

A Data-Based Foundation for Managing Hypertension Services

David J. Cook, MD, MHA; Kenneth Cohen, MD; and Mariefel Nicole Deypalan, MS

According to the CDC, 45% of all US adults have hypertension. Hypertension is the most important risk factor for stroke and myocardial infarction¹ and is a leading cause of chronic kidney disease.^{2,3} Poor blood pressure (BP) control is among the most common problems in health care, with only 43% of hypertensive adults having a controlled BP less than 140/90 mm Hg.⁴

Although hypertension drugs are low cost, the spend on hypertension-related physician visits is significant. Further, relative to individuals without hypertension, those with hypertension have 2.5 times the inpatient cost, almost double the outpatient cost, and nearly triple the annual prescription medication expenditures.⁵ A 2018 analysis estimated that the adjusted annual incremental cost for the hypertensive adult population is \$131 billion higher than that of the nonhypertensive population.⁵ In the absence of a change in prevalence or health trajectory, the annual cost for this population will continue to increase.^{6,7}

As such, improving care delivery, care convenience, and generating health care savings by service redesign is a priority. Higher-value and more convenient care could reduce the cardiovascular and kidney morbidity so closely tied to poor hypertension control. This study sought to better understand utilization of primary care services in a Medicare Advantage (MA) population with hypertension to gauge potential opportunity for virtual delivery models. We hypothesized that analysis of events during and following in-person visits would offer insights into the proportion of visits that might be delivered remotely or might be waste (ie, services not adding clinical value). We also sought to identify predictors of physician visits and the proportion of visits needing face-to-face care, such as visits associated with procedures. Our medication analysis was performed to better understand the medications most common in this population. Finally, predicting medication changes or provider visits might allow better planning of service needs. If predictive models allow for population segmentation, clinician time might be focused on those with predictably greater need, to whom greater time might then be given.

ABSTRACT

OBJECTIVES: To understand primary care visits and medication utilization among older patients with hypertension to gauge opportunity for service redesign.

STUDY DESIGN: Data came from 1,880,331 Medicare Advantage members with hypertension who had a primary care visit and a pharmacy claim for an antihypertensive, antidiabetic, or antilipemic medication. To determine activities associated with a primary care visit, we analyzed 43,258,454 medical claims, 245 procedure codes, and medication management associated with those visits. Models for predicting both hypertension visits and medication management were evaluated and applied.

METHODS: Logistic regression was used to identify which features were predictive of a medication change or a provider visit.

RESULTS: Almost 40% of visits were consultation only, not associated with a procedure, and 26.5% of individuals had no medication change in a year. For prescription changes, 75% were a return to a previously prescribed medication or a medication discontinuation. Twenty percent of the population accounted for 47.9% of visits. Type 2 diabetes and a prior medication change were the strongest predictors of a medication change. A previous medication change was also the strongest predictor of a subsequent provider visit.

CONCLUSIONS: Our analysis suggests that a significant portion of care—consultation-only visits—may be relatively low value. Further, much of medication management may not require an office-based visit. Finally, utilization behavior of patients with hypertension and predictive models are likely to allow informed provisioning of new service models to specific population segments.

Am J Manag Care. 2022;28(8):e282-e288. doi:10.37765/ajmc.2022.89201

METHODS

Establishing Definitions

We investigated MA members continuously enrolled from October 2018 to December 2019 who had at least 1 hypertension diagnosis and a pharmacy claim for an antihypertensive, antidiabetic, or antilipemic medication. The 1,880,331 members satisfying these criteria were used in all subsequent analyses.

Identifying Office-Based Procedures

A text search on procedure descriptions and health care economics service types identified a list of office procedures. Of 27,910 unique procedure codes, we identified the 245 most common. We then identified 43,258,454 medical claims from members with at least 1 hypertension diagnosis and having any of the 245 procedure codes identified. This subset of data was used together with pharmacy claims to analyze the primary care service activities for members with hypertension. Although BP measurement and hemoglobin A_{1c} (HbA_{1c}) are designated as procedures in claims, these are rarely coded, so they were not included as indicating a clinical visit with a procedure.

Defining Modifications in Drug Prescriptions

Prescription changes were identified in the 2019 pharmacy claims for antihypertensive, antidiabetic, and antilipemic medications, and 4 prescription modification scenarios were defined: (1) dosage change of existing medication, (2) return to previously prescribed medication after discontinuation for more than 30 days and at least 1 medication management visit between refills, (3) a new prescription, and (4) medication discontinuation.

Identifying Physician Visits for Medication Management

Medical claims for visits were matched to the nearest subsequent pharmacy claim. If a pharmacy claim occurred within 30 days after a clinician visit, the visit was designated as a medication management visit.

Predictors of Medication Changes

Logistic regression was used to identify features related to a change in prescriptions. Demographics, previous medication changes (flagged quarterly), and the presence of chronic conditions were used as inputs; the response variable was the occurrence of a medication change. A least absolute shrinkage and selection operator (LASSO) regression was used to select the most important features before fitting the final logistic regression model. Five models were compared using the following metrics: Akaike information criterion, sensitivity, specificity, precision, recall, F1 score, area under the receiver operating characteristic curve, and area under the precision-recall curve.

TAKEAWAY POINTS

There is high variability and important overutilization in US health care, and annual spending on hypertension-related physician visits is increasing. Higher-value and more convenient care might then make it possible to reduce the cardiovascular and renal morbidity that is closely tied to poorly controlled hypertension.

- ▶ In our analysis, approximately 40% of physician visits were consultation only.
- ▶ Although 74% of patients had a prescription change in a year, 75% of changes were a medication discontinuation or return to a previously used medication.
- ▶ Visits and medication change can be predicted, potentially allowing better population management and more effective use of clinical resources.

Metrics values were compared across 5 models to select a final model. The one with the best fit and fewest predictors was determined, referred to henceforth as model 5.

Predictors of Medication Management Visits

Of the 1,880,331 members with hypertension, 1,508,706 members had at least 1 medication management visit in 2019. The goal was to determine predictors of medication management visits. As with the models for predicting medication change, models for predicting medication management visits were evaluated and selected based on the most important features using LASSO regression.

Utilization Analysis

We determined the number of annual visits and their population distribution. We then evaluated any association between the highest and lowest utilizers and either consultation-only visits or medication changes.

RESULTS

Population and Visits

A population of 1,880,331 members with hypertension underwent 16,083,318 physician visits in 2019. Of these members, 58% were female, 91% were 65 years or older (Table), and 76% were White (not shown in Table). These visits were associated with 31.5 million claims. The mean and median number of visits per member were 8.6 and 7, respectively. The 20% highest service utilizers accounted for 47.9% of the visits and 46.4% of claims (eAppendix Figure [eAppendix available at ajmc.com]).

Medication Management Visits

Figure 1 shows provider visits for members with hypertension that were associated with procedures. About 59% of provider visits had a procedure code other than a BP or HbA_{1c} measurement. Almost 40% of visits were consultation only, having no concurrent procedures.

Medication Changes

This population of approximately 1.88 million members had about 71.5 million prescription claims in 2019. Of those, 26 million were for antihypertensive, antidiabetic, and antilipemic agents. More

CLINICAL

TABLE. Demographics and Comorbidities of the Study Population*

	n	%	Mean (SD) No. of medication changes in 2019	Mean (SD) No. of medication management visits in 2019
Total members (Medicare Advantage)	1,880,331	100%		
Gender				
Male	798,872	42.49%	2.566 (2.786)	8.585 (6.872)
Female	1,081,459	57.51%	2.406 (2.701)	8.530 (6.799)
Age in years				
20-24	55	0.003%	2.509 (2.516)	8.255 (6.479)
25-29	299	0.016%	2.686 (2.945)	9.017 (11.31)
30-34	940	0.050%	2.718 (2.886)	8.745 (8.398)
35-39	2329	0.12%	3.135 (3.312)	9.578 (8.325)
40-44	4724	0.25%	3.256 (3.267)	10.08 (9.009)
45-49	10,714	0.57%	3.458 (3.462)	10.44 (8.600)
50-54	21,687	1.15%	3.414 (3.400)	10.28 (8.030)
55-59	48,940	2.60%	3.289 (3.295)	10.22 (8.057)
60-64	83,069	4.42%	3.187 (3.230)	9.978 (7.720)
65-69	411,036	21.86%	2.512 (2.768)	7.685 (6.311)
70-74	450,383	23.95%	2.425 (2.708)	8.288 (6.529)
75-79	343,893	18.29%	2.433 (2.685)	8.933 (6.877)
≥80	502,262	26.71%	2.246 (2.512)	8.710 (6.926)
Comorbidities ^b				
Hyperlipidemia	1,303,170	69.31%	2.644 (2.846)	8.939 (6.885)
Type 2 diabetes	738,587	39.28%	3.538 (3.281)	9.540 (7.320)
Arthritis	622,643	33.11%	2.713 (2.870)	11.41 (7.731)
Cataract	546,094	29.04%	2.446 (2.715)	9.359 (6.997)
Chronic kidney disease	508,336	27.03%	3.299 (3.281)	10.73 (7.882)
Ischemic heart disease	465,981	24.78%	3.550 (3.327)	11.19 (7.769)
Hypothyroidism	368,996	19.62%	2.531 (2.790)	9.694 (7.470)
Anemia	361,398	19.22%	3.225 (3.246)	11.58 (8.517)
COPD	320,486	17.04%	2.996 (3.076)	11.50 (8.187)
Atrial fibrillation	265,777	14.13%	3.103 (3.110)	11.58 (8.083)

COPD, chronic obstructive pulmonary disease.

*Medication changes and visits were compared in age groups 20 to 39, 40 to 64, and 65 years and older using the Welch *t* test. The group aged 40 to 64 years had a greater number of medication changes and medication visits relative to the other 2 age groups ($P < .0001$).

^bOnly the 10 most common comorbidities are displayed in this table.

than a quarter of members had no medication changes during the year (Figure 2 [A]). For the 73.5% having a prescription change, the mean and median number of changes were 3.1 and 2, respectively. Notably, 54% of all medication changes were returns to a previously prescribed medication, 21% were a medication discontinuation, and 8.6% were a dosage change. Only 25.1% were a new prescription. Figure 2 (B) shows the proportion of medication change types by quarter. Those aged 40 to 64 years, although less than 10% of the total population, had a greater number of both medication changes and medication visits than those younger than 40 years or those 65 years or older ($P < .0001$) (Table).

Figure 3 shows the 10 most prescribed medications for members with hypertension and the proportion of members who had medication changes. These 10 medications accounted

for 59.2% of prescriptions (3,655,757 of 6,171,022) and for 56.1% of all medication changes.

The upper panel of Figure 4 shows the percentage change in odds for each of the predictors selected by the LASSO regression. Type 2 diabetes was the strongest driver of a medication change, followed by prior medication changes. In contrast, older members were less likely to have a medication change. The presence of conditions such as myocardial infarction, ischemic heart disease, stroke, heart failure, and chronic kidney disease also increased the likelihood of a medication change.

Subsequent Visits

Of more than 20 possible predictors, the strongest predictor of a subsequent visit was a prior medication management visit. The next

3 strongest predictors were clinical variables, arthritis, type 2 diabetes, or ischemic heart disease, followed by a new drug prescription in the third quarter (Q) (lower panel of Figure 4).

Highest and Lowest Utilizers

The top 20% of service utilizers constituted 410,182 members who had a mean of 19 provider visits and a mean of 3.3 medication changes annually. These members in the top 20% accounted for 31.7% of all medication changes, but unexpectedly, the correlation between medication changes and number of provider visits was only 0.28. The 20% of members who were the highest service utilizers accounted for 47% of the consultation-only visits. However, because they consumed 48% of all provider services, the use of consultation-only services is not overrepresented in the top 20% of utilizers.

The lowest 20% of visit utilizers consumed 4.9% of provider visits. This group had a mean of 1.8 visits and 1.4 medication changes annually. These members accounted for 4.5% of the consultation-only visits. As was true among the high utilizers, the proportion of consultation-only visits, as a fraction of total visits, was proportionate. As such, both high and low utilizers consume consultation-only visits in proportion to their overall utilization of provider services.

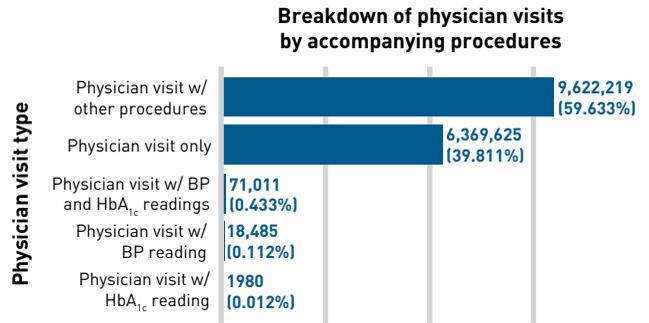
DISCUSSION

Our report captures a very large body of data on US hypertension care: 1.88 million individuals undergoing more than 16 million visits. Our goal was to better understand care delivery within those visits by examining visit procedure codes, assuming that procedural care requires an in-person visit. We found that 40% of hypertension visits were not associated with a procedure code. Although there are procedure codes for BP or HbA_{1c} measures, these can be conducted at home and would not be sufficient to justify an office visit.^{8,9}

For a population of 16 million annual visits, this equates to 6.4 million consultation-only in-person visits. Notably, a 40% reduction in in-person visits for hypertension is what we observed during the early months of the COVID-19 pandemic.⁸ We do not yet know if a 40% reduction in care during the pandemic alters outcomes, but if it does not, these visits might be considered waste. Considering the size of the Medicare population with hypertension and high volume of visits, the health care system stands to gain considerable efficiency and cost savings if consultation-only visits and much of medication management could be reduced and/or delegated to a less costly alternative.

To re-engineer health care to make it less expensive, higher quality, and more convenient, there is a need to identify low-value visits. Here we found that 27% of primary care provider visits were not associated with a medication change. Although we examined only the 3 most common classes of medications, for the 73% of individuals who had a medication change within a year, more than half of those changes were to a previously prescribed medication with which the patient would have experience, 21% were a medication

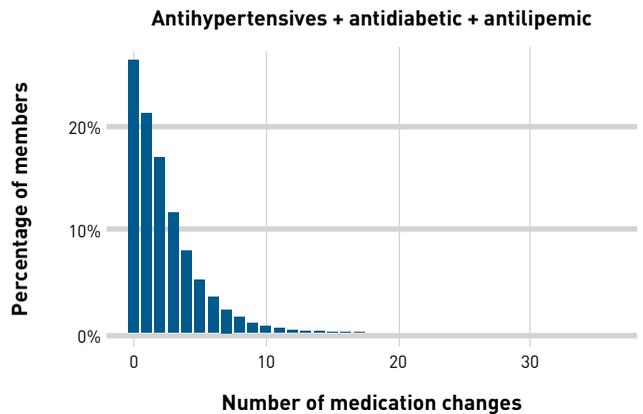
FIGURE 1. Number and Percentage of Physician Visits According to Procedures Done



BP, blood pressure; HbA_{1c}, hemoglobin A_{1c}.

FIGURE 2. Medication Changes Observed by Proportion of Members and by Type and Timing of Change

A. Proportion of members with medication changes



B. Quarterly medication changes by type of change

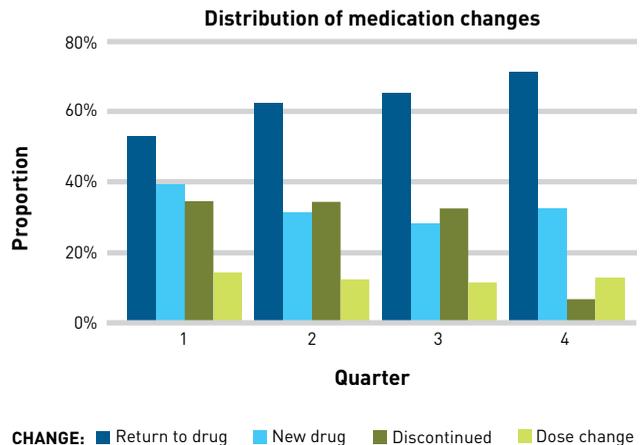
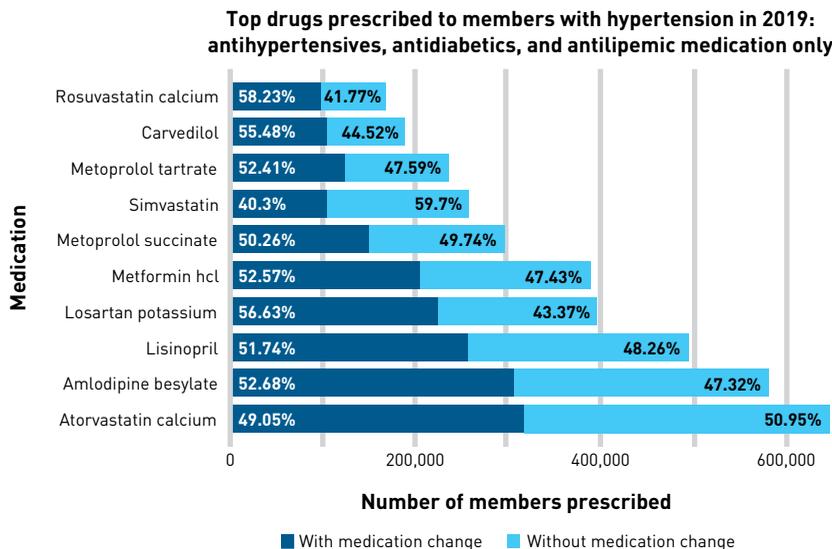


FIGURE 3. Proportion of Members With Hypertension With a Medication Change by Top Prescribed Medications



discontinuation, and 9% were a dosage change. Only 25% of medication changes were to a new medication. If we consider the many barriers to care and constraints on provider time, it is not clear if provider visits for medication discontinuation or resumption of a medication with which a patient is familiar (together constituting 75% of medication changes) are the best use of the provider resource if those decisions can be made in other ways.

Even if we look only at visits with no medication change, 27% of the potential savings is very large. Twenty-seven percent of visits in a population of 1.88 million individuals constitutes more than 4 million visits, or 2 annual visits per person. This is associated with an estimated total direct cost of \$1.2 billion (mean expense per provider visit times number of visits).¹⁰ Although UnitedHealthcare is a large MA insurer, we capture only a small fraction of the US Medicare population. If eliminating visits without procedures or medication changes was extended to traditional Medicare fee-for-service and other payers, the potential cost savings are many multiples greater. To extend the thought experiment, if half the visits for medication discontinuation or restarting a familiar medication were eliminated or done virtually, the potential savings are likely to be in the tens of billions of dollars for US citizens 65 years and older. We are suggesting that eliminating low-value hypertension care is one place to begin to reduce the waste in US health care.

Anticipating Care Needs and Improving Care

From the standpoint of practice operations, the data in Figure 4 are instructive. Of the 10 strongest predictors of medication change, half are a prior medication change. Similarly, the 2 strongest predictors

of a medication visit are Q3 and Q2 medication management visits. The only negative predictors of a medication change are advancing age groups. This type of information should allow us to systematically identify population segments for whom we can anticipate and better plan medication management and service utilization at a panel or population level.

All our observations intersect with the national challenge of inadequate BP control. The reasons for failure in treatment of hypertension include (1) poor patient adherence to lifestyle and medication recommendations, (2) clinician inertia in advancing the medical regimen, and (3) suboptimal management of resistant hypertension.

Perhaps as important for patients is that an in-person visit may constitute a barrier to achieving hypertension control. Remote providers supported by well-designed algorithms should address these issues. First, multiple studies comparing BP measurements in the clinic and the home⁹ have consistently confirmed that the mean ambulatory 24-hour

BP correlates more closely with home measurements than in-clinic measurements. Therefore, whenever appropriate, the target BP should be home based. Second, patient acceptance of self-assessment and virtual health platforms has improved.^{11,12} Reliable, inexpensive home BP monitors and well-designed algorithms for advancing the drug schedule will allow hypertension management to move out of the office setting. This should improve overall hypertension control while freeing up valuable primary care provider time to manage conditions requiring in-person evaluation.

We are not proposing an elimination of in-person visits for hypertension, only more appropriate use informed by predictive models. Those 65 years and older typically have multiple conditions, so an office visit can accomplish many tasks, including multicondition management, reinforcement of health education, and assessment of medication adherence or social determinants of health. However, these tasks might be more successful if they were performed at higher frequency, with lower touch, using new combinations of nonphysician providers and technologies in select subpopulations.

Although we report on a predominantly older MA population, hypertension also occurs in younger adults.¹³ This population is better suited to virtual visit models^{14,15} and will not want to miss work for routine checks or medication changes.¹⁶ More important, if hypertension is controlled at an earlier age, cardiovascular sequelae^{17,18} are likely to be reduced.

The acute outpatient care reductions observed during the COVID-19 pandemic and the rapid expansion and acceptance of telehealth models open the door to health care service redesign.

Our analysis of hypertension care suggests that (1) a significant portion of care may be relatively low value, or waste, and (2) much of medication management can probably be done remotely. For face-to-face visits, optimizing the visit value might be greatly accelerated by data that help inform visit appropriateness, visit timing, visit likelihood, and the activities that might be expected when the visit occurs. With increasing constraints on provider time and a limited health care dollar, we believe a data-based foundation will help transform the care of chronic diseases like hypertension.

Limitations

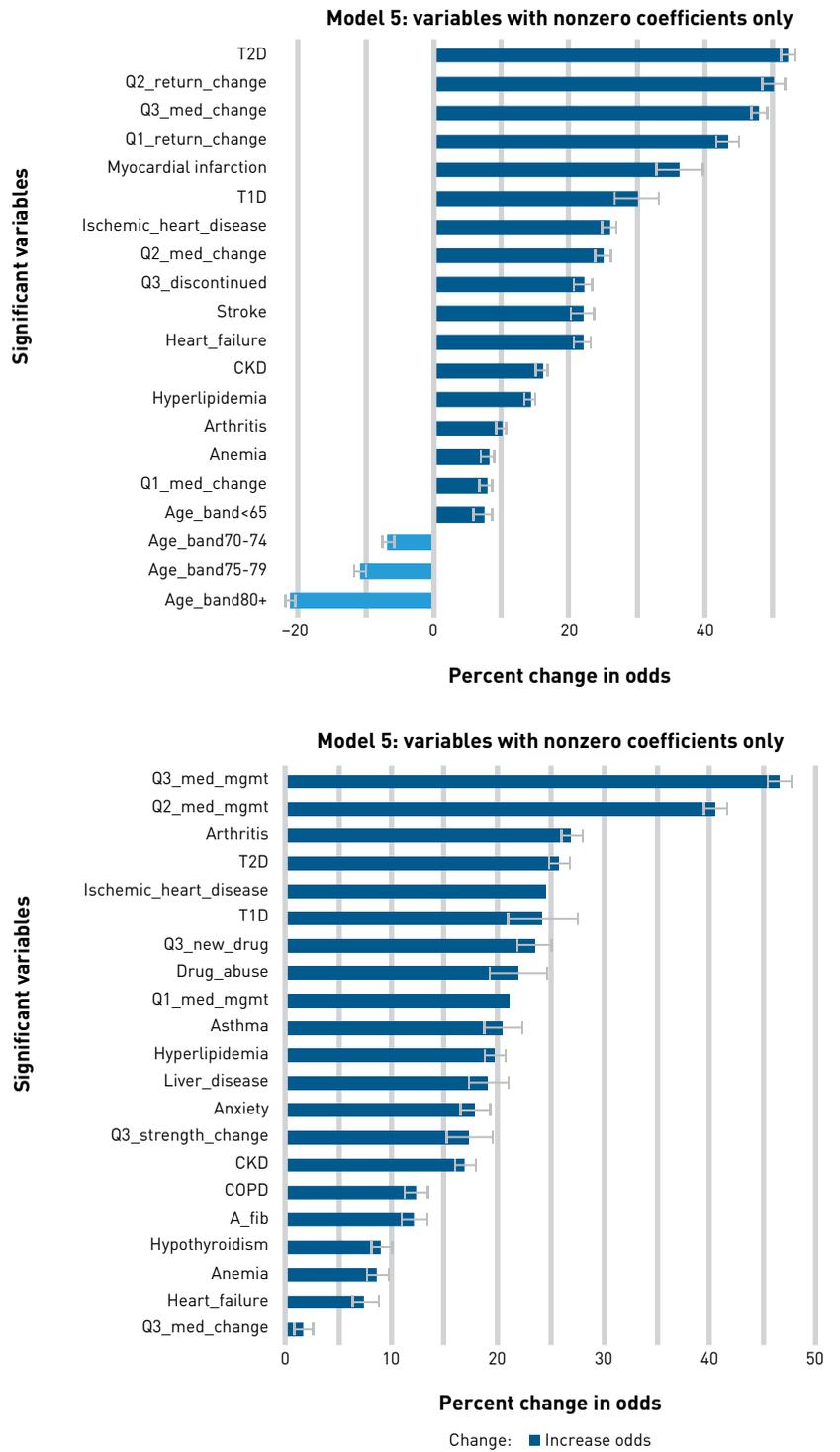
Although we report on approximately 16 million visits and 71 million prescription claims in 1.88 million individuals, the limitations of using administrative claims data are well known. Several limits of claims analysis are evident in the data we report.

First, Figure 1 might suggest that less than 1% of office visits are associated with measurement of BP, HbA_{1c}, or both. This is a claims documentation artifact. These clinical activities can be identified as “procedures,” but they are so routine that they are rarely documented as a procedure code.

Second, our medication analysis did not examine all medication classes used in these 1.88 million members. We evaluated 3 classes of medications: antihypertensive, antidiabetic, and antilipemic drugs. We did this because (1) these are the most common medication classes associated with hypertension^{19,20}; (2) these medications are familiar and low acuity, and might be readily managed without a provider visit; and (3) constraining the analysis to 3 classes rather than every medication potentially prescribed was required to make such an analysis actionable. We also anticipate that the movement to non–face-to-face visits will require providers to first focus on these 3 medication classes.

A third limitation is identified in Figure 3 (B). In Q4 of 2019, the number of medication discontinuations is much lower than in Q1 through Q3. This is due to the pharmacy claim not meeting the discontinuation criteria. We defined a medication discontinuation as no prescription within 30 days following the medication’s supply duration. As such, to have

FIGURE 4. Predictors of Medication Change* (upper) and of a Medication Management Visit (lower) for Each of the Predictors Selected by the LASSO Regression (Model 5) (shown in percentage change in odds of the event)



CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; LASSO, least absolute shrinkage and selection operator; Q, quarter; T1D, type 1 diabetes; T2D, type 2 diabetes.

*Medication changes are indicated as *discontinued*; *return_change*, return to a previous medication; *new_drug*, new prescription; and *med_change*, dosage change.

determined all Q4 attributable discontinuations, our analysis would have had to run through Q1 of 2020. That was outside our study design. The discontinuation rate for Q1 through Q3 is consistent, and should the study have continued into 2020, we would expect a discontinuation rate of approximately 30% to 35% in Q4.

Fourth, representativeness of a study in an MA population might be questioned. In 2021, approximately 26 million (42%) of all Medicare enrollees had an MA plan. MA plans combine hospital and medical insurance, and usually prescription drug coverage, into one plan offered by a private insurer. MA plans also typically offer greater benefits than those covered by original Medicare. Compared with the general US population, those on MA plans tend to be older and have more chronic conditions. Those with MA plans often have fixed incomes, and those incomes are generally lower compared with the overall US adult population.^{10,21,22} Based on these data, we are confident that our study observations are unlikely to be biased by the study population's socioeconomic status and therefore is broadly representative for patients with hypertension 65 years and older.

CONCLUSIONS

Events of the last 2 years—the pandemic, expansion of telehealth, and large investments in technology-based care delivery—have opened the door to health services redesign. Our analysis of hypertension care suggests that (1) a significant portion of care may be relatively low value, or waste, and (2) much of medication management can probably be done remotely. For face-to-face visits, optimizing the visit value might be greatly accelerated by prediction and prescheduling data that help inform visit appropriateness, visit timing, visit likelihood, and the activities that might be expected when the visit occurs. With increasing constraints on provider time and a limited health care dollar, we believe a data-based foundation will help transform the care of chronic diseases like hypertension. ■

Author Affiliations: Optum Labs, UnitedHealth Group (DJC, KC, MND), Minnetonka, MN.

Source of Funding: None.

Author Disclosures: The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (DJC); analysis and interpretation of data (DJC, KC, MND); drafting of the manuscript (DJC, KC, MND); critical revision of the manuscript for important intellectual content (DJC, KC); statistical analysis (MND); and supervision (DJC).

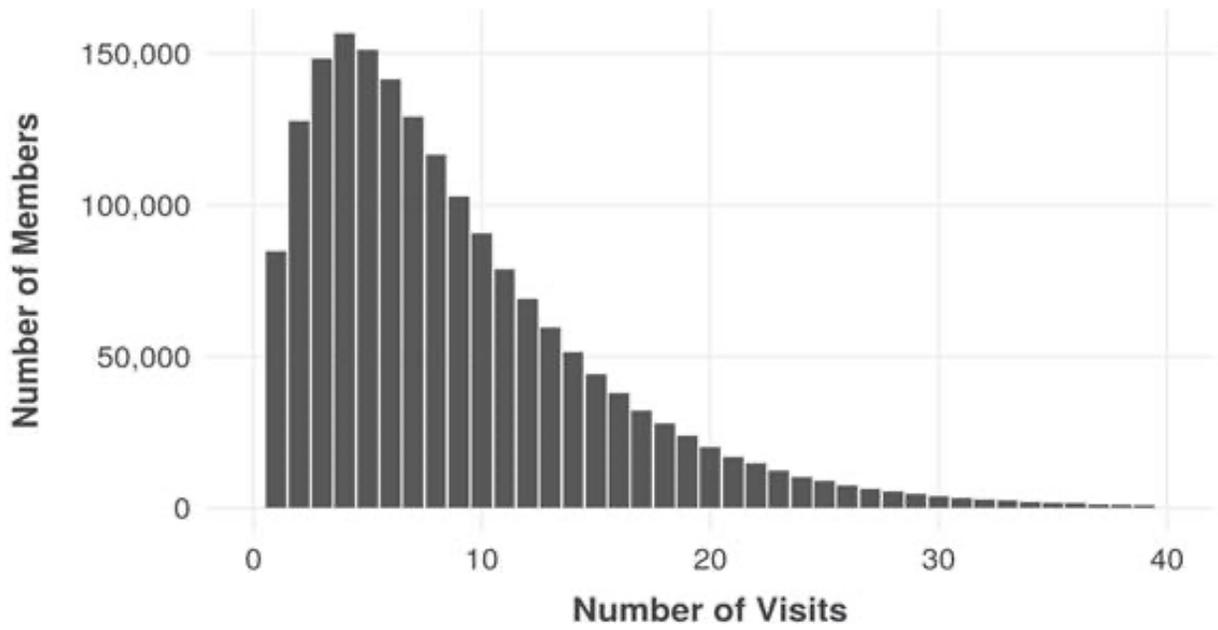
Address Correspondence to: David J. Cook, MD, MHA, Optum Labs, UnitedHealth Group, 5995 Opus Pkwy, Minnetonka, MN 55355. Email: davidcook@optum.com.

REFERENCES

- Sacco RL, Benjamin EJ, Broderick JP, et al. Risk factors. *Stroke*. 1997;28(7):1507-1517. doi:10.1161/01.STR.28.7.1507
- Ku E, Lee BJ, Wei J, Weir MR. Hypertension in CKD: core curriculum 2019. *Am J Kidney Dis*. 2019;74(1):120-131. doi:10.1053/j.ajkd.2018.12.044
- Buffet L, Ricchetti C. Chronic kidney disease and hypertension: a destructive combination. *US Pharmacist*. 2012;37(6):26-29. Accessed April 25, 2021. <https://www.uspharmacist.com/article/chronic-kidney-disease-and-hypertension-a-destructive-combination-35118>
- Muntner P, Hardy ST, Fine LJ, et al. Trends in blood pressure control among US adults with hypertension, 1999-2000 to 2017-2018. *JAMA*. 2020;324(12):1190-1200. doi:10.1001/jama.2020.14545
- Kirkland EB, Heincelman M, Bishu KG, et al. Trends in healthcare expenditures among US adults with hypertension: national estimates, 2003-2014. *J Am Heart Assoc*. 2018;7(11):e008731. doi:10.1161/JAHA.118.008731
- Osthege Y, Fryar CD, Nwankwo T, Nguyen DT. Hypertension prevalence among adults aged 18 and over: United States, 2017-2018. National Center for Health Statistics data brief No. 364. April 2020. Accessed April 25, 2021. <https://www.cdc.gov/nchs/products/databriefs/db364.htm>
- Benjamin EJ, Blaha MJ, Chiuve SE, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2017 update: a report from the American Heart Association. *Circulation*. 2017;135(10):e146-e603. doi:10.1161/CIR.0000000000000485
- George J, MacDonald T. Home blood pressure monitoring. *Eur Cardiol*. 2015;10(2):95-101. doi:10.15420/ecr.2015.10.2.95
- Chang A, Frank J, Knaebel J, Fullam J, Pardo S, Simmons DA. Evaluation of an over-the-counter glycosylated hemoglobin (A1C) test kit. *J Diabetes Sci Technol*. 2010;4(6):1495-1503. doi:10.1177/193229681000400625
- Freed M, Biniek JF, Damico A, Neuman T. Medicare Advantage in 2021: enrollment update and key trends. Kaiser Family Foundation. June 21, 2021. Accessed September 22, 2021. <https://www.kff.org/medicare/issue-brief/medicare-advantage-in-2021-enrollment-update-and-key-trends/>
- Machlin SR, Mitchell EM. Expenses for office-based physician visits by specialty and insurance type, 2016. Agency for Healthcare Research and Quality statistical brief No. 517. October 2018. Accessed April 25, 2021. https://meps.ahrq.gov/data_files/publications/st517/stat517.shtml
- Cook DJ, Altman RB, Westman J, Ventura ME. Can the COVID-19 natural experiment teach us about care value and system preferences? *NEJM Catal Innov Care Deliv*. May 5, 2021. Accessed May 15, 2021. <https://catalyst.nejm.org/doi/full/10.1056/CAT.21.0063>
- Sega R, Facchetti R, Bombelli M, et al. Prognostic value of ambulatory and home blood pressures compared with office blood pressure in the general population: follow-up results from the Pressioni Arteriose Monitorate e Loro Associazioni (PAMELA) study. *Circulation*. 2005;111(14):1777-1783. doi:10.1161/01.CIR.0000160923.04524.5B
- Kruse CS, Krowski N, Rodriguez B, Tran L, Vela J, Brooks M. Telehealth and patient satisfaction: a systematic review and narrative analysis. *BMJ Open*. 2017;7(8):e016242. doi:10.1136/bmjopen-2017-016242
- Viers BR, Pruthi S, Rivera ME, et al. Are patients willing to engage in telemedicine for their care: a survey of preuse perceptions and acceptance of remote video visits in a urological patient population. *Urology*. 2015;85(6):1233-1240. doi:10.1016/j.urology.2014.12.064
- Zhang Y, Moran AE. Trends in the prevalence, awareness, treatment, and control of hypertension among young adults in the United States, 1999 to 2014. *Hypertension*. 2017;70(4):736-742. doi:10.1161/HYPERTENSIONAHA.117.09801
- Polinski JM, Barker T, Gagliano N, Sussman A, Brennan TA, Shrank WH. Patients' satisfaction with and preference for telehealth visits. *J Gen Intern Med*. 2016;31(3):269-275. doi:10.1007/s11606-015-3489-x
- Barney A, Buckelew S, Mesheriakova V, Raymond-Flesch M. The COVID-19 pandemic and rapid implementation of adolescent and young adult telemedicine: challenges and opportunities for innovation. *J Adolesc Health*. 2020;67(2):164-171. doi:10.1016/j.jadohealth.2020.05.006
- Park C, Fang J, Hawkins NA, Wang G. Comorbidity status and annual total medical expenditures in U.S. hypertensive adults. *Am J Prev Med*. 2017;53(6 suppl 2):S172-S181. doi:10.1016/j.amepre.2017.07.014
- Long AN, Dagogo-Jack S. The comorbidities of diabetes and hypertension: mechanisms and approach to target organ protection. *J Clin Hypertens (Greenwich)*. 2011;13(4):244-251. doi:10.1111/j.1751-7176.2011.00434.x
- What is Medicare Part C? HHS. Updated August 3, 2021. Accessed September 22, 2021. <https://www.hhs.gov/answers/medicare-and-medicaid/what-is-medicare-part-c/index.html>
- CMS. Understanding Medicare Advantage plans. Medicare.gov. November 2020. Accessed January 17, 2021. <https://www.medicare.gov/Pubs/pdf/12026-Understanding-Medicare-Advantage-Plans.pdf>

Visit ajmc.com/link/89201 to download PDF and eAppendix

eAppendix Figure. Distribution of visits by members. indicates that the 20% of the population which were the highest utilizers of hypertension-related services accounted for 47.9% of the visits and 46.4% of the claims. Visit counts greater than 40 per year are not shown for reasons of scale.



eAppendix Table 1. Unadjusted and adjusted odds ratios for medication change. Percentages were calculated row-wise.

95% confidence intervals for both odds ratios are given.

* 95% confidence intervals for unadjusted odds ratios were calculated using the Wald method (normal approximation).

	Total (%)	With Medication Change in Q4 2019	Unadjusted Odds Ratio for Medication Change*	Adjusted Odds Ratio for Medication Change
Total Members (Medicare Advantage)	1,880,331	662,715		
Age (reference: 65 – 69)				
Below 65	172,757 (100.)	72028 (41.7)	1.27 (1.25, 1.28)	1.07 (1.06, 1.09)
65 – 69	411,036 (100.)	148128 (36.0)	1.000	1.000
70 – 74	450,383 (100.)	158610 (35.2)	0.96 (0.96, 0.97)	0.933 (0.923, 0.943)
75 – 79	343,893 (100.)	121064 (35.2)	0.96 (0.96, 0.97)	0.893 (0.882, 0.903)
80+	502,262 (100.)	162885 (32.4)	0.85 (0.84, 0.86)	0.789 (0.781, 0.797)
Comorbidities				
Type 1 Diabetes	36,554 (100.)	20,752 (56.8)	2.46 (2.41, 2.51)	1.30 (1.27, 1.33)
Myocardial Infarction	38,695 (100.)	21,645 (55.9)	2.38 (2.33, 2.43)	1.36 (1.33, 1.40)
Type 2 Diabetes	738,587 (100.)	335,205 (45.4)	2.07 (2.05, 2.08)	1.52 (1.51, 1.53)
Heart Failure	257,732 (100.)	120,121 (46.6)	1.74 (1.72, 1.75)	1.22 (1.21, 1.23)
Ischemic Heart Disease	465,981 (100.)	206,908 (44.4)	1.68 (1.67, 1.69)	1.26 (1.25, 1.27)
Stroke	114,923 (100.)	51,302 (44.6)	1.52 (1.50, 1.54)	1.22 (1.20, 1.24)
Chronic Kidney Disease	508,336 (100.)	214,195 (42.1)	1.50 (1.49, 1.51)	1.16 (1.15, 1.17)
Anemia	361,398 (100.)	149,693 (41.4)	1.39 (1.38, 1.40)	1.08 (1.07, 1.09)
Hyperlipidemia	1,303,170 (100.)	483,121 (37.1)	1.30 (1.30, 1.31)	1.14 (1.13, 1.15)
Arthritis	622,643 (100.)	235,938 (37.9)	1.19 (1.18, 1.20)	1.10 (1.09, 1.11)
Previous Medication Changes				
Q3 Medication Change	688,626 (100.)	318,449 (46.2)	2.12 (2.10, 2.13)	1.48 (1.47, 1.49)
Q3 Discontinued Medication	225,836 (100.)	113,701 (50.3)	2.04 (2.02, 2.06)	1.22 (1.21, 1.24)
Q2 Medication Change	702,897 (100.)	324,175 (46.1)	2.12 (2.11, 2.13)	1.25 (1.24, 1.26)
Q2 Return to Previous Medication	427,329 (100.)	217,463 (50.9)	2.35 (2.33, 2.36)	1.50 (1.48, 1.52)
Q1 Medication Change	611,327 (100.)	270,285 (44.2)	1.77 (1.76, 1.78)	1.08 (1.07, 1.09)
Q1 Return to Previous Medication	310,758 (100.)	156,548 (50.4)	2.13 (2.12, 2.15)	1.43 (1.42, 1.45)

eAppendix Table 2. Unadjusted and adjusted odds ratios for medication management visit. Percentages were calculated row-wise.

95% confidence intervals for both odds ratios are given.

* 95% confidence intervals for unadjusted odds ratios were calculated using the Wald method (normal approximation).

	Total	With Medication Management Visit in Q4 2019	Unadjusted Odds Ratio for Medication Management Visit*	Adjusted Odds Ratio for Medication Management Visit
Total Members	1,508,706			
Comorbidities				
Type 1 Diabetes	31,192 (100.)	16,561 (53.1)	1.79 (1.75, 1.84)	1.24 (1.21, 1.28)
Ischemic Heart Disease	406,195 (100.)	189,704 (46.7)	1.55 (1.54, 1.56)	1.25 (1.24, 1.26)
Heart Failure	217,083 (100.)	104,091 (47.9)	1.54 (1.52, 1.55)	1.08 (1.06, 1.09)
Drug Abuse	43,951 (100.)	21,394 (48.7)	1.50 (1.47, 1.53)	1.22 (1.19, 1.25)
Type 2 Diabetes	600,836 (100.)	268,424 (44.7)	1.49 (1.48, 1.50)	1.26 (1.25, 1.27)
Chronic Kidney Disease	427,437 (100.)	193,414 (45.2)	1.44 (1.43, 1.45)	1.17 (1.16, 1.18)
Arthritis	541,270 (100.)	239,358 (44.2)	1.41 (1.40, 1.42)	1.27 (1.26, 1.28)
Asthma	101,938 (100.)	47,573 (46.7)	1.40 (1.38, 1.42)	1.20 (1.19, 1.22)
Liver Disease	89,170 (100.)	41,510 (46.6)	1.39 (1.37, 1.41)	1.19 (1.17, 1.21)
Anemia	303,107 (100.)	137,182 (45.3)	1.38 (1.37, 1.39)	1.09 (1.08, 1.10)
COPD	274,535 (100.)	123,776 (45.1)	1.36 (1.35, 1.37)	1.12 (1.11, 1.13)
Atrial Fibrillation	226,926 (100.)	102,124 (45.0)	1.34 (1.33, 1.35)	1.12 (1.11, 1.13)
Anxiety	167,013 (100.)	74,487 (44.6)	1.30 (1.28, 1.31)	1.18 (1.16, 1.19)
Hyperlipidemia	1,073,475 (100.)	437,176 (40.7)	1.29 (1.28, 1.30)	1.20 (1.19, 1.21)
Hypothyroidism	305,520 (100.)	128,126 (41.9)	1.17 (1.16, 1.18)	1.09 (1.08, 1.10)
Previous Medication Management Visits				
Q3 Medication Management Visit	605,574 (100.)	286,826 (47.4)	1.80 (1.79, 1.81)	1.47 (1.45, 1.48)
Q2 Medication Management Visit	633,618 (100.)	292,247 (46.1)	1.68 (1.67, 1.69)	1.41 (1.39, 1.42)
Q1 Medication Management Visit	606,714 (100.)	270,015 (44.5)	1.47 (1.46, 1.48)	1.21 (1.20, 1.22)
Previous Medication Changes				
Q3 Medication Change	585,523 (100.)	254,416 (43.5)	1.36 (1.35, 1.37)	1.02 (1.01, 1.03)
Q3 Dosage Change	67,497 (100.0)	33,492 (49.6)	1.57 (1.55, 1.60)	1.17 (1.15, 1.20)
Q3 New Drug	164,878 (100.)	79,479 (48.2)	1.53 (1.51, 1.54)	1.23 (1.22, 1.25)