Trends in Total and Out-of-pocket Payments for Noninsulin Glucose-Lowering Drugs Among U.S. Adults With Large-Employer Private Health Insurance From 2005 to 2018

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OBJECTIVE

To estimate trends in total payment and patients' out-of-pocket (OOP) payments of noninsulin glucose-lowering drugs by class from 2005 to 2018.

RESEARCH DESIGN AND METHODS

We analyzed data for 53 million prescriptions from adults aged >18 years with type 2 diabetes under fee-for-service plans from the 2005–2018 IBM MarketScan Commercial Databases. The total payment was measured as the amount that the pharmacy received, and the OOP payment was the sum of copay, coinsurance, and deductible paid by the beneficiaries. We applied a joinpoint regression to evaluate nonlinear trends in cost between 2005 and 2018. We further conducted a decomposition analysis to explore the drivers for total payment change.

RESULTS

Total annual payments for older drug classes, including metformin, sulfonylurea, meglitinide, α-glucosidase inhibitors, and thiazolidinedione, declined during 2005–2018, ranging from −$271 (−53.8%) for metformin to −$2,406 (−92.2%) for thiazolidinedione. OOP payments for these drug classes also reduced. In the same period, the total annual payments for the newer drug classes, including dipeptidyl peptidase-4 inhibitors, glucagon-like peptide 1 receptor agonists, and sodium–glucose cotransporter 2 inhibitors, increased by $2,181 (88.4%), $3,721 (77.6%), and $1,374 (37.0%), respectively. OOP payment for these newer classes remained relatively unchanged. Our study findings indicate that switching toward the newer classes for noninsulin glucose-lowering drugs was the main driver that explained the total payment increase.

CONCLUSIONS

Average annual payments and OOP payment for noninsulin glucose-lowering drugs increased significantly from 2005 to 2018. The uptake of newer drug classes was the main driver.

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An estimated 34.2 million, or 10.5% of, U.S. adults had diabetes in 2018 (1). The health care expenditure for managing diabetes and treating diabetes-related complications was estimated to be $237 billion in 2017 (2). Among all the cost items associated with diabetes, spending on glucose-lowering drugs has been one of the fastest-growing components. Between 1987 and 2011, spending on glucose-lowering medications increased from 27% of all medical spending among individuals with diabetes to 41% (3). Noninsulin medication users were predominant among individuals with diabetes receiving glucose-lowering medications. In 2011, 72% of people with diagnosed diabetes took noninsulin glucose-lowering medications and 58% were on noninsulin glucose-lowering medications only (4). The proportion of people with type 2 diabetes mellitus (T2DM) who initiated noninsulin glucose-lowering drugs within 1 year after the diagnosis had increased from 46.2% in 2007 to 56.7% in 2012 (5).

Many factors may have contributed to the substantial increase in per-person spending on glucose-lowering medications over the last decade. First, three major noninsulin glucose-lowering drugs—dipeptidyl peptidase-4 inhibitors (DPP4), glucagon-like peptide 1 receptor agonists (GLP1), and sodium–glucose cotransporter 2 inhibitors (SGLT2)—have been introduced to the market between 2005 and 2013 and have gradually taken over the markets from older drug classes such as sulfonylurea, meglitinide, α-glucosidase inhibitors (AGI), and thiazolidinedione (TZD) (6). Second, the prices of these newer drug classes were higher and increased over time. For example, the per-tablet listed price of DPP4 increased from $6.67 to $8.92 from 2006 to 2013 (7).

Few studies have systematically examined the payment change for noninsulin glucose-lowering diabetes medications over time in the U.S. Understanding these changes and identifying the key factors that drive the change could facilitate determining how the change has contributed to the overall increase in medical expenditures associated with diabetes and how to find ways to curb the increases and contain overall expenditures associated with diabetes.

Out-of-pocket (OOP) payment reflects the direct financial burden of medical care on patients and their families. It plays an important role in determining patient adherence to diabetes care and, ultimately, the outcome of care. Studies have found that patients' medication adherence was inversely associated with OOP payments (8,9), and this association is especially significant among individuals with diabetes (10,11). One out of seven insured patients with diabetes reported that high OOP cost was a reason for nonadherence (12). Another study found that doubling of OOP payments among insured individuals with diabetes was associated with 25% lower medication adherence (11). Studies have also found that high OOP payment led to lower achievement of glucose goals, lipid level, and blood pressure among Medicare beneficiaries (13), and poorer physical and mental health among individuals with diabetes (14), which can lead to excess overall health care spending (15). Due to the complex drug tier system and the variations in formulary across different health plans, OOP could vary by drug class; this variation has not yet been examined.

The objective of our study was to examine the trends in total payment and OOP payments for various noninsulin glucose-lowering drug classes from 2005 to 2018 in adults with T2DM. We also examined how changes in the use pattern of each drug class have contributed to the payment change.

RESEARCH DESIGN AND METHODS

Data Sources and Study Population

Data for our study were from the 2005–2018 IBM MarketScan Commercial Claims Databases. These databases contain nationwide administrative claims records on health care use and enrollment across a range of settings, including outpatient, inpatient, and pharmacy claims. The population in these databases included employees, dependents, and retirees with large employer–sponsored health plans. The enrollees of these databases represent the U.S. population commercially insured by large employer–sponsored health plans.

We used medication prescription as the primary analytical unit. We restricted medication prescriptions to those filled by individuals aged >18 years with T2DM who were continuously enrolled in fee-for-service health plans. We used both ICD-9 codes (250.X0 and 250.X2) and ICD-10 codes (E11) to identify T2DM diagnoses. To be included in our study, individuals needed to have two outpatient records at least 30 days apart or one inpatient record with the above codes between 2005 and 2018. Records on glucose-lowering drugs were from the pharmacy claims files. We excluded those with type 1 diabetes because the use of noninsulin glucose-lowering drugs is most relevant to the population with T2DM.

Outcome Variables

Our primary outcome variables were the total payment and OOP payment for an annual supply of glucose-lowering medications. Total payment is the payment amount that the pharmacy received, and the OOP payment is the sum of copay, coinsurance, and deductible paid by the patients or their families. We standardized the payment amount by the number of days covered by each prescription and inflated to a yearly supply. All costs were standardized to 2018 USD with use of the consumer price index for medical care services (16).

We used national drug codes provided by the U.S. Food and Drug Administration to identify records of noninsulin glucose-lowering drugs and grouped them into one of eight classes: metformin, sulfonylurea, meglitinide, AGI, TZD, DPP4, SGLT2, and GLP1. We also categorized drug classes based on the time when drugs became available: before or after 2005. Older drugs (those that became available before 2005) included metformin, sulfonylurea, meglitinide, AGI, and TZD; newer drugs (those introduced during and after 2005) included DPP4, SGLT2, and GLP1. Metformin was considered the first-line drug, and all others are referred to as second-line drugs (17).

Trend Analysis

The yearly payment for a drug class was a weighted average payment for all drug brands within the corresponding drug class, in which the weight was the percentage of the prescriptions for the corresponding product in the corresponding year. Payments were plotted against time for description of the trend of payment change from 2005 to 2018, with a 5-month moving average and spline technique for smoothing of the trend line. We used joinpoint regression

to identify the inflection point when the trend started to change and estimated the magnitude of changes in each defined segment of the trend. The regressions included a sine-cosine modifier for adjustment for seasonal fluctuations in payments each year.

We conducted a decomposition analysis to explore how changes in the drug use pattern of different drug classes, versus cost increases within those classes, impacted average payment for second-line drugs. We first determined trends in drug use patterns for each second-line drug class from 2005 to 2018. We then estimated the trend in average payment for each of the seven noninsulin glucose-lowering drugs included in this study. After that, we estimated the trend of average payment for second-line drugs over a hypothetical cohort with observed time-varying payment for each drug class, but a fixed drug use pattern of each drug class, as observed in 2005. We explore how the average payment for second-line drugs would change between 2005 and 2018 by using a hypothetical cohort and assuming that patients were in their original 2005 use patterns.

We used R 3.4.1 to analyze the data and generate tables/figures (18). A STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist is provided in Supplementary Appendix 2.

RESULTS

Our analyses are based on ~53 million claims of noninsulin glucose-lowering drugs used by adults with T2DM. Details of the sample selection flow and sample size are summarized in Supplementary Table 1.

Time Trends in Total Payments

Figure 1*A* presents the trends in the total payment for a yearly supply for all noninsulin glucose-lowering drugs and by drug class. Trends of total payments by product within each drug class are presented in Supplementary Fig. 1. More detailed descriptions of the average total payment change for each drug class from the joinpoint regression analysis are summarized in Table 1.

The average total payment for an annual supply of noninsulin second-line glucose-lowering drugs remained stable between 2005 and 2014 (3.4% annual increasing rate [95% CI 3.0–3.8]) but grew sharply by 20.4% (95% CI 19.3–21.5), or $492.6 (95% CI 477.3–508.0), every year after 2014. In 2018, the average total payment on a yearly supply of second-line glucose-lowering drugs was estimated to be $3,872. The total payment decreased for all older drugs between 2005 and 2018, especially for meglitinide and TZD after 2011. Total payment for sulfonylurea and AGI decreased sharply at annual rates of −36.3% (95% CI −37.9 to −34.6) and −10.2% (95% CI −11.8 to −8.6) before their inflection points, respectively, and continued to decrease at slower rates of −7.9% (95% CI −10.4 to −5.4) and −9.6% (95% CI −12.5 to −6.6) afterward. For meglitinide and TZD, total payment increased between 2005 and 2011 at annual rates of 7.5% (95% CI 6.3–8.7) and 5.8% (95% CI 3.7–7.9), respectively, but then decreased sharply at annual rates of −26.9% (95% CI −28.4 to –25.3) and −38% (95% CI −40.0 to −35.9) afterward. For metformin, the total payment for an annual supply decreased at a rate of −4.5% (95% CI −6.4 to −2.5) yearly before 2014 but increased at a rate of 11% (95% CI 2.7–20.1) afterward. Sulfonylureas had the lowest total payment among all glucose-lowering drug classes in 2018.

In contrast, the newer drugs had a higher total payment amount than older drugs when they first became available and then continued to increase at a higher rate afterward, which enlarged the cost gap between the older drugs and the newer drugs. For DPP4 and GLP1, the total payments for an annual supply increased mildly at rates of 2.8% (95% CI 2.1–3.5) and 5.6% (95% CI 3.9–7.3) before the inflection points, respectively, but grew sharply afterward at annual rates of 8.6% (95% CI 7.7–9.6) and 9.0% (95% CI 7.1–11.0). The total payments for SGLT2 grew rapidly at an annual rate of 12.0% (95% CI 11.4–12.5) before 2015 but slowed to a rate of 5.0% (95% CI 4.2–5.7) afterward. In 2018, newer drugs were generally 8 to 12 times more expensive than the older drugs, among which GLP1 was the costliest ($700 per 30 days). All of the changes above are statistically significant (i.e., $P < 0.05$).

Metformin had more heterogeneity of payments for different products within the same drug class (Supplementary Fig. 1) than other older drug classes. We also found that there has been a growing number of high-priced metformin products recently, with a total payment of $2,000–$6,000 for a 30-day supply (Supplementary Fig. 1).

Time Trends in OOP Payments

Figure 1*B* and Table 2 present the trends in the OOP payments for all noninsulin glucose-lowering drugs and by drug class. The OOP payment for older noninsulin glucose-lowering drugs decreased substantially during the study period. Between 2005 and 2018, the OOP payment for an annual supply of metformin, sulfonylurea, meglitinide, AGI, and TZD decreased by −81.9% (−$128), −75.3% (−$122), −80.2% (−$300), −83.7% (−$325), and −86.7% (−$326), respectively. For newer noninsulin glucose-lowering drugs, despite the sharp increase in total payments, OOP payments were relatively stable, with annual rates of change mostly <5%. On average, we observed an increasing trend of OOP payment for an annual supply of second-line glucose-lowering drugs between 2013 and 2018, by 10.7% ($28) yearly. In 2018, newer drugs had an average OOP payment of ~$550, while older drugs, in general, had annual OOP payments <$100.

Decomposition Analysis

Figure 2 summarizes the change of use pattern for each second-line glucose-lowering drug between 2005 and 2018. Sulfonylureas were the most frequently used second-line glucose-lowering drugs (52.1%) in 2005; this remained stable until 2012 (52.5%) and then decreased rapidly. By 2018, only 30.4% of purchases on second-line glucose-lowering drugs were for a sulfonylurea. The proportion of prescriptions for all older drugs declined from 2005 to 2018: meglitinide from 6.2% to 0.6%, AGI from 0.4% to 0.2%, and TZD from 41.4% to 6.8%. Among the three newer drug classes, the proportion of prescriptions for DPP4 has been increasing since its market entrance (2005) and hit its peak in 2012 (21.4%). However, since 2012, we observed a steady decline in the use of this drug class over the years, which was reduced to 14.5% of all the second-line glucose-lowering drug prescriptions in 2018. Unlike DDP4, the proportions of prescriptions of SGLT2 and GLP1 have been continuously

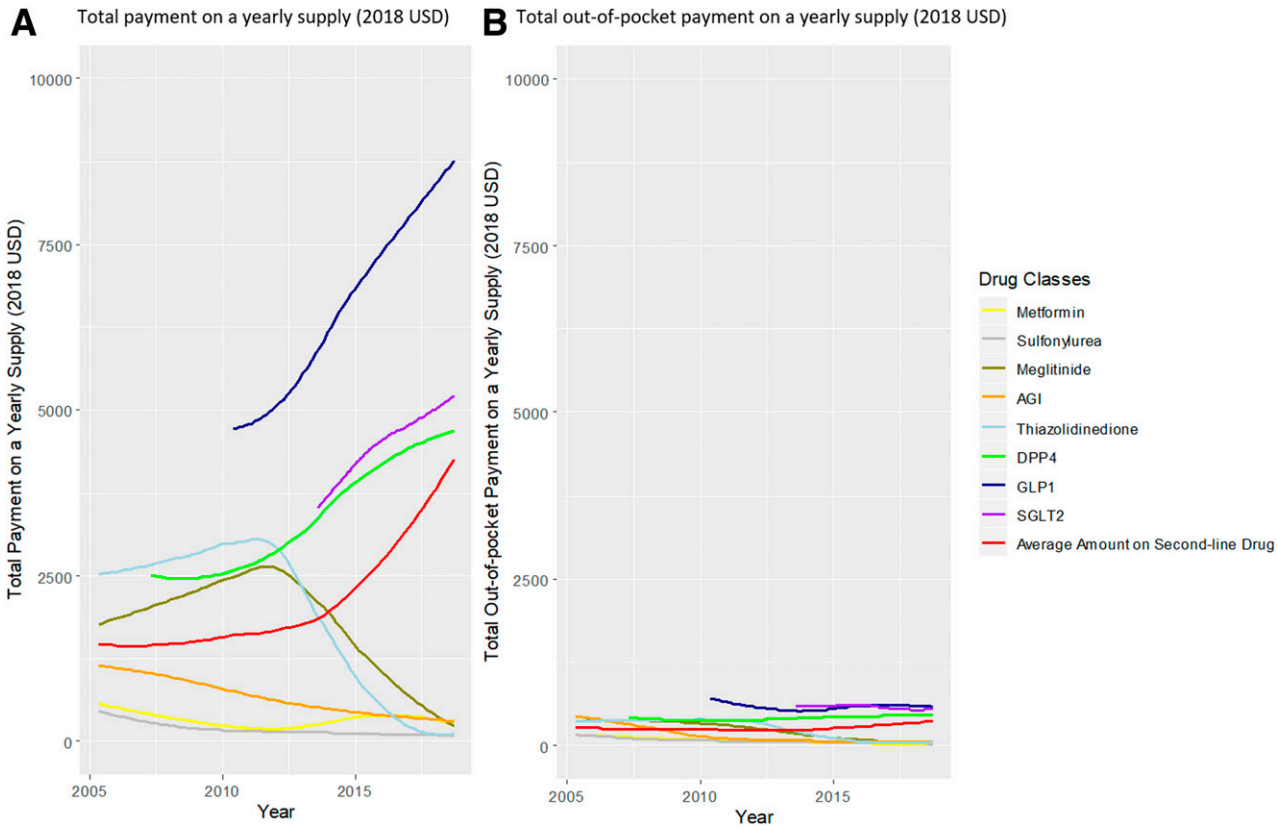

Figure 1—Change of total payment (*A*) and OOP payment (*B*) for a yearly supply of glucose-lowering medication between 2005 and 2018. Each trend line represents the payment of a single drug class, and the red line represents the average payment of a yearly supply of all second-line drugs, weighted by a time-varying use pattern of each drug class.

increasing since their market entrance. In 2018, these two drug classes together occupied almost 50% of the overall market for the second-line glucose-lowering drug (GLP1 25.5% and SGLT2 22.0%).

Figure 3 summarizes the results of the decomposition analysis. We found that if the older drugs had been used at the 2005 rate through 2018, the average total payment and OOP payment would have decreased substantially from 2005 to 2018, by 90% (blue lines), because the total and OOP payments for older drug classes have reduced. However, when the actual market share was applied in calculation of the trend of the average total payment and OOP payment for glucose-lowering drugs (red line), our results showed an increase of almost threefold in total payment from 2005 ($1,498) to 2018 ($3,872) and a 1.5 times increase in OOP payment in the same period ($275–$346). These results suggested that the increases in average total payment and OOP payment for the second-line glucose-lowering drugs are highly attributable to the change in use pattern toward newer drugs, which are 8–12 times more expensive than the older classes.

CONCLUSIONS

Total Payment

We systematically examined the changes in total payments of all eight classes of noninsulin glucose-lowering medication by class from 2005 to 2018 in adults with T2DM. We found a significant decreasing trend in total payment for the five older drug classes. On the contrary, the three newer noninsulin glucose-lowering medications entered the drug market at high total payment amounts (8–12 times more than older drugs), and these payments continued to increase at a rate of ~10% per year afterward. Meanwhile, more patients started to use newer ones, especially SGLT2 and GLP1. By 2018, almost 50% of second-line glucose-lowering drug users were using either SGLT2 or GLP1. This change in drug use pattern toward newer drug classes was attributable to the recent findings from several clinical trials that have demonstrated promising cardio- and renoprotective benefits associated with use of SGLT2 and GLP1 (19–23). On the contrary, most of the clinical trials on older drug classes failed to demonstrate such a cardioprotective effect. Unlike SGLT2 and GLP1, trials for DPP4 have reported mixed results, and its benefit in preventing cardiovascular and renal disease remained inconclusive (24). This partially explained the downward trend in the use of DPP4 between 2012 and 2018. The sequencing of glucose-lowering drug initiation now favors SGLT2 and GLP-1 for prevention of cardiovascular and renal disease (24).

Our finding on changes in the average payment for noninsulin glucose-lowering medications before 2013 is consistent with the result from a previous study with use of data from the Medical Expenditure Panel Survey (2002–2013) (7). Literature exploring the trend of payment change after 2013 is lacking. An online report by the GoodRx Research team revealed that between 2014 and 2019, the average list price for noninsulin glucose-lowering

Table 1—Change of total payments for an annual supply of medication between 2005 and 2018 (2018 USD)

	Payment (annual)					Annual change before inflection points				Annual change after inflection points			
						Absolute†*		Relative††*		Absolute†*		Relative††*	
Drug class	2005/ market entrance	2018	Absolute change 2005–2018	Relative change 2005–2018	Inflection points (year)	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Metformin	504.2	233.1	−271.1	−53.8%	2014	−14.3	−21.5 to −7.2	−4.5%	−6.4 to −2.5	33.8	6.6–61.1	11.0%	2.7–20.1
Sulfonylurea	435.9	96.6	−339.4	−77.8%	2007	−154.2	−161.1 to −147.3	−36.3%	−37.9 to −34.6	−12.1	−19.4 to −4.8	−7.9%	−10.4 to −5.4
Meglitinide	1881.9	499.0	−1,382.8	−73.5%	2011	128.6	106.1–151.1	7.5%	6.3–8.7	−414.0	−455.8 to −372.1	−26.9%	−28.4 to −25.3
AGI	1,083.6	314.5	−769.1	−71.0%	2011	−87.2	−97.0 to −77.5	−10.2%	−11.8 to −8.6	−44.8	−62.8 to −26.7	−9.6%	−12.5 to −6.6
TZD	2,608.9	203.1	−2,405.8	−92.2%	2011	65.8	25.5–106.1	5.8%	3.7–7.9	−509.6	−578.3 to −441.0	−38.0%	−40.0 to −35.9
DPP4	2,468.7	4,650.0	2,181.3	88.4%	2010	45.7	25.7–65.7	2.8%	2.1–3.5	292.2	267.1–317.4	8.6%	7.7–9.6
GLP1	4,791.9	8,512.7	3,720.8	77.6%	2011	153.9	81.7–225.8	5.6%	3.9–7.3	575.0	496.4–653.6	9.0%	7.1–11.0
SGLT2	3,719.6	5,094.1	1,374.5	37.0%	2015	453.7	430.7–476.7	12.0%	11.4–12.5	235.2	201.6–268.8	5.0%	4.2–5.7
Average†††	1,497.5	3,871.8	2,374.3	158.6%	2014	47.4	41.8–53.0	3.4%	3.0–3.8	492.6	477.3–508.0	20.4%	19.3–21.5

†Absolute change ($year_i$) = cost ($year_i$) − cost ($year_{i-1}$). ††Relative change ($year_i$) = cost ($year_i$) / cost ($year_{i-1}$) − 1. †††Average payment of all second-line drugs, including all the listed drug classes except metformin.
*P values <0.05 for all parameters provided in this column.

Table 2—Change of copayments for an annual supply of medication between 2005 and 2018 (2018 USD)

	Payment (annual)					Annual change before inflection points				Annual change after inflection points			
						Absolute†		Relative††*		Absolute†*		Relative††*	
Drug class	2005/market entrance	2018	Absolute change 2005–2018	Relative change 2005–2018	Inflection points (year)	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean*	95% CI
Metformin	155.6	28.1	−127.5	−81.9%	2010	−17.1	−17.6 to −16.6	−12.5%	−13.3 to −11.7	−7.3	−8.0 to −6.6	−14.2%	−15.4–13.0
Sulfonylurea	161.5	39.9	−121.6	−75.3%	2006	−75.3	−78.8 to −71.9	−36.9%	−39.3 to −34.5	−6.2	−9.8 to to −2.7	−9.0%	−12.5 to −5.4
Meglitinide	374.4	74.0	−300.4	−80.2%	2017	−32.4	−34.1 to −30.7	−15.5%	−16.5 to −14.5	20.0	−11.7 to 51.8**	−4.2%	−22.6 to 18.6
AGI	388.2	63.2	−325.0	−83.7%	2010	−67.5	−72.1 to −62.9	−26.0%	−28.1 to −23.9	−6.6	−13.2 to −0.1	−8.6%	−12.3 to −4.7
TZD	376.5	50.1	−326.4	−86.7%	2015	−30.1	−34.6 to −25.6	−14.2%	−16.1 to −12.3	−48.7	−65.8 to −31.6	−31.5%	−37.0 to −25.4
DPP4	410.6	455.4	44.8	10.9%	2010	−12.4	−15.3 to −9.5	−3.0%	−3.7 to −2.3	11.7	8.2–15.1	2.8%	2.0–3.7
GLP1	665.7	594.5	−71.2	−10.7%	2012	−59.9	−65.9 to −53.9	−9.6%	−10.5 to −8.6	17.4	9.5–25.2	3.1%	1.7–4.5
SGLT2	587.6	549.1	−38.6	−6.6%	2015	13.8	5.2–22.3	2.3%	0.8–3.8	−31.5	−45.2 to −17.7	−5.3%	−7.5 to −3.0
Average†††	274.8	345.9	71.1	25.9%	2013	−4.5	−5.6 to −3.4	−1.8%	−2.2 to −1.4	28.5	25.7–31.2	10.7%	9.5–11.9

†Absolute change ($year_i$) = cost ($year_i$) − cost ($year_{i-1}$). ††Relative change ($year_i$) = cost ($year_i$) / cost ($year_{i-1}$) − 1. †††Average payment of all second-line drugs, including all the listed drug classes except metformin.
*All parameters provided in this column have *P* values <0.05. **This is the only point estimate that has a *P* value >0.05.

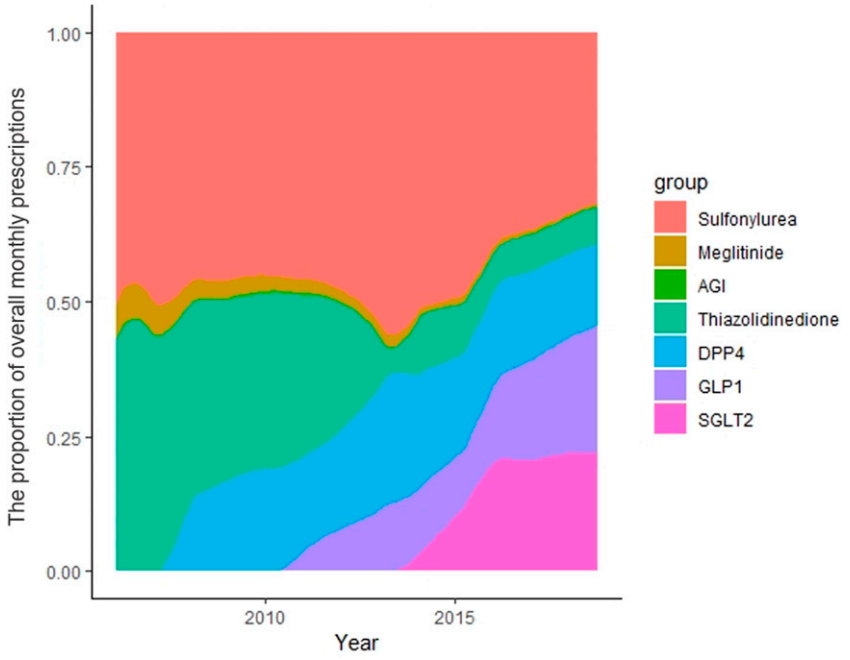

Figure 2—Change of use pattern of second-line medications between 2005 and 2018.

medications increased by almost twofold (25), which is in line with what we found in this study. To date, there are no studies that examined the change of payments for noninsulin glucose-lowering drugs by class among privately insured Americans after 2013. Our study provides baseline information that may be valuable for monitoring of the change in payments for noninsulin glucose-lowering drugs over time among people with large private insurance and for assessing the impact of health policy or market changes on these payments.

A recent study published in Health Affairs (26) summarized the average list price change for non-diabetes-specific medications between 2005 and 2015. They found that although the newer drugs accounted for most of the increased drug expenditures, there was also a large price increase for older drugs. Our findings on the payment change for older second-line drug classes were different from the finding of this study. One of the possible reasons that there was not a cost increase for older glucose-lowering drugs in our study is that the three newer glucose-lowering drug classes entered the market in the last decade and patients with diabetes switched from older drug classes to these new drugs. The newer drugs, especially SGLT2 and GLP1, may be more effective in lowering

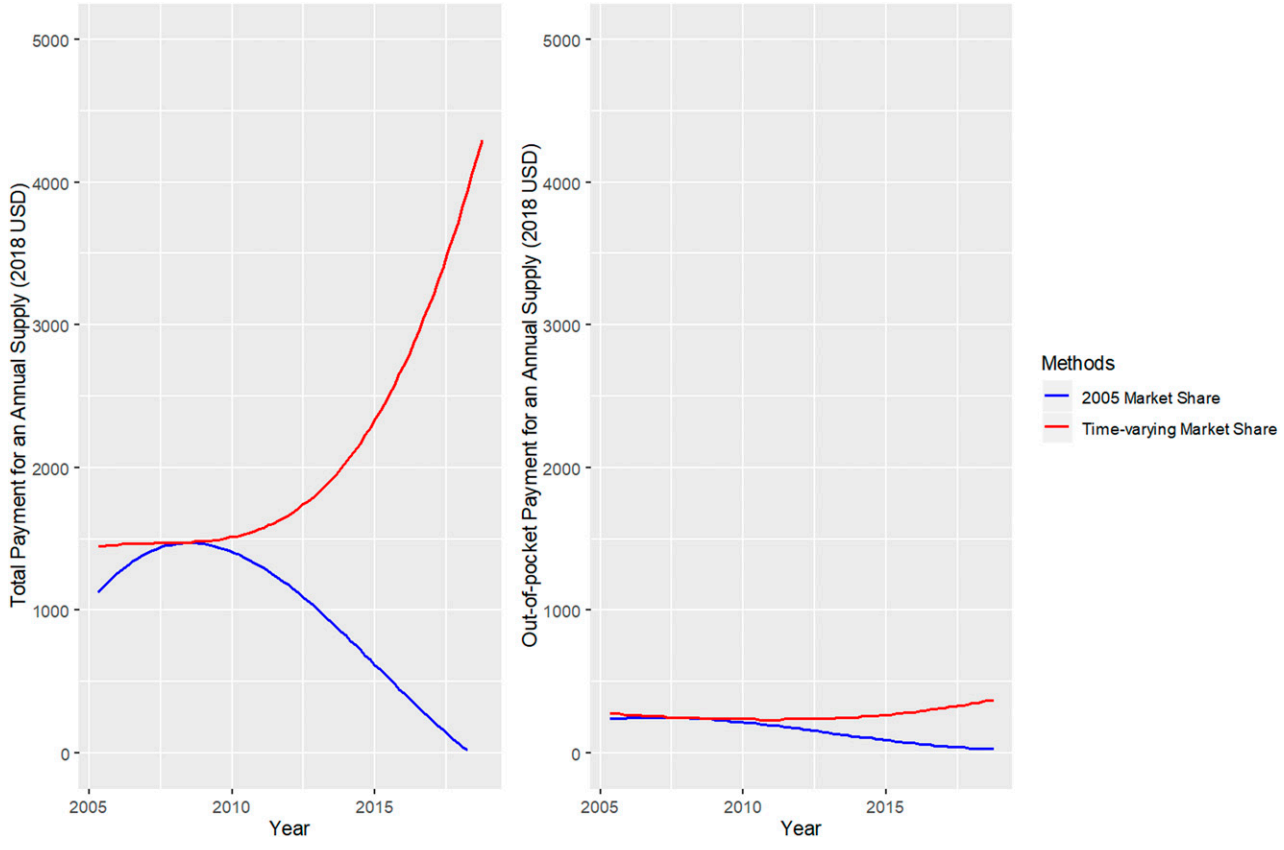

Figure 3—Change of average total payment and OOP payment for a yearly supply of glucose-lowering medication between 2005 and 2018.

patients' glucose levels or provide more clinical benefits (27). Loss in market share left limited room for price increases in the older drugs. Although metformin is an older drug, it is used as a first-line glucose-lowering medication. The payment amount for metformin has been increasing since 2015. In fact, metformin has the fastest escalation speed (11% per year) in total payment among all noninsulin antidiabetes medications after 2015. The increase in total payment for metformin may lead to a substantial increase in overall medication expenditures nationally, as it is the most widely used glucose-lowering medication in the U.S. (6).

A previous study found a large price variation in glucose-lowering medications, even within the same class (28). In our study, we found that the cost variation was minimal for newer drug classes but relatively large for certain older drug classes. We found that metformin has the highest heterogeneity of payments across different products, among which several products cost $2,000–$6,000 per year.

Average total payment for noninsulin glucose-lowering medication almost tripled between 2005 and 2018 (Figs. 1 and 3). Switching from older low-cost drugs toward newer high-cost medications was the main driver for the total payment increase between 2013 and 2018. From 2005 to 2018, payments for an annual supply of older drug classes reduced by >90%. Thus, if only older drugs were used in 2018, the total payment for noninsulin glucose-lowering drugs would have been 90% lower, an amount below the level paid in 2005. Payments for newer drugs were comparable or at most twice as much as the payment for older drugs in 2010, but the payment difference between the older and newer drugs increased sharply thereafter. In 2018, payers spent 8–12 times more for newer antidiabetes medications compared with older drugs, and the number of users of newer medications in this privately insured population with diabetes exceeded 60%.

The shift to the use of newer glucose-lowering drug classes raises two key questions: *1*) do the newer drug classes lead to better long-term clinical outcomes, and *2*) even with better clinical outcomes, are the newer drug classes cost-effective in comparison with older ones? For the first question, there is growing evidence demonstrating the additional clinical benefits of SGLT2 and GLP1 beyond glucose control, compared with older drugs and DPP4 (20,29–31), among patients with diabetes and with established cardiovascular complications or at high risk for cardiovascular disease with multiple risk factors. However, studies exploring the heterogeneous clinical efficacy of SGLT2 and GLP1 in subpopulations with different characteristics are lacking. Individuals with certain characteristics might benefit even more (or less) from these two drug classes than the population average. The use of treatment should be linked to individualized characteristics for achievement of optimal health output. For the second question, it is unknown whether the higher cost for newer drugs can be justified by the additional clinical benefit. In our previous study, where we reviewed 18 cost-effectiveness evaluations on newer drug classes compared with older classes, we found that most studies reported that newer drugs were cost-effective based on a $50,000/quality-adjusted life-year threshold (32). However, medication payments for most of those studies were from before 2013. The payment gap between newer and older drug classes has increased substantially between 2013 and 2018. It would be beneficial to further evaluate whether the newer drug classes with the 2018 payment levels would still be deemed cost-effective compared with the older drug.

OOP Payment

OOP payments on older drug classes were reduced by ~80% between 2005 and 2018. Patients paid ~$50 for an annual supply of those drugs in 2018. For the newer drugs, the OOP payment amount was 10 times higher for an annual supply (~$500), although a stable trend between the market entrance date and 2018 was observed. This finding implies that the rising payments on newer drugs were not directly transferred to the cost-sharing component of the patients in this population insured by large commercial health plans. With the current insurance design, most of the payment for the newer glucose-lowering drugs was through copay, in which patients are required to pay only a fixed amount regardless of the total cost. Thus, the increased total payments on the newer drugs had minimal impact on patients' cost-sharing amounts. Policy efforts limiting patients' cost to minimal (33), or even zero (24) may also limit patients' OOP payments.

Although the OOP payment for noninsulin glucose-lowering drugs did not increase between 2005 and 2018, the sharply escalating total payment for these drugs can still potentially increase economic burden for patients. For example, the fast increasing drug costs paid by insurance companies may lead to an increase in premiums for the patients from a larger pool. In addition, studies have shown that an increase in insurance premiums can cause patients to switch to plans with lower premiums but higher cost sharing (34). A plan with high cost sharing might then discourage medication adherence, leading to an increase in the risk of complications and thus further increase the economic burden on patients for treatment of these complications (35).

The current drug market lacks ways to control drug costs. Cost sharing has been used as an effective mechanism to control drug prices by controlling public demand for pharmaceuticals (36,37) in many countries, including the U.S. (37). However, our study found that the cost-sharing amount was no longer sensitive to the total payment change. In other words, because the OOP amount remained unchanged, the public demand was unlikely to be directly influenced by payment change. Thus, the findings suggest that the current cost-sharing mechanism is no longer serving as an effective mechanism for cost containment of noninsulin glucose-lowering drugs by class. Moreover, in 2018, health plans paid $4,000–$8,000 for an annual supply of newer drug classes but <$400 for older drugs. This might partially explain the change of use pattern toward newer drugs (i.e., moral hazard [38]), and the increased demand for newer drugs can then create room for further increases in price.

Limitations

Our study has a few limitations. First, all of the estimates were generated from a commercial claims database, which contains individuals younger than the general population. It is possible that individuals with Medicare coverage, or with other or no coverage, had a payment

pattern different from our estimates. Second, our study excluded products containing multiple agents from different drug classes. Considering that the objective of our study was to estimate the payment change in each drug class, this limitation might not be relevant to our study aim; however, it likely affects overall estimates. Third, our study relied on drug claims paid by the payers. Patients who purchased drugs directly without filing a claim or receiving drugs at no cost are not included. Lastly, the presented cost estimations were measured by the payments made by insurers, not including potential rebates granted by manufacturers to private payers either directly or through pharmacy benefit managers. These potential rebates may partially mitigate the increasing trends in costs. A few studies have examined the rebate amount and concluded that the rebates also increased substantially between 2012 and 2017 (39). The reason why researchers were anxious to know the rebate amount is because rebate, if flowed back to the payer, can be used to offset the cost burden and mitigate the observed increase in payment. However, all of the previous studies used manufacturer-reported net benefit for quantification of the rebate amount. This number, although useful, does not differentiate the rebate amount that flows back to the payers that can offset the cost burden of the health care system from the rebate amount consumed by the supply chain (e.g., pharmaceutical benefit manager). It is also possible that the majority of the rebates should still be counted toward the cost of the health care system because they did not flow back to the payers and offset the cost. Studies are warranted to explore this further.

Conclusion

Our study identified patterns of change in the total payment of noninsulin glucose-lowering drugs by class. Average total and OOP payments for an annual supply of second-line drugs increased substantially from 2005 to 2018. The total payment on older drugs declined markedly, while the total payment increases in newer drugs tended to accelerate over time. OPP payments varied by drug type but mostly declined over time within each drug class. The key driver for the average total payment increase was the shifting use pattern toward high-cost newer drugs.

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