

# Medication Adherence Star Ratings Measures, Health Care Resource Utilization, and Cost

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**C**hronic disease medication nonadherence rates are estimated to range from 30% to 50%.<sup>1-4</sup> For older individuals, adherence is challenging due to cost, polypharmacy, medication adverse events, lack of social support, declining cognitive function, and lower health literacy.<sup>5-10</sup> Whereas good medication adherence is associated with better clinical outcomes<sup>11,12</sup> and reductions in mortality risk,<sup>13</sup> nonadherence is associated with adverse health outcomes and increased health care utilization.<sup>14-16</sup> Among older patients discharged after acute coronary syndromes, nonadherence to statin therapy was associated with 2.7 times the odds of mortality,<sup>17</sup> whereas adherence was associated with a 27% lower relative risk of major adverse cardiovascular events.<sup>18</sup> An estimated 30% to 65% of adults with hypertension are nonadherent to their blood pressure medications,<sup>19,20</sup> and nonadherence is associated with uncontrolled hypertension and poor outcomes.<sup>21</sup> For patients with diabetes, a recent meta-analysis noted a nonadherence rate of 32.1%.<sup>22</sup> Adherence to diabetes medications improves hemoglobin A<sub>1c</sub>, weight, and quality of life and reduces the risk of hypoglycemia,<sup>23</sup> whereas nonadherence is associated with poor glycemic control and increased mortality risk.<sup>24</sup>

The impact of medication nonadherence on health care resource use and costs is pronounced. Among patients with diabetes, nonadherence to oral antidiabetic medications was associated with 27% higher all-cause and 21% higher diabetes-related hospital visits and significantly greater costs.<sup>25</sup> An analysis of patients with diabetes and/or hypertension demonstrated that patients with the highest adherence experienced 36% reduced odds of emergency department (ED) visits, 44% reduced odds of hospitalization in internal medicine wards, and 37% reduced odds of hospitalization in surgical wards compared with patients with the lowest adherence.<sup>26</sup> Another review covering 14 disease states found that all-cause nonadherence costs ranged from \$5372 to \$52,341 per patient.<sup>27</sup> The total costs of nonadherence to the US health care system are estimated to be as much as \$528 billion (2016 US\$) per year.<sup>28</sup> These high costs have driven an interest in understanding how medication nonadherence in common comorbid conditions, such as diabetes, hypertension, and hyperlipidemia, affects health care resource utilization (HCRU).

## ABSTRACT

**OBJECTIVE:** To examine the association between missed CMS Star Ratings quality measures for medication adherence over 3 years for diabetes, hypertension, and hyperlipidemia medications (9 measures) and health care utilization and relative costs.

**STUDY DESIGN:** Retrospective cohort study.

**METHODS:** The study examined eligible patients who qualified for the diabetes, statin, and renin-angiotensin system antagonist medication adherence measures in 2018, 2019, and 2020 and were continuously enrolled in a Medicare Advantage prescription drug plan from 2017 through 2021. A total of 103,900 patients were divided into 4 groups based on the number of adherence measures missed (3 medication classes over 3 years): (1) missed 0 measures, (2) missed 1 measure, (3) missed 2 or 3 measures, and (4) missed 4 or more measures. To achieve a quality measure, patients had to meet the Pharmacy Quality Alliance 80% threshold of proportion of days covered during the calendar year.

**RESULTS:** The mean age of the cohort was 71.1 years, and 49.9% were female. Compared with patients who missed 0 of 9 adherence measures, those who missed 1 measure, 2 or 3 measures, and 4 or more measures experienced 12% to 26%, 22% to 42%, and 24% to 50% increased risks, respectively, of all-cause and diabetes-related inpatient stays and all-cause and diabetes-related emergency department visits (all *P* values < .01). Additionally, patients who missed 1, 2 or 3, and 4 or more adherence measures experienced 14%, 19%, and 20% higher monthly medical costs, respectively.

**CONCLUSIONS:** Missing Star Ratings quality measures for medication adherence was associated with an increased likelihood of health care resource utilization and increased costs for patients taking medications to treat diabetes, hypertension, and hyperlipidemia.

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Through its Star Ratings system, CMS creates plan ratings that indicate the quality of Medicare plans on a scale of 1 to 5 stars, with 5 stars being the highest rating. The overall star rating is determined through numerous performance quality measures, including medication adherence quality measures for diabetes, hypertension, and cholesterol medications that are endorsed by the Pharmacy Quality Alliance (PQA). If a plan does not earn 4 or 5 stars aggregate, the plan will not achieve the per-member, per-year quality bonus payment that funds much of the differentiating benefits that can lead a member to select it over other plans during the annual enrollment period. It is challenging to achieve 4 or 5 stars without performing well on the renin-angiotensin system antagonist (RASA), statin, and diabetes medication adherence measures.<sup>29</sup> A cohort study examining data from 2009 to 2015 found that meeting the PQA adherence measures for diabetes, statin, and RASA medications was associated with lower HCRU and costs over 1 year.<sup>30</sup> However, the diabetes, statin, and hypertension groups were evaluated individually, and the study did not consider multiple measures of adherence over time. For patients with all 3 conditions, adherence does not occur in a silo. Hence, the objective of this study was to examine the association between achieving the CMS Star Ratings adherence quality measure for the diabetes, hypertension, and hyperlipidemia medication classes consecutively over 3 years (9 total adherence measures) and HCRU and relative cost outcomes. Considering multiple Star Ratings measures simultaneously over multiple years offers the opportunity for a unique contribution to the existing literature.

## METHODS

### Study Design, Data Source, and Patient Selection

We used a retrospective cohort design and the Humana Research Database to identify patients eligible for inclusion in the PQA adherence measures for receiving diabetes, statin, and RASA therapies in each calendar year from January 1, 2018, through December 31, 2020. To qualify, at least 2 filled prescriptions on different dates of service per year for each quality measure were required. The first fill of the medication class needed to be at least 91 days prior to the end of the measurement calendar year, and patients were required to have at least 1 prescription claim for each of the 3 therapies within the first 3 months of 2018. Eligible patients were enrolled continuously in a Medicare Advantage prescription drug (MAPD) plan from January 1, 2017, through December 31, 2021. Patients were indexed January 1, 2018, and outcomes were measured from April 1, 2018, through December 31, 2020.

Each patient could achieve 3 adherence measures in each year (2018, 2019, and 2020). To achieve a specific CMS Star Ratings system medication adherence quality measure, patients had to meet the PQA threshold of a proportion of days covered (PDC) of

## TAKEAWAY POINTS

We evaluated the association between the number of CMS Star Ratings quality measures of medication adherence missed for diabetes, hypertension, and hyperlipidemia (3 medications over 3 years = 9 total measures) and health care utilization and costs for patients enrolled in a Medicare Advantage prescription drug plan.

- ▶ Compared with patients missing 0 of 9 quality measures, patients who missed 1, 2 or 3, or 4 or more measures had greater odds of all-cause and diabetes-related inpatient stays and emergency department visits and increased total and medical costs.
- ▶ Addressing missed medication adherence quality measures may reduce health care resource utilization and costs for patients with diabetes, hyperlipidemia, and hypertension.

at least 80% during the calendar year.<sup>31,32</sup> CMS defines PDC as the percentage of days in the measurement period covered by prescription claims in the target drug class based on the prescription fill date and days' supply. PDC was calculated by dividing the number of covered days by the number of days in the measurement period. The PDC calculation was adjusted for overlapping prescriptions for the same drug based on active ingredient. Patients were divided into 4 groups: (1) missed 0 of 9 adherence measures, (2) missed 1 adherence measure, (3) missed 2 or 3 adherence measures, and (4) missed 4 or more adherence measures.

### Ethical Approval

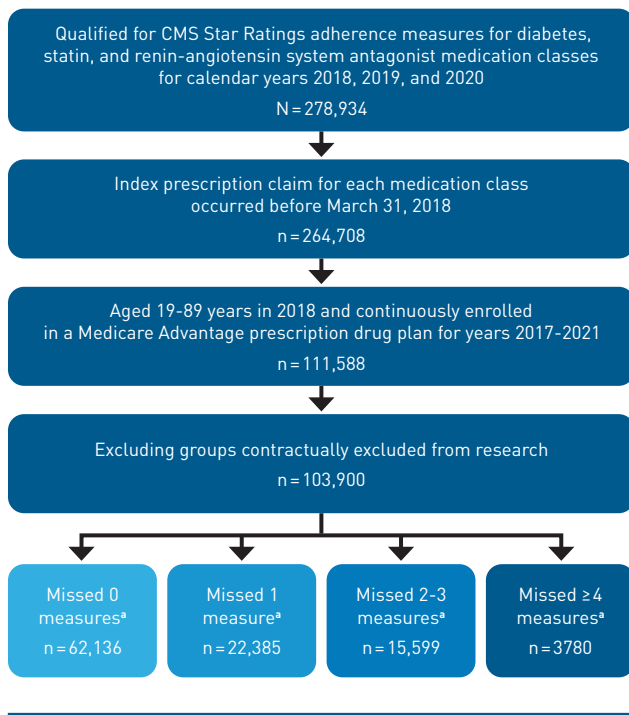
The Humana Healthcare Research Human Subject Protection Office used HHS regulations 45 CFR 46 and the Office for Human Research Protections guidance on Coded Private Information or Specimens Use in Research, Guidance (2008) to determine this study did not constitute human subjects research and did not require institutional review board oversight.

### Measures

**Baseline patient characteristics.** Age, sex, and resident state were determined at index date. Geographic region was assigned as Northeast, Midwest, South, or West. Population density assignment was based on patient zip code at index date that was matched to the rural-urban commuting area (RUCA) codes.<sup>33</sup> We applied the Washington State Department of Health's RUCA consolidation system<sup>34</sup> to determine the population density as urban (> 50,000 persons), suburban (10,000 to 50,000 persons), or rural (< 10,000 persons). Race/ethnicity was assessed as White, Black, or other. Other included Hispanic/Latino, Native Hawaiian/Pacific Islander, and other/unknown. Low-income subsidy status of Medicare beneficiaries and dual Medicare-Medicaid eligibility were identified based on flags in the CMS database. Plan type for MAPD beneficiaries was determined as health maintenance organization, preferred provider organization, or other.

Comorbidity burden was measured via the Elixhauser Comorbidity Index, which uses 31 categories of diagnosis codes to calculate a score that is associated with hospital charges, length of stay, and mortality.<sup>35,36</sup> We used the Elixhauser algorithm and combined it with methodology from Klabunde et al<sup>37</sup> to confirm the presence of

**FIGURE 1.** Attrition Diagram



\*Three measures per year for 3 consecutive years (9 total measures).

the comorbidities in the 12-month preindex period. The Elixhauser score ranges from 0 to 31, with higher scores indicative of more comorbidity. We assessed the Diabetes Complications Severity Index using 7 categories of complications during the 12-month preindex period (cardiovascular disease, nephropathy, retinopathy, peripheral vascular disease, stroke, neuropathy, and metabolic disease) and calculated a score to predict adverse outcomes including hospitalization and mortality.<sup>38</sup> The score ranges from 0 to 13, and higher scores indicate greater severity of diabetes complications.

**Study outcomes.** Utilization of all-cause health care resources was assessed based on place of service. Inpatient episodes of care were derived from facility claims using bill type, revenue codes, and dates of service. ED visits were identified using revenue codes, place of treatment codes, and *Current Procedural Terminology/Healthcare Common Procedure Coding System* codes. Diabetes-related HCRU was defined based on medical claims with an *International Classification of Diseases, Tenth Revision, Clinical Modification* diagnosis code of E10.\* or E11.\* in the first, second, or third position and was identified based on place of service as described earlier. Diabetes-related avoidable hospitalizations were measured using the diabetes composite prevention quality indicator measure from the Agency for Healthcare Research and Quality.<sup>37</sup>

Health care costs (total, medical, and pharmacy) were calculated and based on the health plan total allowed amount, including patient-paid costs for a given procedure or health care encounter. Costs

for all services were adjusted to 2021 dollars utilizing the medical Consumer Price Index and reported as relative total, medical, and pharmacy costs. Absolute costs are proprietary to the institution and cannot be shared.

### Statistical Analysis

Baseline demographic and clinical characteristics were described for patients in each adherence measure group. To compare characteristics across treatment groups,  $\chi^2$  tests were conducted for categorical variables and analysis of variance for continuous variables. Inverse probability of treatment weighting was used to adjust for baseline characteristic differences between the missed 0 of 9 quality adherence measures group (reference) and each of the other 3 adherence measure groups.<sup>39-42</sup> Three separate binary logistic regression models were used to estimate a propensity score for each patient (ie, a conditional probability of being treated given the observed baseline characteristics). Weights were calculated for each patient as the inverse of the probability of receiving the treatment that they received, and they were stabilized to reduce the variance of the effect estimate, therefore accounting for extreme observations.<sup>43</sup> The stabilized weights were included in the outcome models; weighted logistic regression models were fit to evaluate the association between the adherence measure groups and HCRU outcomes, and a weighted generalized linear model with a  $\gamma$  distribution and log-link was used to estimate statistical differences for cost.

## RESULTS

A total of 103,900 patients met all eligibility criteria (Figure 1). The 4 study groups were (1) patients who missed 0 of 3 adherence measures in 3 consecutive years (9 total measures) (n=62,136; 59.8%), (2) patients who missed 1 adherence measure (n=22,385; 21.5%), (3) patients who missed 2 or 3 adherence measures (n=15,599; 15.0%), and (4) patients who missed 4 or more adherence measures (n=3780; 3.6%). Demographic characteristics for unweighted cohorts are presented in Table 1. After applying weights, standardized mean differences were small and a balance was achieved between the adherence measure cohorts on baseline population and clinical characteristics.

As the number of quality measures missed increased, there was a linear increase in the percentage of patients using health care resources (Figure 2). For patients missing 0, 1, 2 or 3, and 4 or more adherence measures, the percentage of all-cause inpatient stays increased from 19.3% to 23.3% to 25.4% to 26.3%, respectively, and the percentage of all-cause ED visits increased from 45.0% to 49.8% to 52.3% to 54.9%, respectively. A similar pattern was observed for diabetes-related utilization. The percentage of diabetes-related inpatient stays increased from 5.4% to 6.0% to 6.5% to 6.7%, the percentage of diabetes-related ED visits increased from 21.1% to 23.4% to 25.4% to 27.4%, and the percentage of diabetes-related avoidable hospitalizations increased from 0.8% to 1.0% to 1.5% to 1.7% for patients missing 0, 1, 2 or 3, and 4 or more adherence measures, respectively.

**TABLE 1.** Baseline Characteristics

Variable <sup>a</sup>	Missed 0 measures <sup>b</sup> (n = 62,136)	Missed 1 measure <sup>b</sup> (n = 22,385)	Missed 2-3 measures <sup>b</sup> (n = 15,599)	Missed ≥ 4 measures <sup>b</sup> (n = 3780)	P	Missed 1 vs missed 0 weighted P <sup>c</sup>	Missed 2-3 vs missed 0 weighted P <sup>c</sup>	Missed ≥ 4 vs missed 0 weighted P <sup>c</sup>
Age in years, mean (SD)	71.2 (7)	71.2 (7)	70.8 (7)	70.0 (8)	< .001	.894	.713	.099
Female, n (%)	30,384 (48.9%)	11,360 (50.7%)	8093 (51.9%)	2025 (53.6%)	< .001	.974	.994	.424
Geographic region, n (%)					< .001	.525	.277	.056
Northeast	1497 (2.4%)	537 (2.4%)	354 (2.3%)	83 (2.2%)				
Midwest	11,947 (19.2%)	3989 (17.8%)	2740 (17.6%)	618 (16.3%)				
South	42,558 (68.5%)	15,702 (70.1%)	10,969 (70.3%)	2703 (71.5%)				
West	6134 (9.9%)	2157 (9.6%)	1536 (9.8%)	376 (9.9%)				
Population density: urban, n (%)	38,622 (62.2%)	14,102 (63.0%)	9846 (63.1%)	2335 (61.8%)	< .001	> .99	.997	.888
Race/ethnicity, n (%)					< .001	.908	.977	.973
White	46,344 (74.6%)	16,084 (71.9%)	10,739 (68.8%)	2319 (61.3%)				
Black	10,661 (17.2%)	4377 (19.6%)	3447 (22.1%)	1109 (29.3%)				
Other	5131 (8.3%)	1924 (8.6%)	1413 (9.1%)	352 (9.3%)				
Plan type, n (%)					< .001	.999	.998	.948
HMO	34,216 (55.1%)	12,248 (54.7%)	8423 (54.0%)	1946 (51.5%)				
PPO	22,119 (35.6%)	7915 (35.4%)	5634 (36.1%)	1426 (37.7%)				
Other	5801 (9.3%)	2222 (9.9%)	1542 (9.9%)	408 (10.8%)				
LIS and/or dual eligibility, n (%)	13,298 (21.4%)	5033 (22.5%)	3631 (23.3%)	1090 (28.8%)	< .001	.863	.950	.619
Elixhauser Comorbidity Index score, <sup>d</sup> mean (SD)	3.50 (2.1)	3.65 (2.2)	3.57 (2.2)	3.41 (2.1)	< .001	.421	.797	.686
DCSI score, <sup>e</sup> mean (SD)	1.17 (1.4)	1.24 (1.4)	1.18 (1.4)	1.06 (1.4)	< .001	.971	.978	.227
≥ 1 inpatient admission, n (%)	5249 (8.4%)	2211 (9.9%)	1544 (9.9%)	374 (9.9%)	< .001	.981	.917	.689
≥ 1 emergency department visit, n (%)	14,633 (23.5%)	6205 (27.7%)	4455 (28.6%)	1157 (30.6%)	< .001	.985	.942	.855

DCSI, Diabetes Complications Severity Index; HMO, health maintenance organization; LIS, low-income subsidy; PPO, preferred provider organization.

<sup>a</sup>Measurements were made on the date of index or over a 1-year time period prior to the index date for inpatient admissions and emergency department visits.

<sup>b</sup>Three measures per year for 3 consecutive years (9 total measures).

<sup>c</sup>Differences were evaluated by weighted  $\chi^2$  tests for categorical variables and weighted *t* tests for continuous variables.

<sup>d</sup>The Elixhauser Comorbidity Index uses 31 categories of *International Classification of Diseases, Ninth Revision* and *International Statistical Classification of Diseases, Tenth Revision* diagnosis codes to calculate a score that is associated with hospital charges, length of stay, and mortality.

<sup>e</sup>The DCSI uses 7 categories of complications (cardiovascular disease, nephropathy, retinopathy, peripheral vascular disease, stroke, neuropathy, and metabolic disease) to calculate a score to predict adverse outcomes including hospitalization and mortality based on the number and severity of complications associated with diabetes.

**Table 2** shows the ORs for the association between adherence measure group and HCRU outcomes. The odds of all-cause and diabetes-related inpatient stays and ED visits were 1.12 to 1.26 times higher for those who missed 1 adherence measure, 1.22 to 1.42 times higher for those who missed 2 or 3 adherence measures, and 1.24 to 1.50 times higher for those who missed 4 or more adherence measures compared with patients achieving all 9 adherence measures. The odds of diabetes-related avoidable admissions were 1.30, 1.87, and 2.10 times higher for those who missed 1, 2 or 3, and 4 or more measures, respectively, compared with patients who missed 0 of 9 adherence measures.

Mean ratio estimates for the association of adherence measures with total, medical, and pharmacy costs are presented in **Table 3**. Compared with patients who missed 0 of 9 adherence measures over 3 years, those who missed 1, 2 or 3, and 4 or more adherence

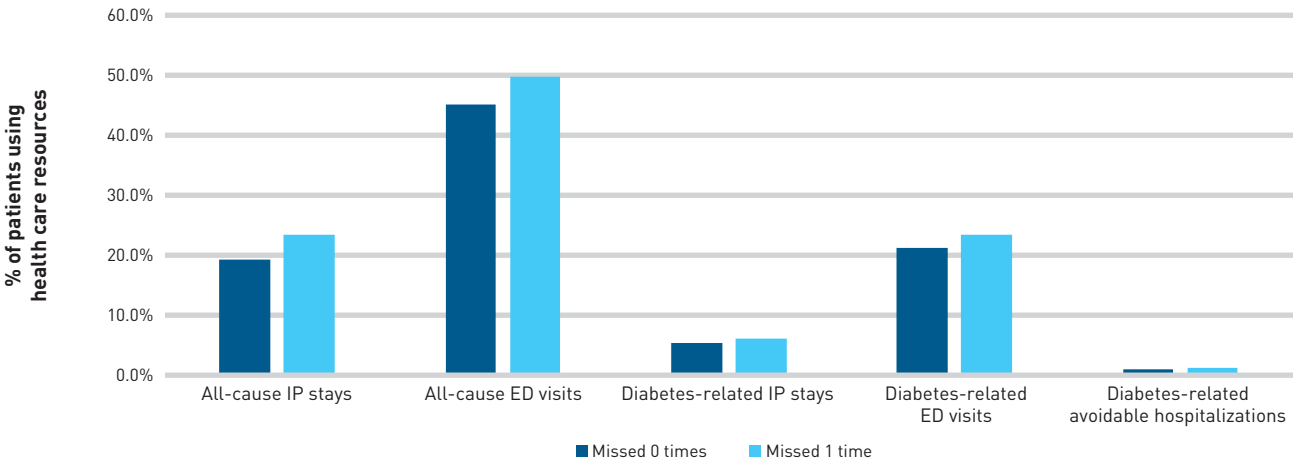
measures experienced 11%, 13%, and 11% higher per-person per-month total costs, respectively. Patients who missed 1, 2 or 3, and 4 or more adherence measures had 14%, 19%, and 20% higher per-person per-month medical costs, respectively, compared with patients who missed 0 of 9 adherence measures. Patients who missed 1 and 2 or 3 adherence quality measures had 9% and 3% higher per-person per-month pharmacy costs, respectively; there were no significant pharmacy cost differences for patients who missed 4 or more adherence measures vs missing 0 of 9 measures.

## DISCUSSION

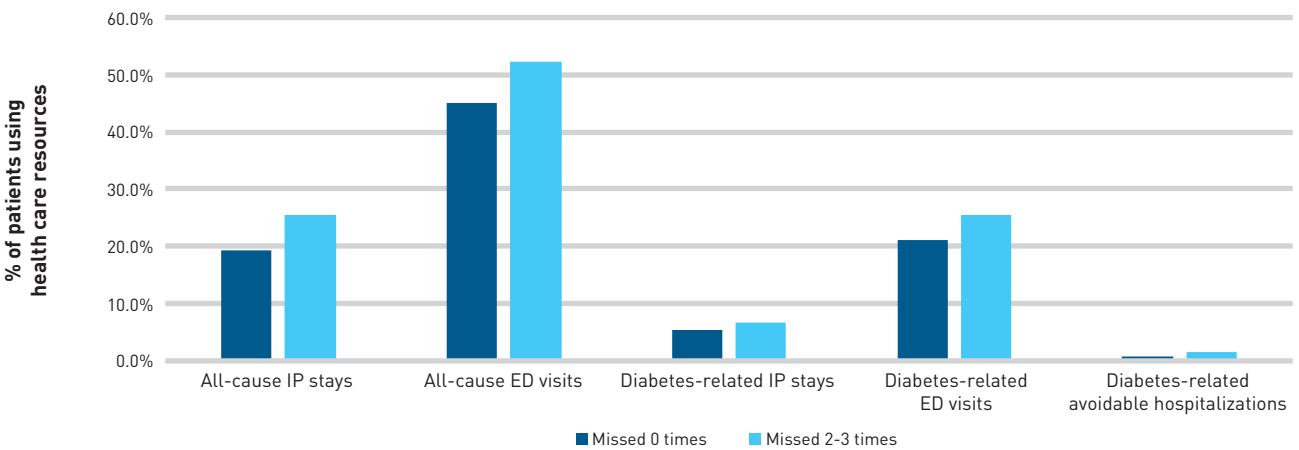
In this study of patients prescribed diabetes, statin, and RASA medications, we analyzed the relationship between achieving year-over-year CMS Star Ratings medication adherence measures and health care

**FIGURE 2.** IPTW-Adjusted Comparison of Health Care Resource Utilization by Number of Times Medication Adherence Measures Were Missed Over 3 Years

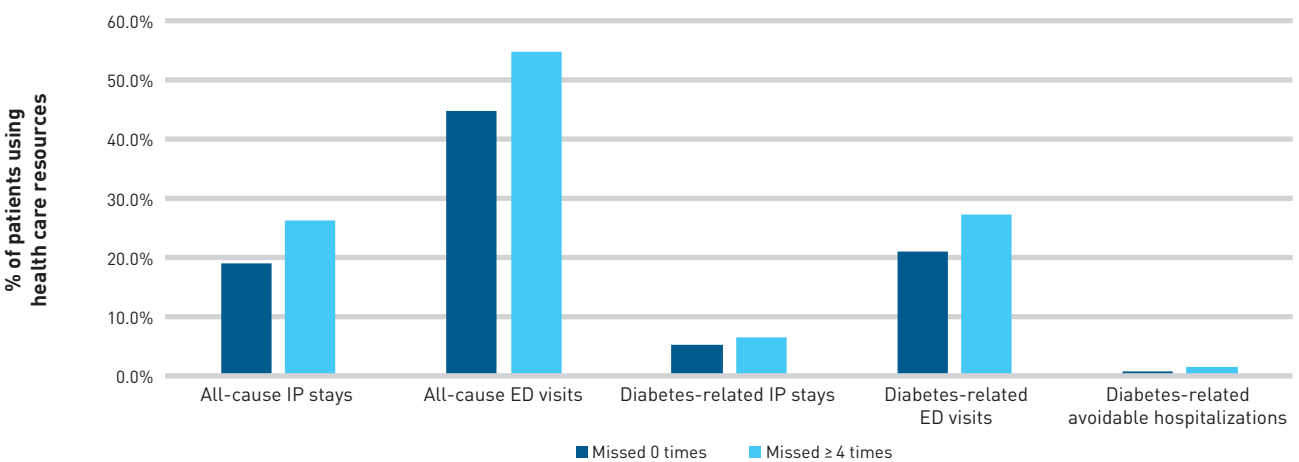
**A.** Comparing missed 1 time vs missed 0 times<sup>a</sup>



**B.** Comparing missed 2-3 times vs missed 0 times<sup>a</sup>



**C.** Comparing missed ≥4 times vs missed 0 times<sup>a</sup>



ED, emergency department; IP, inpatient; IPTW, inverse probability of treatment weighting.

<sup>a</sup>Differences were statistically significant (all  $P < .01$ ).

**TABLE 2.** Weighted ORs (95% CIs) for the Association of CMS Star Ratings Medication Adherence Quality Measures With Inpatient Admissions and ED Visits

Health care resource utilization	Missed 1 measure vs missed 0 measures <sup>a</sup>		Missed 2-3 measures vs missed 0 measures <sup>a</sup>		Missed ≥ 4 measures vs missed 0 measures <sup>a</sup>	
	OR (95% CI)	Weighted P	OR (95% CI)	Weighted P	OR (95% CI)	Weighted P
All-cause inpatient admission	1.26 (1.25-1.31)	<.0001	1.42 (1.37-1.49)	<.0001	1.49 (1.38-1.60)	<.0001
All-cause ED visit	1.21 (1.17-1.25)	<.0001	1.35 (1.30-1.40)	<.0001	1.50 (1.41-1.62)	<.0001
Diabetes-related inpatient admission	1.12 (1.05-1.19)	.0008	1.22 (1.13-1.31)	<.0001	1.24 (1.09-1.42)	.0014
Diabetes-related ED visit	1.13 (1.10-1.18)	<.0001	1.27 (1.22-1.33)	<.0001	1.41 (1.31-1.53)	<.0001
Diabetes-related avoidable admission	1.30 (1.11-1.52)	<.0001	1.87 (1.59-2.19)	<.0001	2.10 (1.61-2.74)	<.0001

ED, emergency department.

<sup>a</sup>Three measures per year for 3 consecutive years (9 total measures).

**TABLE 3.** Mean Ratio Estimates (95% CIs) for the Association of CMS Star Ratings Medication Adherence Quality Measures With Total, Medical, and Pharmacy Costs

All-cause health care costs	Missed 1 measure vs missed 0 measures <sup>a</sup>		Missed 2-3 measures vs missed 0 measures <sup>a</sup>		Missed ≥ 4 measures vs missed 0 measures <sup>a</sup>	
	Mean ratio estimates (95% CI)	Weighted P	Mean ratio estimates (95% CI)	Weighted P	Mean ratio estimates (95% CI)	Weighted P
Total PPPM	1.11 (1.10-1.12)	<.0001	1.13 (1.11-1.14)	<.0001	1.11 (1.08-1.14)	<.0001
Medical PPPM	1.14 (1.12-1.16)	<.0001	1.19 (1.17-1.21)	<.0001	1.20 (1.16-1.24)	<.0001
Pharmacy PPPM	1.09 (1.07-1.10)	<.0001	1.03 (1.02-1.05)	<.0001	1.00 (0.98-1.04)	.672

PPPM, per person per month.

<sup>a</sup>Three measures per year for 3 consecutive years (9 total measures).

utilization and costs. To our knowledge, this is the first study to consider the impact of multiple star measures simultaneously over multiple years on HCRU. The results showed that of the 9 total time points (3 medications over 3 years), patients who missed 1 or more adherence measures had increased odds of utilizing health care resources and higher health care costs compared with those who missed 0 adherence measures over 3 years. The more measures missed, the higher the utilization and costs. These results align with those of work by Campbell et al, which considered adherence to PQA medication quality measures separately for RASA, diabetes, and statin therapies over 1 year.<sup>30</sup> Unlike our study, which included individuals who were eligible for all 3 adherence measures (RASA, diabetes, statin) at every time point, their analysis evaluated the 3 groups individually. Inpatient utilization was 41.5%, 30.3%, and 18.9% lower in the adherent groups for RASA, statin, and diabetes medications, respectively, compared with nonadherent groups.<sup>30</sup> Patterns for cost were similar to those seen in our study, and inpatient expenditures showed the biggest differences between adherent and nonadherent groups, with 41.9% lower total cost for the adherent group compared with the nonadherent group for the RASA category.<sup>30</sup> This compares with our findings that missing 1 adherence measure from any of the RASA, diabetes, or statin categories increased the risk of all-cause inpatient stays, all-cause ED visits, diabetes-related inpatient stays, and diabetes-related ED visits by 12% to 26%. These numbers increased to 22% to 42% for the group missing 2 or 3 adherence measures and to 24% to 50% for the

group missing 4 or more adherence measures. We observed 11% to 13% higher per-person, per-month total costs across the nonadherent groups relative to those who missed 0 of 9 adherence measures.

A yearlong study considering adherence to the PQA quality measure for statins found that compared with nonadherent patients, those who did meet the statin quality measures experienced 4.7% fewer outpatient visits and 27.5% fewer inpatient stays.<sup>44</sup> They also experienced 9.9% lower outpatient costs and 28.3% lower inpatient costs.<sup>44</sup> Another yearlong study of the PQA statin medication adherence quality measure noted that patients adherent to statins had more outpatient visits but fewer inpatient visits and had lower outpatient, inpatient, and total expenditures; adherence was associated with \$18.81 lower per-person, per-month total health care expenditures, despite higher rates of outpatient utilization.<sup>45</sup> Patients with multiple chronic diseases are also at an increased risk of poor clinical outcomes if they do not take their medications as prescribed. It is estimated that up to 125,000 preventable deaths occur each year due to medication nonadherence.<sup>2</sup> Adherence to medications is important to mitigate these adverse outcomes.<sup>46</sup>

This study provides deeper insight into the association of Star Ratings adherence measure achievement with health care use and costs and supports the need for clinical program offerings to address nonadherence. Health plans and health care providers play an important role in improving medication adherence, which may, in turn, improve health care outcomes and reduce costs.<sup>30,47-50</sup> Interventions such as patient education, reminders, and medication management

programs may help improve medication adherence.<sup>51-53</sup> Health plans also may consider incentivizing medication adherence by offering lower co-payments<sup>54</sup> and dispensing 90 days' fill for prescriptions.<sup>55</sup> Behavior change programs are effective for improving adherence for individuals taking all 3 medication classes.<sup>56</sup> Comprehensive interventions involving nurses and pharmacists demonstrate improvements in clinical parameters including hemoglobin A<sub>1c</sub> normalization, blood pressure improvement, and better lipid control.<sup>57</sup> In addition to programs focused on improving patient adherence to CMS Star Ratings medication measures, future research may benefit from a focus on better defining measures of adherence, including creating new measures to more accurately capture medication use behavior.<sup>58,59</sup>

### Strengths and Limitations

A strength of this assessment of 3 distinct PQA measures over 3 years is that it provides a longer, in-depth view of medication adherence in a population with multimorbidity. Traditionally, studies have considered 1 measure in 1 category at a time, but our approach gathered data on 3 measures per year over 3 years to capture the multimorbidity issue. Other strengths include the large sample size and the use of inverse probability of treatment weighting with the propensity score method to balance for demographic and clinical characteristics.

Our study also has some limitations. We categorized patients in 4 groups based on the number of adherence time points missed (out of 9 total). For the group categorized as having missed 2 or 3 times or 4 or more times, this meant that patients could have missed the same adherence measure year over year (eg, diabetes in 2018, 2019, and 2020) or a different adherence measure each year (eg, diabetes in 2018, RASA in 2019, and statin in 2020). Both instances would result in the patient being categorized in the group having missed 2 or 3, despite a difference in the actual adherence measure that was missed. This categorization limited our ability to estimate the impact of individual Star Ratings adherence measures for each disease condition. Our analyses also did not test for a lag in effects. For example, we did not assess whether nonadherence in one year resulted in admissions in a following year or the same year. Alternatively, it is unknown whether a health care utilization encounter in an earlier year was associated with medication nonadherence the following year. These questions present an opportunity for future research. Additionally, use of administrative claims data may be subject to coding errors and lack granular medical history. The study also did not measure the reasons for nonadherence, which may impact study outcomes. Lastly, we utilized data for Humana MAPD beneficiaries only, so the results may not be generalizable to commercially insured individuals or the overall US population.

## CONCLUSIONS

Patients who miss adherence quality measures have increased risks of HCRU and increased costs. Adherence to quality measures

may reduce inpatient stays and ED visits by 21% to 50% and may reduce total health care costs by 11% to 13%. Health care providers and payers should focus on improving medication adherence, which may improve outcomes and reduce costs to the health care system. Further research is needed to understand the reasons for nonadherence and the impact of adherence interventions on health care outcomes and costs. ■

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**Authorship Information:** Concept and design (IBP, LC, SS, HP, PR); acquisition of data (HP, PR); analysis and interpretation of data (IBP, LC, SS, SWD, PR); drafting of the manuscript (IBP, SWD); critical revision of the manuscript for important intellectual content (IBP, LC, SS, HP, SWD, PR); statistical analysis (PR); administrative, technical, or logistic support (IBP, LC, SS, HP, SWD); and supervision (IBP).

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