enrollees in MA plans, we restricted our analyses to those with diabetes who had received at least 1 prescription for a diabetes medication during the year of study.²⁶ Thus, our study sample focuses on enrollees with diabetes being treated with medication and excludes those who received a diagnosis of diabetes but were being treated conservatively through lifestyle modification and diet.

Beneficiary and Health Plan Characteristics

The Medicare Master Beneficiary Summary Files provided data on age, sex, race/ethnicity, region of the country, and, when applicable, Medicaid coverage and disability as the original reason for Medicare eligibility.^{27,28}

Using CMS data, we categorized health plans (defined based on Medicare contracts) as large (> 25,000 enrollees) vs small, and we identified health plans new to MA since 2006.

Characterizing Medication Use and Guideline Concordance

We lacked data on clinical indicators, such as glycated hemoglobin levels, that typically drive decisions regarding use of medication; therefore, in addition to analyzing medication use overall, we focused on prespecified cohorts that we defined for this study to identify those with diabetes at a similar level of disease control for whom

a clinician had decided that initiation or escalation of medical therapy was warranted. Medications were identified through drug or product names (see **eAppendix Table 1** [eAppendix available at ajmc.com] for a full list and how they were classified).

For patients who received a new prescription for any diabetes medication in the year of interest and had received no diabetes medications in the prior year, we categorized the *initial medication choice* by class. These enrollees are likely those who previously had been treated with diet and lifestyle modification and who a physician now thought needed to start medication treatment. We considered metformin to be the only guideline-concordant initial choice of medication.

For those treated with a single drug in the prior year, we then characterized the *choice of second medication* for those started on the 2 most commonly prescribed initial drug classes (metformin and sulfonylureas). Although guidelines regarding second medications allow for individualized use of medications from any of multiple classes, the guidelines also suggest that cost could be a consideration.²⁹ Because of their less frequent use, we grouped into 1 category all relatively newly available medications without a generic alternative, such as sodium-glucose cotransporter-2 (SGLT-2) inhibitors, dipeptidyl peptidase-4 (DPP-4) inhibitors, and GLP-1 receptor agonists.

Finally, we examined whether those patients who were *starting insulin* received short-/rapid-acting, intermediate-acting, long-acting, or combination insulin, counting patients filling prescriptions for 2 types of insulin within 30 days as receiving combination therapy. When insulin therapy is necessary, guidelines consistently recommend beginning with basal or long-acting insulin. We did not differentiate between human and analogue insulin.

We based our classifications on largely consistent recommendations from the American College of Physicians, the American Diabetes Association, and the American Geriatrics Society for the treatment of elderly adults with diabetes during the time period of our study.^{14,15,29-32} Finally, we considered long-acting sulfonylureas to be guideline discordant at any stage of treatment because of increased risks of hypoglycemia in the elderly population.^{33,34}

Adherence and Drug Spending

These analyses included all patients taking any diabetes medication in a year. We calculated each beneficiary's total, out-of-pocket, and Part D plan monthly diabetes drug spending over the year. Finally, for each medication taken, we calculated the medication possession ratio as a measure of adherence.³⁵ This measure counts the number of days of supply that a patient had starting from the date of the first prescription fill to the date of the last prescription filled during the year plus the days supplied from that last prescription. Higher numbers indicate greater adherence.

Statistical Analyses

We first compared the characteristics of enrollees in TM and MA who were identified as users of diabetes medications by available Part D prescription claims. As in previous studies, for all

comparisons between the MA and TM samples, we first reweighted the TM sample to match the MA sample distribution by geography and demographic characteristics (age [in 5-year ranges], sex, race/ethnicity) and then aggregated these results to obtain national estimates that were weighted by the enrollment of MA plans.^{5,6,36} Matching on geography controlled for variation in practice patterns within Medicare across regions.^{37,38} By matching at the zip code level where possible (73% of the prevalent cohort), we also controlled for unmeasured socioeconomic characteristics associated with residence at this level of geography, as well as the proportion who were dually eligible for Medicaid. Of note, excluding those dually enrolled in Medicaid did not substantively affect our results, so dual-eligible enrollees were included in the study.

We tabulated characteristics of all enrollees with diabetes on medication as well as those initiating any drug treatment and those initiating treatment with insulin, testing differences between MA and TM proportions or means using χ^2 or *t* tests as appropriate. We calculated the unadjusted and adjusted MA mean, the matched TM mean, the difference, and their respective standard errors, and we performed χ^2 , *F*, and *t* tests as appropriate to assess significance. Because of the size of our sample, most overall MA-TM differences that we report were statistically significant at the $P < .001$ level unless otherwise noted in the tables. Therefore, comparisons were not adjusted for multiple comparisons.

Lastly, as an illustrative example to examine variation in spending among MA plans, we modeled total spending for beneficiaries on 2 medications, using hierarchical linear regression models that included a random effect for each MA contract, as well as random effects for MA and TM at the state and hospital referral region levels. The random effects variance parameters quantify the variation across plans of savings relative to matched TM enrollees in its same service area after accounting for market- and state-level variation and sampling error.

All analyses were conducted using SAS software version 9.2 (SAS Institute). Our study protocol was approved by the Harvard Medical School Human Studies Committee. This work was funded by the National Institute on Aging, which had no role in the design of the study or in the collection, analysis, and interpretation of the data.

RESULTS

During 2015 and 2016, we studied 1,027,884 enrollees in TM and 838,420 enrollees in MA who were enrolled for the full year in Medicare and had available Part D pharmaceutical claims. Their respective characteristics are shown in **Table 1**. Among these enrollees, 62,265 from TM and 49,089 from MA initiated treatment with an initial diabetes drug (including all oral medications or insulin) during this time period, and, of these, 24,530 in TM and 16,635 in MA first started using insulin (including as an initial medication). In each treatment category, White enrollees were overrepresented in TM (near 75%) relative to MA (60%), and Hispanic enrollees were underrepresented in TM (7%-9%) relative to MA (21%-23%). More TM enrollees were eligible for Medicaid (25.7% vs 21.2% overall).

After weighting, there were no observable demographic differences between the MA and TM populations.

Overall Medication Use

Overall, use of metformin was lower in TM by about 3 percentage points (Table 2). For example, among those on 1 medication, 59.8% of TM enrollees were on metformin compared with 62.7% of MA enrollees. Use of short-acting sulfonylureas was also lower in TM (19.7% vs 23.6%), but use of long-acting sulfonylureas, which should be avoided in elderly patients, was slightly higher in TM (17.1% vs 16.3%). Rates of insulin use were higher in TM (19.7% vs 17.4%). The largest TM-MA difference was for use of any of the new classes of medication (such as DPP-4 or SGLT-2 inhibitors), which was 5.1 percentage points higher in TM (21.3% vs 16.2%).

Choice of First Medication

Consistent with guidelines for the initial treatment of older patients with diabetes, metformin was the predominant first medication, but it was used slightly less frequently in TM than in MA (71.7% vs 72.8%; absolute difference, 1.1 percentage points) (Table 3). For the remaining approximately 30% of patients started on a medication, short-acting sulfonylureas were less often used in TM (6.9% vs 9.1%). These differences were offset predominantly by higher use in TM of a medication from a newer class (9.9% vs 6.8%). Thiazolidinediones were rarely the initial medication (less than 2% in both programs).

These differences varied somewhat by region and plan characteristics. Most notably, TM enrollees in the South were started on metformin 2.3 percentage points less frequently than MA enrollees, and TM enrollees in the West were started on a new medication 5 percentage points more frequently than those in MA. Those enrolled in large and more established plans were about 1 percentage point less likely to start a medication from another class.

Choice of Second Medication

Either a sulfonylurea (for those on metformin) or metformin (for those on a sulfonylurea) was the second-choice medicine for more than half of those given a second medicine (Table 4). However, for those who started metformin first, use of a sulfonylurea as a second medication was 8 percentage points lower in TM (53.7% vs 61.5%), which was primarily offset by use of medication from a new class (29.7% vs 22.0%). Patterns were similar for those who started a sulfonylurea first (with metformin the most common choice of second drug), but the differences were about half the

TABLE 1. Demographic Characteristics of Medicare Enrollees Receiving Medication for Diabetes, 2015-2016*

| Characteristic | All on any diabetes medication | | All starting any medication ^b | | All starting insulin ^b | |
|--------------------|--------------------------------|---------|--|--------|-----------------------------------|--------|
| | TM | MA | TM | MA | TM | MA |
| n | 1,027,884 | 838,420 | 62,265 | 49,089 | 24,530 | 16,635 |
| Age group in years | | | | | | |
| 66-69 | 13.0% | 13.6% | 16.3% | 16.7% | 13.9% | 14.4% |
| 70-74 | 31.0% | 34.4% | 34.7% | 37.0% | 29.0% | 32.7% |
| 75-79 | 24.6% | 25.3% | 22.8% | 23.7% | 22.2% | 23.7% |
| 80-84 | 16.2% | 15.6% | 13.7% | 13.1% | 15.7% | 16.0% |
| ≥85 | 14.6% | 11.1% | 12.6% | 9.5% | 19.2% | 13.3% |
| Race/ethnicity | | | | | | |
| White | 76.0% | 58.4% | 76.9% | 62.0% | 73.9% | 59.5% |
| Black | 10.2% | 13.8% | 9.8% | 13.2% | 12.2% | 14.4% |
| Hispanic | 7.8% | 21.1% | 7.3% | 18.2% | 8.7% | 21.7% |
| Other | 6.0% | 6.7% | 6.0% | 6.6% | 5.2% | 4.8% |
| Sex | | | | | | |
| Male | 44.9% | 45.8% | 46.0% | 48.4% | 44.6% | 47.1% |
| Female | 55.1% | 54.2% | 54.0% | 51.6% | 55.4% | 52.9% |
| Region | | | | | | |
| Northeast | 18.9% | 18.8% | 18.9% | 18.9% | 18.6% | 20.4% |
| Midwest | 24.0% | 16.4% | 22.6% | 16.7% | 25.0% | 18.7% |
| South | 40.6% | 38.7% | 41.6% | 39.3% | 40.3% | 38.0% |
| West | 16.5% | 26.2% | 16.9% | 25.1% | 16.1% | 22.9% |
| Dual eligible | | | | | | |
| Yes | 25.7% | 21.2% | 24.3% | 19.3% | 41.3% | 32.2% |

MA, Medicare Advantage; TM, traditional Medicare.

*Unweighted estimates are presented. All differences by category are statistically significant at $P < .0001$ with the exception of sex for those starting insulin. After weighting, there were no differences by construction.

^bThose 66 years and older who had not been on any medication or insulin in the prior year.

magnitude. Differences for smaller and newer plans were larger than for established and larger MA plans.

New to Insulin

Among those new to insulin, the percentage of patients started on long-acting insulin was higher in TM than in MA (63.5% vs 58.2%) (eAppendix Figure 1), with the largest differences in the Midwest.

Medication Costs and Adherence

Annual diabetes-related medication costs are summarized in Table 5, stratified by the number of medications being taken. In each stratum, the percentage of enrollees with total costs of more than \$1000 was greater in TM than MA (differences of 4.0, 8.2, and 2.9 percentage points for those taking 1, 2, and 3 medications, respectively). Similarly, mean spending was \$149 higher in TM for those taking 1 medication and \$298 higher for those on 2 medications. These differences were largest in the West and Midwest, as well as in large and established health plans. Out-of-pocket spending showed similar patterns. Medication possession ratios generally were 90%

TABLE 2. Prevalence of Use of Medications Among Those Receiving Any or 1, 2, or 3 Medications for Diabetes (%)^a

| Prevalence of use | Metformin | | | Sulfonylureas (short) | | | Sulfonylureas (long) | | | Thiazolidinediones | | | Insulin | | | Other ^b | | |
|-------------------|-----------|------|------|-----------------------|------|------|----------------------|------|------|--------------------|------|------|---------|------|------|--------------------|------|------|
| | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff |
| Overall | 67.7 | 70.1 | -2.5 | 19.7 | 23.6 | -4.0 | 17.1 | 16.3 | 0.8 | 6.6 | 6.1 | 0.5 | 19.7 | 17.4 | 2.3 | 21.3 | 16.2 | 5.1 |
| On 1 medication | 59.8 | 62.7 | -2.9 | 8.8 | 10.8 | -2.1 | 7.6 | 7.6 | 0.1* | 2.0 | 1.7 | 0.2 | 15.1 | 12.6 | 2.5 | 6.8 | 4.5 | 2.2 |
| On 2 medications | 79.7 | 82.8 | -3.2 | 31.5 | 39.6 | -8.1 | 27.2 | 26.8 | 0.4 | 8.0 | 7.4 | 0.7 | 22.5 | 20.4 | 2.0 | 31.2 | 22.9 | 8.2 |
| On 3 medications | 91.1 | 91.9 | -0.8 | 44.3 | 50.9 | -6.5 | 41.8 | 38.3 | 3.5 | 25.9 | 27.7 | -1.8 | 39.3 | 38.8 | 0.4* | 70.8 | 64.4 | 6.4 |

Diff, difference; MA, Medicare Advantage; TM, traditional Medicare.

**P* < .01.

^aTM estimates are weighted to match MA distributions by age category, sex, race/ethnicity categories, and geography. All overall MA-TM differences (first row) are statistically significant at *P* ≤ .001 except for long-acting sulfonylureas (*P* = .02) and insulin (*P* = .22). Significant differences by region, plan age, and plan size are noted by asterisks, signifying *P* < .01.

^bOther includes glucagon-like peptide-1 receptor agonists, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, meglitinides, and D-phenylalanine derivatives.

TABLE 3. Choice of Initial Diabetes Medication in TM and MA^a

| | Metformin | | | Sulfonylureas (short) | | | Sulfonylureas (long) | | | Thiazolidinediones | | | Insulin* | | | Other ^b | | |
|-------------|-----------|-------|-------|-----------------------|-------|-------|----------------------|------|-------|--------------------|------|------|----------|-------|-------|--------------------|------|------|
| | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff |
| Overall | 71.7% | 72.8% | -1.1% | 6.9% | 9.1% | -2.2% | 6.5% | 6.2% | 0.3% | 1.6% | 1.4% | 0.2% | 8.8% | 8.6% | 0.2% | 9.9% | 6.6% | 3.3% |
| Region | | | * | | | * | | | * | | | | | | * | | | * |
| Northeast | 70.3% | 70.3% | 0.0% | 7.5% | 8.8% | -1.3% | 6.2% | 7.0% | -0.8% | 1.2% | 1.1% | 0.0% | 7.7% | 8.6% | -0.9% | 13.1% | 9.7% | 3.4% |
| Midwest | 71.1% | 72.7% | -1.5% | 7.3% | 8.2% | -0.9% | 7.9% | 7.0% | 0.9% | 1.5% | 1.2% | 0.3% | 9.7% | 10.0% | -0.3% | 7.6% | 5.7% | 2.0% |
| South | 70.1% | 72.3% | -2.3% | 6.1% | 8.3% | -2.2% | 7.2% | 7.1% | 0.1% | 1.7% | 1.4% | 0.3% | 10.1% | 8.6% | 1.5% | 9.7% | 7.0% | 2.7% |
| West | 75.5% | 75.4% | 0.1% | 7.5% | 11.4% | -3.9% | 4.6% | 3.5% | 1.1% | 1.9% | 1.7% | 0.2% | 7.1% | 7.7% | -0.6% | 9.5% | 4.5% | 5.0% |
| Plan age | | | | | | * | | | | | | | | | | | | * |
| Established | 71.5% | 72.5% | -1.0% | 7.0% | 8.9% | -1.9% | 6.4% | 6.7% | -0.3% | 1.7% | 1.4% | 0.2% | 8.7% | 8.5% | 0.2% | 10.2% | 6.4% | 3.8% |
| New | 71.8% | 73.0% | -1.2% | 6.9% | 9.3% | -2.4% | 6.5% | 5.7% | 0.8% | 1.6% | 1.4% | 0.2% | 8.9% | 8.7% | 0.2% | 9.7% | 6.8% | 2.9% |
| Plan size | | | | | | * | | | | | | | | | | | | * |
| Small | 71.6% | 72.7% | -1.0% | 7.2% | 8.9% | -1.7% | 6.4% | 6.0% | 0.4% | 1.6% | 1.4% | 0.2% | 9.4% | 9.1% | 0.2% | 9.3% | 7.0% | 2.3% |
| Large | 71.7% | 72.8% | -1.1% | 6.8% | 9.2% | -2.4% | 6.5% | 6.2% | 0.3% | 1.6% | 1.4% | 0.3% | 8.6% | 8.4% | 0.2% | 10.2% | 6.5% | 3.7% |

Diff, difference; MA, Medicare Advantage; TM, traditional Medicare.

**P* < .01.

^aTM estimates are weighted to match MA distributions by age category, sex, race/ethnicity categories, and geography. Numbers in difference columns are percentage points. Differences between TM and MA are statistically significant at the *P* < .0001 level, except for those with asterisks, which were < .01.

^bOther includes glucagon-like peptide-1 receptor agonists, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, meglitinides, and D-phenylalanine derivatives.

or higher and generally did not substantively differ between TM and MA or by plan characteristics (eAppendix Table 2).

Analyses of estimated differences in mean spending for those taking 2 medications arrayed by MA plan (contract) showed that the variation in spending across MA plans after controlling for geographical factors was similar in magnitude (SD, \$240) to the observed overall difference in spending between MA and TM (mean difference, \$298, as noted above) (eAppendix Figure 2).

DISCUSSION

Patterns of use of diabetes medications for beneficiaries enrolled in TM and MA differ, even after identifying enrollees at a stage of

disease who either start medication therapy or require an additional medication. More importantly, these prescribing patterns have important implications for both the quality and costs of care. Metformin, which is recommended as first-line treatment in type 2 diabetes by all major guidelines and is available as a relatively inexpensive generic medication, was used more frequently in MA as both a first and second agent. In contrast, medication choices in TM generally were costlier, with greater use of expensive new classes of medications as both first- and second-line treatment leading to higher levels of both plan and out-of-pocket spending for TM beneficiaries. To achieve these savings, however, enrollees in MA plans more frequently receive sulfonylureas, which have the potential to cause hypoglycemia in older patients.

TABLE 4. Choice of Second Medication After Starting Metformin or a Sulfonylurea in TM and MA^a

| | Sulfonylurea/ metformin second | | | Thiazolidinedione second | | | Insulin second | | | Other ^b second | | |
|--------------------|-----------------------------------|-------|--------|-----------------------------|------|-------|-------------------|-------|-------|------------------------------|-------|-------|
| | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff |
| Metformin first | 53.7% | 61.5% | -7.8% | 5.4% | 5.6% | -0.2% | 11.2% | 10.8% | 0.4% | 29.7% | 22.0% | 7.7% |
| Region | | | * | | | | | | * | | | * |
| Northeast | 49.1% | 56.9% | -7.8% | 3.5% | 3.6% | -0.1% | 9.3% | 10.0% | -0.7% | 38.1% | 29.5% | 8.6% |
| Midwest | 61.4% | 62.8% | -1.4% | 4.6% | 4.9% | -0.3% | 11.6% | 12.5% | -0.8% | 22.4% | 19.9% | 2.5% |
| South | 54.8% | 62.7% | -8.0% | 6.0% | 5.4% | 0.6% | 10.7% | 10.8% | -0.1% | 28.5% | 21.0% | 7.5% |
| West | 50.2% | 62.4% | -12.2% | 6.6% | 8.2% | -1.7% | 13.3% | 10.4% | 2.9% | 30.0% | 19.0% | 11.0% |
| Plan type | | | | | | | | | | | | |
| Established | 54.4% | 60.5% | -6.1% | 5.3% | 5.7% | -0.5% | 11.6% | 11.0% | 0.7% | 28.7% | 22.8% | 5.9% |
| New | 53.3% | 62.1% | -8.7% | 5.5% | 5.6% | -0.1% | 11.0% | 10.7% | 0.2% | 30.2% | 21.6% | 8.6% |
| Plan size | | | * | | | | | | | | | * |
| Small | 52.9% | 63.4% | -10.5% | 5.4% | 5.3% | 0.1% | 11.3% | 10.2% | 1.1% | 30.3% | 21.1% | 9.2% |
| Large | 54.4% | 59.7% | -5.3% | 5.4% | 5.9% | -0.6% | 11.0% | 11.4% | -0.4% | 29.2% | 22.9% | 6.3% |
| Sulfonylurea first | 58.6% | 62.5% | -3.9% | 5.5% | 6.0% | -0.5% | 14.3% | 14.3% | 0.0% | 21.6% | 17.2% | 4.4% |
| Region | | | * | | | | | | | | | * |
| Northeast | 59.1% | 62.2% | -3.1% | 3.5% | 3.9% | -0.4% | 12.7% | 12.6% | 0.2% | 24.6% | 21.4% | 3.3% |
| Midwest | 60.3% | 60.3% | 0.0% | 5.8% | 5.8% | 0.0% | 16.2% | 17.6% | -1.4% | 17.7% | 16.3% | 1.4% |
| South | 56.9% | 61.7% | -4.8% | 5.6% | 6.4% | -0.8% | 14.7% | 14.5% | 0.2% | 22.8% | 17.4% | 5.4% |
| West | 60.7% | 66.4% | -5.7% | 6.8% | 7.1% | -0.4% | 13.4% | 12.9% | 0.5% | 19.1% | 13.5% | 5.6% |
| Plan type | | | | | | | | | | | | |
| Established | 60.7% | 62.3% | -1.5% | 5.2% | 5.7% | -0.5% | 14.5% | 14.6% | -0.2% | 19.7% | 17.5% | 2.2% |
| New | 57.6% | 62.7% | -5.0% | 5.7% | 6.2% | -0.5% | 14.2% | 14.2% | 0.1% | 22.5% | 17.0% | 5.5% |
| Plan size | | | * | | | | | | | | | * |
| Small | 57.2% | 62.3% | -5.1% | 5.4% | 6.1% | -0.6% | 14.8% | 14.4% | 0.4% | 22.6% | 17.3% | 5.4% |
| Large | 60.1% | 62.8% | -2.7% | 5.6% | 5.9% | -0.4% | 13.9% | 14.2% | -0.3% | 20.5% | 17.1% | 3.4% |

Diff, difference; MA, Medicare Advantage; TM, traditional Medicare.

* $P \leq .01$.

^aTM estimates are weighted to match MA distributions by age category, sex, race/ethnicity categories, and geography. Numbers in difference columns are percentage points. Overall MA-TM differences (first rows) are statistically significant at $P < .0001$ for sulfonylurea/metformin and other. For those who started a sulfonylurea first, there were no significant differences for starting a thiazolidinedione or insulin second. For those who started metformin first, the difference for those starting insulin second was significant ($P < .01$). Significant differences by region, plan age, and plan size are noted by asterisks, signifying $P \leq .01$.

^bOther includes glucagon-like peptide-1 receptor agonists, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, meglitinides, and D-phenylalanine derivatives.

Our study found substantially greater use of new diabetes agents that do not yet have generic alternatives as both first- and second-line treatment options in TM, substantially contributing to higher spending for those in TM. The use of some of these newer classes of medications, however, could represent higher quality of care, particularly for higher-risk populations with established cardiovascular or chronic kidney disease. For instance, emerging evidence supports the use of SGLT-2 and GLP-1 inhibitors to treat specific high-risk populations with established cardiovascular disease or chronic kidney disease.^{18,19,21-23,39} We note, however, that studies have not found consistent advantages in these groups with respect to cardiovascular events or mortality and that these benefits have not been shown for average-risk patients.^{9,10,20,40,41} Moreover, older patients with more limited life expectancy may not receive these potential benefits. Consequently, guidelines continue to recommend that the choice of a second medication should be

individualized based on patient preferences and, potentially, cost.¹¹ Although our study could not assess patient preferences, MA treatment regimens in most plans demonstrated lower mean costs for both plans and patients, even among patients using the same number of medications, and these differences could be substantial. Whether these differences will translate into improved outcomes is not clear and will require future research.

Surprisingly, we found more frequent use of basal insulin in TM than in MA when first starting treatment with insulin. Multi-injection insulin regimens may be difficult for elderly patients to manage and administer, with little incremental value over once-daily administration of a single long-acting agent, while also carrying increased risk for hypoglycemia.^{33,42} Although this finding might reflect that MA physicians may turn to insulin later in the course of treatment, the reasons for this difference are not clear.

TABLE 5. Annual Total and Out-of-Pocket Spending for Patients With Diabetes Taking 1, 2, or 3 Medications*

| | 1 medication | | | 2 medications | | | 3 medications | | |
|---|--------------|-------|-------|---------------|--------|-------|---------------|--------|-------|
| | TM | MA | Diff | TM | MA | Diff | TM | MA | Diff |
| Percentage with total cost > \$1000 | | | | | | | | | |
| All | 20.4% | 16.4% | 4.0% | 46.6% | 38.4% | 8.2% | 83.4% | 80.5% | 2.9% |
| Region | | | * | | | * | | | * |
| Northeast | 22.4% | 19.6% | 2.8% | 51.2% | 45.9% | 5.3% | 86.8% | 84.8% | 1.9% |
| Midwest | 20.7% | 18.2% | 2.5% | 41.6% | 37.6% | 4.0% | 81.5% | 77.9% | 3.6% |
| South | 19.7% | 15.3% | 4.4% | 45.2% | 36.8% | 8.3% | 82.1% | 80.6% | 1.5% |
| West | 19.6% | 14.0% | 5.6% | 48.1% | 34.3% | 13.8% | 83.0% | 76.7% | 6.3% |
| Plan type | | | | | | * | | | |
| Established | 20.5% | 15.4% | 5.1% | 47.1% | 36.7% | 10.4% | 84.0% | 79.7% | 4.3% |
| New | 20.3% | 17.4% | 2.9% | 46.0% | 40.2% | 5.9% | 82.8% | 81.2% | 1.6% |
| Plan size | | | * | | | * | | | * |
| Small | 20.9% | 17.7% | 3.2% | 46.7% | 40.2% | 6.5% | 83.0% | 81.6% | 1.4% |
| Large | 20.1% | 15.7% | 4.4% | 46.5% | 37.5% | 9.0% | 83.6% | 79.9% | 3.7% |
| Mean total cost | | | | | | | | | |
| All | \$774 | \$626 | \$149 | \$1704 | \$1406 | \$298 | \$3304 | \$3021 | \$283 |
| Region | | | * | | | * | | | * |
| Northeast | \$826 | \$733 | \$93 | \$1860 | \$1697 | \$163 | \$3513 | \$3317 | \$197 |
| Midwest | \$807 | \$706 | \$101 | \$1526 | \$1364 | \$162 | \$3064 | \$2760 | \$305 |
| South | \$751 | \$591 | \$160 | \$1640 | \$1354 | \$286 | \$3247 | \$3050 | \$196 |
| West | \$743 | \$529 | \$214 | \$1790 | \$1242 | \$547 | \$3319 | \$2798 | \$521 |
| Plan type | | | | | | * | | | |
| Established | \$759 | \$578 | \$182 | \$1705 | \$1330 | \$376 | \$3315 | \$2943 | \$372 |
| New | \$790 | \$676 | \$114 | \$1702 | \$1484 | \$218 | \$3292 | \$3098 | \$194 |
| Plan size | | | * | | | * | | | * |
| Small | \$796 | \$697 | \$98 | \$1701 | \$1499 | \$201 | \$3296 | \$3202 | \$95 |
| Large | \$764 | \$590 | \$174 | \$1705 | \$1359 | \$346 | \$3308 | \$2926 | \$381 |
| Mean out-of-pocket cost | | | | | | | | | |
| All | \$251 | \$201 | \$50 | \$558 | \$454 | \$104 | \$1103 | \$999 | \$104 |
| Region | | | * | | | * | | | * |
| Northeast | \$258 | \$241 | \$17 | \$603 | \$577 | \$26 | \$1159 | \$1180 | -\$20 |
| Midwest | \$251 | \$234 | \$17 | \$475 | \$437 | \$38 | \$964 | \$890 | \$74 |
| South | \$248 | \$181 | \$67 | \$545 | \$417 | \$129 | \$1100 | \$946 | \$154 |
| West | \$251 | \$177 | \$74 | \$594 | \$409 | \$185 | \$1137 | \$951 | \$186 |
| Plan type | | | | | | * | | | |
| Established | \$246 | \$181 | \$65 | \$557 | \$422 | \$135 | \$1106 | \$965 | \$141 |
| New | \$256 | \$223 | \$34 | \$559 | \$487 | \$72 | \$1100 | \$1032 | \$67 |
| Plan size | | | * | | | * | | | * |
| Small | \$257 | \$240 | \$16 | \$556 | \$518 | \$38 | \$1106 | \$1135 | -\$29 |
| Large | \$249 | \$182 | \$67 | \$558 | \$421 | \$137 | \$1101 | \$928 | \$174 |

Diff, difference; MA, Medicare Advantage; TM, traditional Medicare.

* $P \leq .0001$.

*TM estimates are weighted to match MA distributions by age category, sex, CMS/Social Security Administration race categories, and geography. Numbers in difference columns are percentage points. All overall MA-TM differences are statistically significant at the $P < .0001$ level. Significant differences by region, plan age, and plan size are noted by asterisks, signifying $P \leq .0001$, with the exception of plan type for those on 2 medications ($P = .004$).

Our study results suggest that managed care approaches to diabetes can bring about care that is both more guideline concordant (at least in the case of first-line medications) and less expensive, although this was not uniformly the case for all MA health plans. How might some health plans achieve such results? Although our study did not explore mechanisms, there are several potential explanations. Most MA enrollees choose integrated MA–Part D plans, which may facilitate a more integrated approach to the management of all aspects of diabetes, including the use of medications, than is practiced by the stand-alone Part D plans that are used by TM beneficiaries.

Some health plans employ various approaches such as increased use of guidelines, audits, and feedback to encourage a more uniform approach to treatment within the plan, including the use of less costly medications as initial selections.⁴³ Our results showed greater TM–MA differences for larger and more established health plans, which might be more likely to have the capacity for managing such programs.⁴⁴ Second, health plans can employ financial incentives to physicians and physician organizations that encourage use of preferred lower-cost agents, thus delegating responsibility for management of prescribing patterns to the providers. For instance, some MA health plans have entered into capitation-type arrangements with physician organizations that also put these organizations at risk for drug spending. Plans using management mechanisms like these might choose to discourage adoption of some newer and more expensive medications until their marginal value is clearly proven in the literature. Of note, many of the studies noted above—those supporting the use of some newer agents in higher-risk populations—came out after the period of our study. However, it will be important to monitor choices of medications in such plans to ensure that patients are not denied more expensive medications when they may be of benefit. Finally, plans also have direct control over their formularies, and integrated plans may make different choices related to inclusion, tiering, or cost sharing that can also influence use of medications.

Limitations

Our study has several potential limitations. First, our analyses were limited to claims data, so we could not assess the adequacy of diabetes control using measures such as glycated hemoglobin levels. Second, we lacked data on functional status and frailty, each of which may affect decision-making and treatment goals. Third, because we lacked information on the date of first diagnosis, we could not control for the duration of diabetes when treatment began, which might have differed for MA and TM. For this reason, we focus much of our analyses on initial treatment choices for patients who had previously not been on a medication, as well as patterns of adding medications for those who had been on a single agent, which effectively controls for disease status. Fourth, we were unable to assess formulary status of medications, which also can influence medication choice. Fifth, our data extend back almost 5 years, so these findings might differ using more current data. In particular, use of newer agents with no generic alternatives

might have accelerated over this time period. Finally, because we lacked information on comorbid conditions for MA enrollees (for whom we lacked claims), we could not examine the extent to which comorbid conditions such as cardiovascular disease or heart failure influenced medication choices, nor could we examine longer-term complications of diabetes such as retinopathy, nephropathy, or cardiovascular disease.

CONCLUSIONS

We found substantial differences in patterns of medication use between beneficiaries in TM and enrollees in MA health plans, although with substantial variation among MA plans. Costly and complex regimens are used more frequently in TM than MA across all treatment levels, reflecting more frequent use within MA of medications that can cause hypoglycemia (eg, sulfonylureas) and less frequent use of newer agents, which might be of particular benefit for higher-risk patients. These findings suggest that managed care approaches adopted by at least some plans influence diabetes treatment practices. As our health system strives to find opportunities to lower health spending and improve the value of care, chronic diseases such as diabetes present a substantial opportunity for cost savings that increase the value of care, but they also raise concerns about stinting on care that might ultimately benefit some subgroups of patients. ■

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eAppendix Table 1. Drug Classifications

I. Biguanides

| Brand name | Generic Name |
|-------------------------|---------------------|
| fortamet | metformin hcl |
| glucophage | metformin hcl |
| glucophage xr | metformin hcl |
| glumetza | metformin hcl |
| metformin hcl | metformin hcl |
| metformin hcl er | metformin hcl |
| metformin hydrochloride | metformin hcl |
| riomet | metformin hcl |

II. Long Acting Sulfonylurea (LASU)

| Brand name | Generic Name |
|-------------------|----------------------|
| amaryl | glimepiride |
| glimepiride | glimepiride |
| diabeta | glyburide |
| glyburide | glyburide |
| micronase | glyburide |
| Glynase | glyburide |
| glycron | glyburide,micronized |
| Diabenese | chlorpropamide |

III. Short Acting Sulfonylurea (SASU)

| Brand name | Generic Name |
|-------------------|---------------------|
| Tolinase | tolazamide |
| Orinase | tolbutamide |
| Diabenese | chlorpropamide |
| Glucotrol | glipizide |
| glipizide | glipizide |

IV. Thiazolidinediones

| Brand name | Generic Name |
|-------------------|-----------------------|
| actos | pioglitazone hcl |
| pioglitazone hcl | pioglitazone hcl |
| avandia | rosiglitazone maleate |

V. Others

V-i. Alpha-glucosidase inhibitors

| Brand name | Generic Name |
|------------|--------------|
| acarbose | acarbose |
| glyset | miglitol |
| precose | acarbose |

V-ii. GLP-1 agonists

| Brand name | Generic Name |
|------------|------------------------|
| Bydureon | exenatide microspheres |
| Victoza | liraglutide |
| Byetta | exenatide |
| Trulicity | dulaglutide |
| Adlyxin | lixisenatide |
| tanzeum | albiglutide |
| eperzan | albiglutide |
| Gattex | teduglutide |

V-iii. Meglitinides

| Brand name | Generic Name |
|-------------|--------------|
| nateglinide | nateglinide |
| Starlix | nateglinide |
| Prandin | repaglinide |

V-iv. DPP-4 inhibitors

| Brand name | Generic Name |
|------------|-----------------------|
| Onglyza | saxagliptin hcl |
| Januvia | sitagliptin phosphate |
| Tradjenta | linagliptin |
| nesina | alogliptin |

V-iv. SGL-2 inhibitors

| Brand name | Generic Name |
|------------|---------------|
| invokana | canagliflozin |
| farxiga | dapagliflozin |
| jardiance | empagliflozin |

VI. Combination Pills

| Brand name | Generic Name |
|-------------------------|-------------------------|
| glucovance | glyburide/metformin hcl |
| glyburide-metformin hcl | glyburide/metformin hcl |

| | |
|-------------------------|--------------------------------|
| glucovance | glyburide, micro/metformin hcl |
| glyburide-metformin hcl | glyburide, micro/metformin hcl |
| Alogliptin/pioglitazone | Oseni |
| glipizide-metformin | glipizide/metformin hcl |
| jentadueto | linagliptin/metformin hcl |
| metaglip | glipizide/metformin hcl |
| actoplus met | pioglitazone hcl/metformin hcl |
| actoplus met xr | pioglitazone hcl/metformin hcl |
| duetact | pioglitazone hcl/glimepiride |
| pioglitazone-metformin | pioglitazone hcl/metformin hcl |
| duetact | pioglitazone/glimepiride |
| prandimet | repaglinide/metformin hcl |
| avandaryl | rosiglitazone/glimepiride |
| avandamet | rosiglitazone/metformin hcl |
| kombiglyze xr | saxagliptin hcl/metformin hcl |
| janumet | sitagliptin phos/metformin hcl |
| juvisync | sitagliptin/simvastatin |
| janumet xr | sitagliptin phos/metformin hcl |
| invokamet | canagliflozin/metformin hcl |
| Glyxambi | Empagliflozin/linagliptin |
| Xigduo XR | Dapagliflozin/metformin hcl |
| Kazano | Alogliptin/metformin |
| Synjardy | Empagliflozin/metformin |

VII. Insulins

VII-i. Short/Rapid

| Brand name | Generic Name |
|-------------------|------------------------|
| apidra | insulin glulisine |
| apidra solostar | insulin glulisine |
| humalog | insulin lispro |
| novolin r | insulin regular, human |
| relion novolin r | insulin regular, human |
| novolog | insulin aspart |
| novolog flexpen | insulin aspart |

VII-ii. Medium

| Brand name | Generic Name |
|-------------------|------------------------|
| humulin l | insulin zinc human rec |

| | |
|---------------------|-----------------------------|
| humulin n | nph, human insulin isophane |
| iletin i nph | insulin isophane nph,bf-pk |
| iletin ii nph(pork) | insulin isophane,pork pure |
| novolin n | nph, human insulin isophane |
| novolin n innolet | nph, human insulin isophane |
| novolin l | insulin zinc human rec |

VII-iii, Long

| Brand name | Generic Name |
|-------------------|--------------------------------|
| humulin u | insulin zinc extend human rec |
| lantus | insulin glargine,hum.rec.anlog |
| lantus solostar | insulin glargine,hum.rec.anlog |
| levemir | insulin detemir |
| levemir flexpen | insulin detemir |

VII-iv. Combination

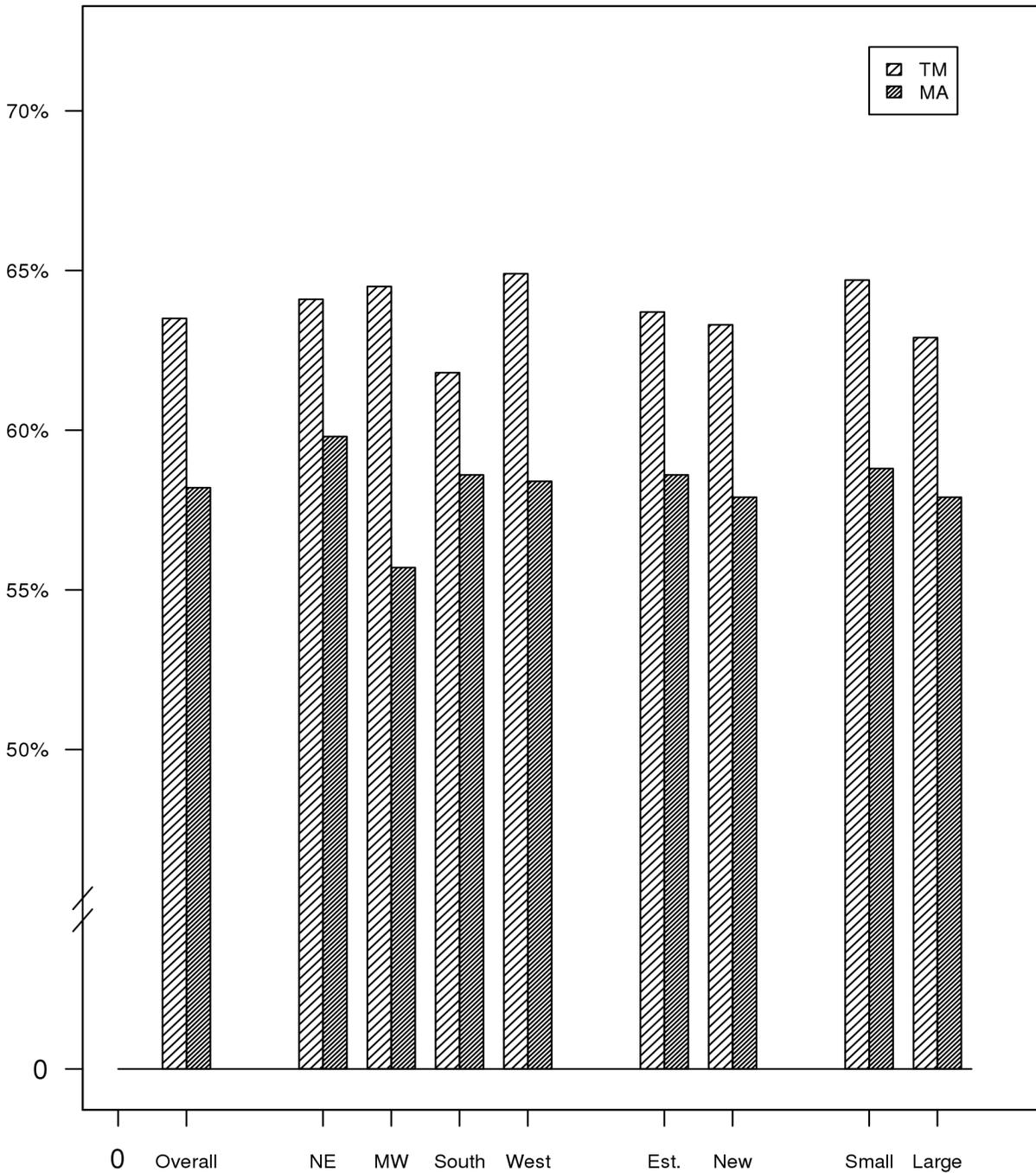
| Brand name | Generic Name |
|---------------------------|--------------------------------|
| humulin 70-30 | hum insulin nph/reg insulin hm |
| humulin 50-50 | hum insulin nph/reg insulin hm |
| humulin 70/30 | hum insulin nph/reg insulin hm |
| humalog mix 50-50 | insulin npl/insulin lispro |
| humalog mix 75-25 | insulin npl/insulin lispro |
| humalog mix 50/50 | insulin npl/insulin lispro |
| humalog mix 75/25 | insulin npl/insulin lispro |
| novolin 70-30 | hum insulin nph/reg insulin hm |
| novolin 70-30 innolet | hum insulin nph/reg insulin hm |
| novolin 70/30 | hum insulin nph/reg insulin hm |
| relion novolin 70/30 | hum insulin nph/reg insulin hm |
| novolog mix 70-30 | insuln asp prt/insulin aspart |
| novolog mix 70-30 flexpen | insuln asp prt/insulin aspart |

eAppendix Table 2. Medication Possession Ratios Among Enrollees in MA and TM (2016)

| N | | Metformin | | | LASU | | | SASU | | | TZD | | | FFS |
|-------------------------------|---------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | FFS | HMO | Diff | FFS | HMO | Diff | FFS | HMO | Diff | FFS | HMO | Diff | |
| 423,140 | ALL | 90.5% | 90.1% | 0.3% | 91.9% | 91.7% | 0.2% | 92.2% | 91.7% | 0.5% | 92.7% | 92.2% | 0.4% | 90.6% |
| Race/Ethnicity | | | | | | | | | | | | | | |
| 264,275 | 1.White | 91.7% | 91.2% | 0.5% | 92.5% | 92.4% | 0.2% | 93.2% | 92.7% | 0.5% | 93.6% | 93.1% | 0.5% | 91.2% |
| 64,430 | 2.Black | 87.0% | 86.4% | 0.5% | 90.0% | 89.4% | 0.6% | 90.0% | 89.2% | 0.8% | 90.0% | 89.3% | 0.7% | 87.8% |
| 21,947 | 4.Asian | 92.2% | 91.5% | 0.8% | 93.3% | 92.6% | 0.7% | 92.9% | 92.8% | 0.1% | 94.0% | 93.3% | 0.7% | 93.1% |
| 72,488 | 5.Hisp. | 88.2% | 88.7% | -0.5% | 90.3% | 90.9% | -0.6% | 90.2% | 90.5% | -0.3% | 90.8% | 90.9% | -0.1% | 89.9% |
| Age | | | | | | | | | | | | | | |
| 69,464 | 2.66-69 | 89.8% | 89.7% | 0.1% | 91.6% | 91.5% | 0.1% | 91.5% | 91.1% | 0.3% | 92.0% | 92.1% | -0.1% | 89.5% |
| 142,606 | 3.70-74 | 90.5% | 90.0% | 0.4% | 91.9% | 91.6% | 0.3% | 92.0% | 91.5% | 0.5% | 92.4% | 92.2% | 0.2% | 90.3% |
| 103,958 | 4.75-79 | 90.6% | 90.3% | 0.3% | 91.9% | 91.7% | 0.2% | 92.3% | 91.9% | 0.5% | 93.0% | 92.0% | 1.0% | 90.7% |
| 63,161 | 5.80-84 | 90.7% | 90.2% | 0.5% | 91.9% | 91.7% | 0.2% | 92.3% | 91.8% | 0.5% | 92.9% | 92.5% | 0.4% | 91.3% |
| 43,951 | 6.85+ | 90.7% | 90.4% | 0.3% | 91.9% | 92.4% | -0.5% | 92.8% | 92.3% | 0.5% | 93.2% | 92.8% | 0.4% | 91.4% |
| Sex | | | | | | | | | | | | | | |
| 193,798 | Male | 91.0% | 90.5% | 0.4% | 92.2% | 92.0% | 0.2% | 92.5% | 91.9% | 0.6% | 93.0% | 92.4% | 0.7% | 90.9% |
| 229,342 | Female | 90.0% | 89.8% | 0.3% | 91.6% | 91.4% | 0.2% | 91.8% | 91.5% | 0.4% | 92.3% | 92.1% | 0.2% | 90.3% |
| Region | | | | | | | | | | | | | | |
| 77,941 | NE | 91.3% | 90.5% | 0.8% | 92.7% | 92.1% | 0.6% | 93.1% | 92.2% | 0.9% | 93.3% | 92.3% | 1.0% | 91.7% |
| 70,790 | MW | 91.7% | 91.0% | 0.7% | 92.7% | 92.4% | 0.3% | 93.3% | 92.6% | 0.6% | 93.7% | 93.1% | 0.6% | 91.0% |
| 166,163 | S | 89.6% | 89.3% | 0.2% | 91.2% | 91.3% | -0.1% | 91.7% | 91.2% | 0.5% | 91.9% | 92.0% | -0.1% | 89.6% |
| 108,245 | W | 90.5% | 90.5% | 0.0% | 91.8% | 91.7% | 0.2% | 91.4% | 91.6% | -0.2% | 92.8% | 92.0% | 0.8% | 90.9% |
| Plan Duration in Mcare | | | | | | | | | | | | | | |
| 178,217 | Old | 90.5% | 90.0% | 0.5% | 91.8% | 91.9% | -0.1% | 92.2% | 91.7% | 0.5% | 92.7% | 91.9% | 0.8% | 90.6% |
| 244,923 | New | 90.4% | 90.2% | 0.2% | 91.9% | 91.6% | 0.4% | 92.2% | 91.7% | 0.4% | 92.7% | 92.5% | 0.2% | 90.5% |
| Plan Size | | | | | | | | | | | | | | |
| 121,921 | Small | 90.6% | 90.1% | 0.5% | 92.0% | 91.6% | 0.4% | 92.2% | 91.7% | 0.6% | 92.6% | 92.1% | 0.5% | 90.7% |
| 301,219 | Big | 90.4% | 90.1% | 0.3% | 91.8% | 91.8% | 0.1% | 92.1% | 91.7% | 0.4% | 92.7% | 92.3% | 0.4% | 90.5% |

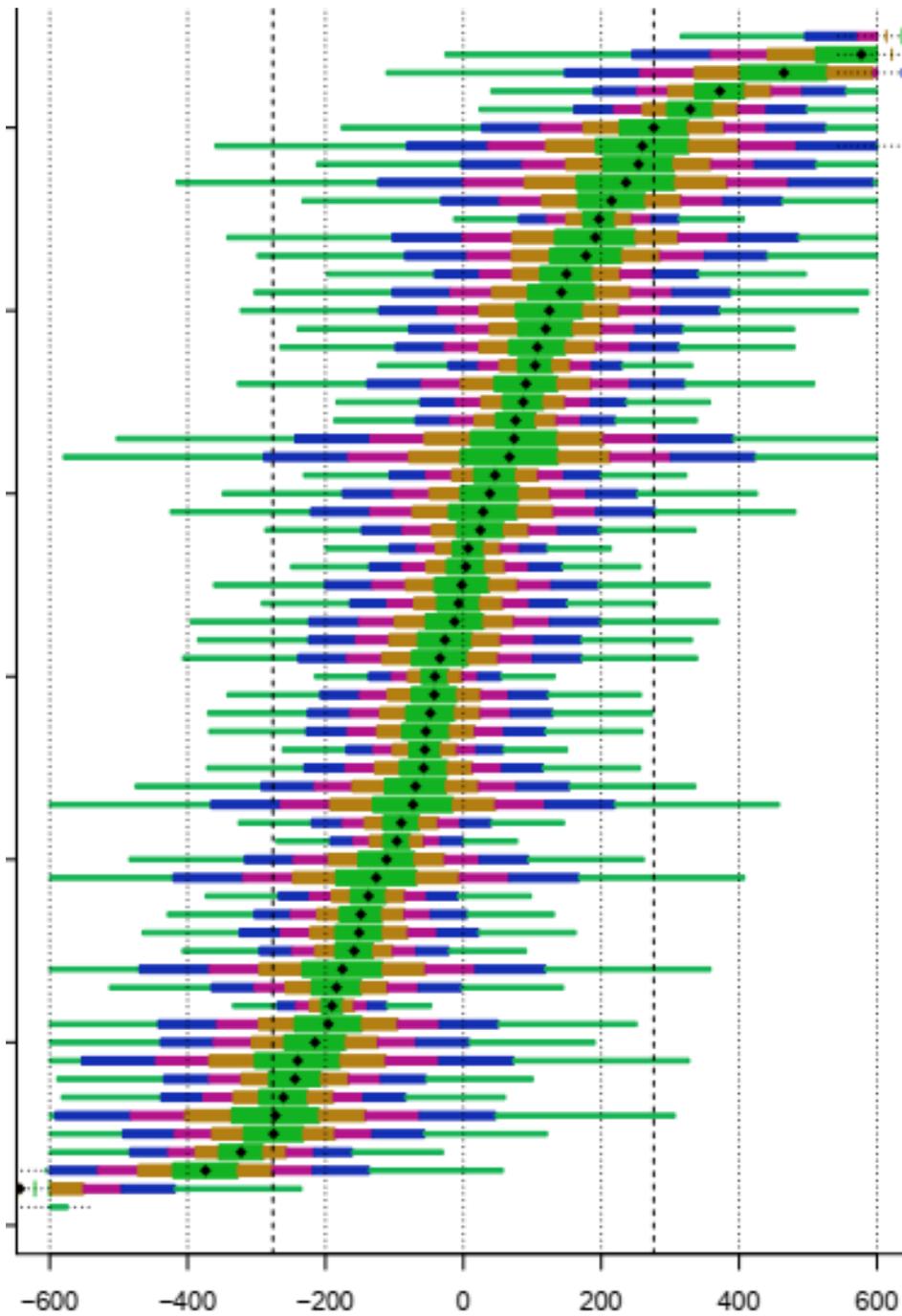
eAppendix Figure 1

Figure 1. Long-Acting Insulin as Choice of Initial Insulin for Diabetes Treatment, 2015-2016



Notes: Percentages show the percent of beneficiaries being started on long-acting insulin when beginning insulin therapy. Results are presented for use overall and then stratified by region and health plan type.

eAppendix Figure 2. Variability Among Medicare Advantage Plans in Total Diabetes Medication Costs



Notes: To examine variation in spending among MA plans, we modeled total spending for beneficiaries on two medications, using hierarchical linear regression models that included a random effect for each MA contract as well as random effects for MA and TM performance at the state and HRR levels. The random effects variance parameters quantify the variation across

plans of savings relative to matched TM enrollees in its same service area after accounting for market and state level variation and sampling error. The extremes represent the 90% credible interval with the 80%, 60%, 40%, and 20% credible intervals shown by color and thickness. The diamond represents the posterior median and every third contract is shown.