Ambulatory Medication Reconciliation and Frequency of Hospitalizations and Emergency Department Visits in Patients With Diabetes

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OBJECTIVE

To investigate the association between ambulatory medication reconciliation and health care utilization in patients with diabetes.

RESEARCH DESIGN AND METHODS

In this retrospective cohort analysis, we studied adults taking at least one diabetes medication treated in primary care practices affiliated with two academic medical centers between 2000 and 2014. We assessed the relationship between the fraction of outpatient diabetes medications reconciled over a 6-month period and the composite primary outcome of combined frequency of emergency department (ED) visits and hospitalizations over the subsequent 6 months.

RESULTS

Among 261,765 reconciliation assessment periods contributed by 31,689 patients, 176,274 (67.3%), 27,775 (10.6%), and 57,716 (22.1%) had all, some, or none of the diabetes medications reconciled, respectively. Patients with all, some, or no diabetes medications reconciled had 0.354, 0.377, and 0.384 primary outcome events per 6 months, respectively ($P < 0.0001$). In a multivariable analysis adjusted for demographics and comorbidities, having some or all versus no diabetes medications reconciled was associated with a lower risk of the primary outcome (rate ratio 0.94 [95% CI 0.90–0.98; $P = 0.0046$] vs. 0.92 [0.89–0.95; $P < 0.0001$], respectively). Introduction of feedback to individual providers was associated with a significant increase in the odds of all diabetes medications being reconciled (2.634 [2.524–2.749]; $P < 0.0001$).

CONCLUSIONS

A higher fraction of reconciled outpatient diabetes medications was associated with a lower frequency of ED visits and hospitalizations. Individual performance feedback could help to achieve more comprehensive medication reconciliation.

Medication discrepancies—unintended differences in medication information for a given patient between different sites of care—are common (1–6). Many medication discrepancies have the potential to lead to patient harm (3,5,7,8). Medication reconciliation, a standardized process of comparing a patient's medication record to the medications the patient is actually taking, can reduce medication discrepancies

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(9–11). The World Health Organization has named medication reconciliation as one of its top five high-risk areas for standardization in patient safety (12), and medication reconciliation has been one of The Joint Commission's National Patient Safety Goals since 2005 (13).

Although most studies of medication reconciliation have focused on the inpatient environment (10), inaccurate medication records remain a challenge in ambulatory settings as well (14–16). Some studies have indicated that ambulatory medication reconciliation can improve accuracy of outpatient medication records (17–19). However, whether ambulatory medication reconciliation can decrease health care utilization, particularly emergency department (ED) visits and hospitalizations (20), remains uncertain.

Patients with diabetes are at a particularly high risk for medication errors (21,22). Adverse drug events stemming from medications used to treat diabetes commonly lead to ED visits and hospitalizations (23–25). We therefore studied whether ambulatory medication reconciliation in patients with diabetes is associated with a lower risk of ED visits and hospitalizations.

RESEARCH DESIGN AND METHODS

Study Design

We performed a retrospective cohort study among patients with diabetes to determine the association between the fraction of outpatient diabetes medications reconciled over a specified period (see below) and a subsequent risk of ED visits and hospitalizations.

Study Cohort

Adult patients with diabetes followed by primary care physicians affiliated with Brigham and Women's Hospital (BWH) and Massachusetts General Hospital (MGH) between 1 January 2000 and 30 June 2014 were studied. Patients were included in the analysis if they fulfilled all the following criteria: *1*) were at least 18 years old, *2*) had documented evidence of diabetes (diabetes on the electronic medical record [EMR] problem list, HbA_{1c} of at least 7.0% (53 mmol/mol), or at least three ICD-9 codes for diabetes), *3*) were followed for at least 12 months during the study period, and *4*) had taken at least one diabetes medication while they were followed. Patients with missing zip codes were excluded to enable adjustment for median household income by zip code. During the study period, BWH and MGH had programs that actively encouraged outpatient medication reconciliation since 2012, including individual provider performance feedback (26). These programs were not limited to patients with diabetes and/or diabetes medications. This study was approved by the Partners HealthCare System institutional review board (Somerville, MA), and the requirement for written informed consent was waived.

Study Measurements

A patient was entered into the study on the last of the following dates: *1*) first primary care note, *2*) 18th birthday, *3*) first documented evidence of diabetes, *4*) first record of a diabetes medication, or *5*) 1 January 2000. The patient was then followed to assess outpatient diabetes medication reconciliation until the first of the following: *1*) last primary care note or *2*) 30 June 2014. To account for the fact that effects of medication reconciliation were not expected to be observed over a prolonged period, the study follow-up period was divided into 6-month-long reconciliation assessment periods that started on 1 January and 1 July of each calendar year while the patient was in the study. A unique reconciliation assessment period served as the unit of analysis. Study outcomes were evaluated during the subsequent 6 months (outcome ascertainment period). For example, for a reconciliation assessment period between 1 January 2003 and 30 June 2003, the outcome ascertainment period was between 1 July 2003 and 31 December 2003. A single patient could contribute multiple reconciliation assessment and outcome ascertainment periods to the analysis.

The categorized fraction of diabetes medications reconciled during the reconciliation assessment period served as the predictor variable. A medication was considered reconciled if any of the following actions were performed in the EMR (in accordance with BWH and MGH policies): *1*) medication record was edited, *2*) prescription was generated, or *3*) medication was confirmed on a special EMR reconciliation screen. Because the possible numeric fractions of medications reconciled highly depend on the number of medications in the denominator, the fraction of medications reconciled was represented in the analysis as a categorical variable with three possible values: none, some (which included all values not equal to 0 or 1) and all. Information on the dosage of medications prescribed or taken was available to the reconciling providers but was not used in these categorizations.

The combined number of hospitalizations or ED visits at BWH or MGH during the subsequent outcome assessment period served as the composite primary outcome. In addition to the composite primary outcome, *1*) hospitalizations for any cause and *2*) ED visits for any cause were analyzed as secondary outcomes. ED visits for any cause followed by a hospitalization were excluded to avoid double-counting; the combination of the two events was counted as a single hospitalization. All data for the study were obtained from the EMR at Partners HealthCare, an integrated health care delivery network founded by BWH and MGH.

Statistical Analysis

Summary statistics were calculated by using frequencies and proportions for categorical data and means, SDs, and medians for continuous variables. In univariable analysis, the relationship between the fraction of diabetes medications reconciled and the study outcomes was evaluated using the Kruskal-Wallis test.

In multivariable analysis, a negative binomial model was used to account for overdispersion. This model was used to determine the association between the categorized fraction of diabetes medications reconciled and study outcomes while accounting for longitudinal repeated measurements within individual patients and providers' random effects and adjusting for the patient's demographics (age, sex, race/ethnicity, primary language, median household income by zip code, marital status, and health insurance status), study year, Charlson comorbidity index (CCI), treatment with insulin, categorized fraction of reconciled nondiabetes medications, smoking history, systolic and diastolic blood pressure, BMI, HbA_{1c} level, logarithm of estimated glomerular filtration rate (eGFR), number of hospital admissions in the 12 months preceding the reconciliation assessment period, number of primary care visits

during the reconciliation assessment period, and the logarithm of the number of diabetes and nondiabetes medications the patient was taking.

In addition, we analyzed the factors associated with the higher fraction of reconciled diabetes medications. We used a multinomial logistic regression model to determine the association between predictor variables (patient demographics, CCI, smoking history, blood pressure, BMI, HbA_{1c} level, eGFR, number of diabetes medications, treatment with insulin, number of hospital admissions in the 12 months preceding the reconciliation assessment period, number of primary care visits during the reconciliation assessment period, and whether the reconciliation assessment period took place after reconciliation feedback was instituted at BWH and MGH) and the categorical outcome variable (none, some, or all) representing the fraction of diabetes medications reconciled while accounting for clustering within individual patients. Because patients who were only taking one diabetes medication could not have some (but only all or none) of their medications reconciled, their data were analyzed separately.

Multiple imputation procedure was used to account for missing data (blood pressure, BMI, HbA_{1c}, and eGFR) both in the primary analysis and in the evaluation of the factors associated with medication reconciliation. Interpretation of *P* values was adjusted for multiple hypothesis testing using the Simes-Hochberg method (27,28). All analyses were performed with SAS 9.4 statistical software (SAS Institute, Cary, NC).

RESULTS

We identified 32,880 adult patients with diabetes who were followed in primary care settings for at least 1 year and were taking diabetes medications during the study period. We excluded 191 patients who did not have income by zip code information available. The remaining 31,689 patients represented by 261,765 reconciliation assessment periods were included in the analysis. Among these, 176,274 (67.3%), 27,775 (10.6%), and 57,716 (22.1%) reconciliation assessment periods had all, some, and no diabetes medications reconciled, respectively. Most (21,015 [66.3%]) of the study patients had a baseline $HbA_{1c} \geq 7.0\%$ (53 mmol/mol); they were followed on average for 57 months (Table 1). During the reconciliation assessment periods, patients had a median of four primary care visits and took a median of one diabetes medication (Supplementary Table 1).

Diabetes Medication Reconciliation and ED Visits and Hospitalizations

Over the subsequent 6-month outcome assessment period, patients with all, some, or no diabetes medications reconciled had a mean of 0.354, 0.377, and 0.384 composite primary outcome events, respectively ($P < 0.0001$). Over the same period (Fig. 1), patients with all, some, or no diabetes medications reconciled had 0.223, 0.232, and 0.230 ED visits ($P = 0.0296$) and 0.132, 0.145, and 0.154 hospitalizations ($P < 0.0001$), respectively. No consistent relationship was observed for reconciliation of nondiabetes medications. Among 258,526 reconciliation assessment periods with at least one nondiabetes medication, periods with no, some, and all nondiabetes medications reconciled were followed by a mean of 0.278, 0.397, and 0.335 primary outcome events, respectively.

In multivariable analysis, a larger fraction of diabetes medication reconciled remained associated with lower frequency of the composite primary outcome (Table 2). Compared with patients who had no diabetes medications reconciled, those who had some of their diabetes medications reconciled had a rate ratio (RR) of the primary outcome events of 0.94 (0.90–0.98; $P = 0.0046$), and patients who had all diabetes medications reconciled had an RR of 0.92 (0.89–0.95; $P < 0.0001$). Findings for secondary outcomes were similar (Table 2). Other patient characteristics associated with lower frequency of the composite primary outcome events were female sex, lower HbA_{1c}, better kidney function, lower CCI, no insulin therapy, lower frequency of primary care visits, and absence of hospitalizations in the preceding 12 months.

In a secondary analysis, the association between the composite primary outcome and reconciliation of insulin and sulfonylureas only was weaker than the association with reconciliation of all diabetes medications; the RR for reconciliation of all insulins and sulfonylureas was 0.95 (95% CI 0.92–0.98; $P = 0.002$) and for reconciliation of some insulins and sulfonylureas 0.97 (0.95–1.00; $P = 0.34$). An analysis of the difference of the effect of reconciliation of diabetes medications before versus after 2012 (when individual feedback to clinicians was introduced) showed no statistically significant difference (0.98; 95% CI 0.90–1.06; $P = 0.58$).

Table 1—Baseline characteristics of study patients

Variable	Value
Participants, *n*	31,689
Age (years), mean (SD)	59.4 (13.7)
Female sex	15,914 (50.2)
White race	18,724 (59.1)
Median household income by zip code ($1,000), mean (SD)	67.2 (25.5)
English as the primary language	25,483 (80.8)
Government insurance	16,457 (51.9)
Married	15,408 (48.6)
History of smoking	17,159 (54.2)
Treated with insulin	12,305 (38.8)
Follow-up (days), mean (SD)	1,757 (1,458)
BMI (kg/m^2), mean (SD)	32.0 (6.2)
HbA_{1c}, mean (SD)	
%	8.0 (1.9)
mmol/mol	64 (11.8)
SBP (mmHg), mean (SD)	130.7 (16.0)
DBP (mmHg), mean (SD)	75.7 (9.8)
eGFR ($mL/min/1.73\ m^2$), mean (SD)	76.0 (25.0)
CCI, mean (SD)	6.2 (4.2)

Data are *n* (%) unless otherwise indicated. DBP, diastolic blood pressure; SBP, systolic blood pressure.

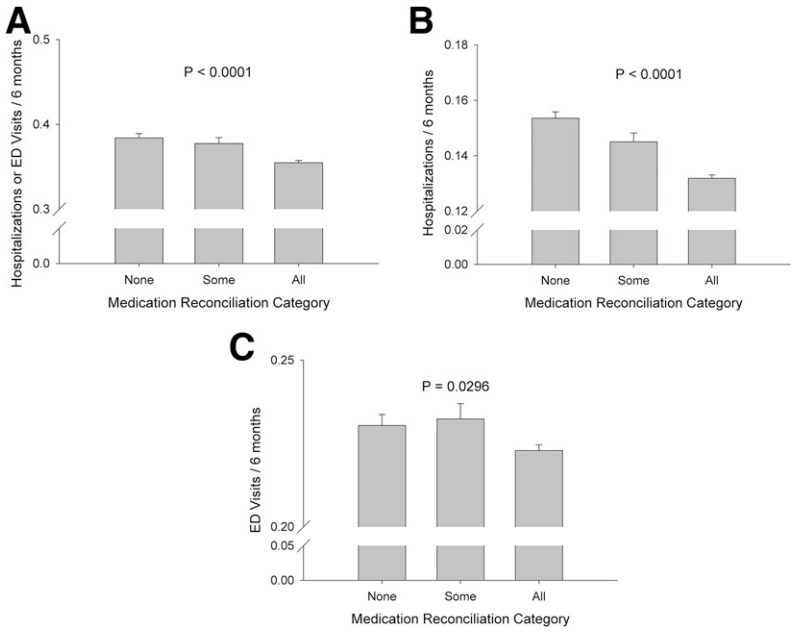

Figure 1—Diabetes medication reconciliation and rate of hospitalizations and ED visits. *A*: Primary composite outcome. *B*: Hospitalizations. *C*: ED visits. Error bars indicate SE.

Predictors of Diabetes Medication Reconciliation

In multivariable analysis of factors associated with a higher fraction of reconciled diabetes medications among 124,408 reconciliation assessment periods with multiple diabetes medications, feedback to individual providers was associated with a significant increase in the probability of all diabetes medications being reconciled at the expense of the lower probability of only some diabetes medications being reconciled (Table 3). Other factors associated with higher probability of all diabetes medications being reconciled included a greater number of primary care visits, nonwhite race, primary language other than English, and higher HbA_{1c} level. The results were similar among the 133,357 reconciliation assessment periods with only one diabetes medication (Table 3).

CONCLUSIONS

In this large retrospective cohort study, we found that higher rates of reconciliation of diabetes medications were associated with lower frequency of hospitalizations and ED visits and that higher rates of medication reconciliation were observed after introduction of performance feedback at the individual provider level. These findings have important implications for both individual clinician practice of medicine and health policy.

Medication reconciliation is an important patient safety measure. It can reduce medication discrepancies, potential adverse drug events, and actual adverse drug events (9,10,19). However, the effect of inpatient medication reconciliation on health care utilization remains uncertain (9,10), and little information is available on the relationship between health care utilization and ambulatory medication reconciliation. To our knowledge, the current study is the first to show a strong association between higher fraction of reconciled outpatient medications and lower rates of ED visits and hospitalization, an important finding in this era of intensifying efforts for controlling health care costs. Although the analysis was retrospective in nature and, therefore, cannot provide definitive evidence of a causal link, the finding of a dose-response relationship between diabetes medication reconciliation and both the composite primary outcome and hospitalizations offers an additional degree of reassurance.

Medication reconciliation is not without its own costs. The medication reconciliation process typically takes 15–20 min and sometimes as long as 30–60 min (29–32). The resulting high cost of nurse/pharmacist time spent on verifying the patient's medication information is a known barrier to medication reconciliation (33,34). This barrier can be even higher in the ambulatory setting where 15–20 min required for medication reconciliation can consume the entire time slot allotted for the patient's encounter with the clinician. Consequently, both individual providers and health system administrators must be aware of the balance between the costs and downstream benefits of the medication reconciliation process. The current study provides some of the information necessary to illuminate this balance.

Medication reconciliation can take different forms. The system used at the institutions included in this analysis during the study period required reconciliation at the individual medication level. However, many EMR systems allow wholesale reconciliation through a click of a button, which attests that the provider reviewed all the patient's medications. Our findings, therefore, may not be generalizable to institutions that use a significantly different process for medication reconciliation.

The current analysis only found health care utilization benefits with reconciliation of diabetes medications. This could be related to some diabetes medications having low therapeutic indices, and incorrect dosing can easily lead to adverse events (e.g., hypoglycemia) that require emergency health care services. In a national study, insulin was the second most common medication implicated in adverse drug events leading to an ED visit by older patients (24). Similarly, insulins were the second most common and oral diabetes medications the fourth responsible for adverse drug events leading to hospitalizations among older patients (25). Reconciliation of diabetes medications could therefore decrease the risk of the patient taking an incorrect dose and prevent an adverse drug event that otherwise would have led to a hospitalization or an ED visit, explaining our findings. Although we could not find a consistent relationship between ED visits/hospitalizations and reconciliation of nondiabetes medications as a whole, reconciliation of certain other high-risk medication classes possibly is associated with reduced health care utilization; this should be studied further.

Little is known about factors that influence medication reconciliation. The current study shows that a quality improvement program that provides medication reconciliation performance feedback to individual clinicians and

Table 2—Effect of patient characteristics and medication reconciliation on frequency of ED visits and hospitalization

	Combined ED visits and hospitalizations		ED visits		Hospitalizations	
Variable	RR (95% CI)	*P* value	RR (95% CI)	*P* value	RR (95% CI)	*P* value
Age[a] (years)						
<50	2.027 (1.935–2.124)	<0.0001	2.064 (1.970–2.162)	<0.0001	1.690 (1.597–1.789)	<0.0001
50–64	1.242 (1.198–1.288)	<0.0001	1.230 (1.186–1.276)	<0.0001	1.194 (1.144–1.246)	<0.0001
65–74	0.978 (0.947–1.011)	0.1859	0.944 (0.913–0.976)	0.0008	1.046 (1.007–1.086)	0.0212
Female	0.955 (0.932–0.979)	0.0002	0.974 (0.950–0.999)	0.4170	0.888 (0.862–0.915)	<0.0001
White	0.903 (0.878–0.929)	<0.0001	0.835 (0.811–0.860)	<0.0001	1.035 (1.000–1.072)	0.0499
Government insurance	1.169 (1.141–1.199)	<0.0001	1.177 (1.147–1.207)	<0.0001	1.130 (1.096–1.165)	<0.0001
English[b]	1.087 (1.052–1.123)	0.005	1.066 (1.032–1.102)	0.0001	1.108 (1.064–1.155)	<0.0001
Married	0.865 (0.845–0.886)	<0.0001	0.829 (0.809–0.849)	<0.0001	0.931 (0.904–0.958)	<0.0001
Income[c]	0.945 (0.940–0.950)	<0.0001	0.937 (0.932–0.943)	<0.0001	0.963 (0.957–0.970)	<0.0001
History of smoking	1.066 (1.041–1.091)	<0.0001	1.070 (1.044–1.096)	<0.0001	1.036 (1.006–1.067)	0.0168
SBP[d]	0.999 (0.998–1.00)	0.0268	0.999 (0.998–1.000)	0.0049	1.000 (1.000–1.001)	0.6072
DBP[e]	1.00 (0.998–1.001)	0.5556	1.001 (0.999–1.002)	0.2943	1.000 (1.000–1.000)	0.0089
BMI[f]	1.004 (1.002–1.006)	<0.0001	1.002 (0.999–1.004)	0.0056	1.000 (0.998–1.002)	0.9172
HbA_{1c}	1.036 (1.029–1.044)	<0.0001	1.034 (1.026–1.042)	<0.0001	1.047 (1.037–1.056)	<0.0001
eGFR[g]	0.854 (0.833–0.875)	<0.0001	0.882 (0.860–0.903)	<0.0001	0.732 (0.712–0.753)	<0.0001
CCI	1.172 (1.168–1.176)	<0.0001	1.144 (1.139–1.148)	<0.0001	1.171 (1.166–1.76)	<0.0001
Treated with insulin	1.271 (1.238–1.305)	<0.0001	1.259 (1.225–1.294)	<0.0001	1.286 (1.245–1.329)	<0.0001
Primary care visits	1.038 (1.035–1.040)	<0.0001	1.038 (1.036–1.041)	<0.0001	1.027 (1.024–1.030)	<0.0001
Number of nondiabetes medications[g]	1.446 (1.414–1.478)	<0.0001	1.450 (1.417–1.484)	<0.0001	1.455 (1.415–1.497)	<0.0001
Number of diabetes medications[g]	0.864 (0.838–0.890)	<0.0001	0.861 (0.834–0.888)	<0.0001	0.879 (0.847–0.913)	0.0283
Hospitalizations in the preceding 12 months	1.382 (1.365–1.399)	<0.0001	1.318 (1.304–1.333)	<0.0001	1.354 (1.338–1.370)	<0.0001
Nondiabetes medications reconciled[h]						
Some	1.011 (0.968–1.055)	0.6330	1.012 (0.968–1.059)	0.5950	1.094 (0.956–1.65)	0.7340
All	1.136 (1.081–1.194)	<0.0001	1.127 (1.070–1.888)	<0.0001	1.177 (1.105–1.254)	<0.0001
Diabetes medications reconciled[i]						
Some	0.938 (0.898–0.980)	0.0046	0.927 (0.886–0.970)	0.0010	0.942 (0.893–0.994)	0.0283
All	0.920 (0.892–0.950)	<0.0001	0.917 (0.888–0.947)	<0.0001	0.917 (0.883–0.952)	<0.0001

DBP, diastolic blood pressure; SBP, systolic blood pressure. [a]Age >74 years served as the comparison group. [b]Recorded as the primary language. [c]Median household income by zip code by $10,000. [d]SBP by 10 mmHg. [e]DBP by 10 mmHg. [f]BMI by 1 kg/m^2. [g]Parameterized as a natural logarithm. [h]No nondiabetes medications reconciled served as the comparison group. [i]No diabetes medications reconciled served as the comparison group.

compares them with their peers (initiated in 2012 at both study institutions [separately]) is associated with a significant increase in reconciliation. This finding demonstrates a systemwide effect on medication reconciliation rates and provides a blueprint for successful implementation. A higher frequency of primary care visits also is linked to higher rates of medication reconciliation likely because every visit provides an additional opportunity for reconciliation (which in this analysis was evaluated over a 6-month period). On the other hand, several demographic characteristics of patients, specifically white race and English as the primary language, were associated with lower medication reconciliation rates. The reasons for this finding are uncertain and deserve additional investigation.

Risk of ED visits and hospitalizations among patients with diabetes may be affected by multiple factors in addition to medication reconciliation. One such factor is the risk of hypoglycemia associated with medications used to treat diabetes. In this study, the number of diabetes medications the patient was taking was inversely related to frequency of both ED visits and hospitalizations. Because most diabetes medications, apart from sulfonylureas and insulin, have a lower risk of hypoglycemia, this finding may be an indirect indication of the additional risk of adverse events associated with hypoglycemia-prone medications. On the other hand, the analysis did not have sufficient power to establish whether the observed decrease in health care utilization with higher diabetes medication reconciliation rates was specifically due to diabetes-related events (i.e., whether it was due to a change in the incidence of hypoglycemia). As a result, the nature of the links between evidence of reconciliation and the medical outcomes the analysis uncovered is not fully understood.

The current study had a number of strengths. It was a large analysis of >30,000 demographically diverse patients. Furthermore, the analysis included periods when medication reconciliation was not explicitly encouraged (before its introduction as a National Patient Safety Goal by The Joint Commission in 2005), was encouraged at the institutional level (2005–2011), and was encouraged at the individual provider level (after 2012), allowing for greater generalizability across various health care settings.

The study's findings, however, must be interpreted in light of its limitations. As a retrospective analysis, the study cannot provide definitive evidence of a causative relationship but only an association. Its conclusions are necessarily tentative and

Table 3—Effect of patient characteristics on diabetes medication reconciliation

	Reconciliation assessment periods with more than one diabetes medication				Reconciliation assessment periods with one diabetes medication	
	All diabetes medications reconciled		Some diabetes medications reconciled		All medications reconciled	
Variable	OR (95% CI)	*P* value	OR (95% CI)	*P* value	Estimate (95% CI)	*P* value
Age[a] (years)						
<50	0.966 (0.932–1.002)	0.0659	0.936 (0.897–0.977)	0.0024	0.935 (0.906–0.965)	<0.0001
50–64	1.071 (1.044–1.098)	<0.0001	1.06 (1.029–1.091)	0.0001	1.023 (1.001–1.045)	0.039
65–74	1.067 (1.037–1.098)	<0.0001	1.004 (0.971–1.037)	0.8303	1.034 (1.009–1.058)	0.006
Female sex	0.978 (0.946–1.011)	0.1848	1.053 (1.014–1.094)	0.0078	1.031 (1.003–1.06)	0.029
White	0.778 (0.749–0.807)	<0.0001	0.851 (0.815–0.889)	<0.0001	0.872 (0.846–0.899)	<0.0001
Government insurance	1.045 (1.009–1.081)	0.0129	1.05 (1.009–1.092)	0.0167	0.97 (0.942–0.998)	0.039
English[b]	0.716 (0.684–0.75)	<0.0001	0.899 (0.852–0.948)	<0.0001	0.804 (0.774–0.834)	<0.0001
Married	0.921 (0.892–0.951)	<0.0001	0.99 (0.953–1.027)	0.5864	0.993 (0.966–1.02)	0.596
Income[c]	0.983 (0.976–0.989)	<0.0001	0.989 (0.982–0.997)	0.0067	0.972 (0.967–0.977)	<0.0001
History of smoking	1.088 (1.054–1.124)	<0.0001	1.073 (1.034–1.114)	0.0002	1.08 (1.052–1.11)	<0.0001
SBP[d]	1.005 (0.993–1.017)	0.3895	0.999 (0.986–1.013)	0.8984	0.985 (0.975–0.995)	0.003
DBP[e]	0.964 (0.944–0.983)	0.0003	0.982 (0.959–1.005)	0.1219	0.998 (0.981–1.015)	0.789
BMI[f]	1.015 (1.012–1.017)	<0.0001	1.01 (1.007–1.013)	<0.0001	1.008 (1.006–1.01)	<0.0001
HbA_{1c}	1.047 (1.036–1.059)	<0.0001	1.021 (1.009–1.034)	0.0009	1.043 (1.032–1.053)	<0.0001
eGFR[g]	1.274 (1.223–1.327)	<0.0001	1.223 (1.166–1.283)	<0.0001	1.079 (1.042–1.117)	<0.0001
CCI	0.988 (0.983–0.992)	<0.0001	1.001 (0.995–1.006)	0.7883	0.983 (0.979–0.987)	<0.0001
Treated with insulin	0.861 (0.832–0.89)	<0.0001	1.005 (0.966–1.046)	0.8147	0.911 (0.88–0.943)	<0.0001
Number of diabetes medications	0.933 (0.906–0.961)	<0.0001	1.731 (1.679–1.786)	<0.0001	NA	NA
Primary care visits	1.091 (1.086–1.095)	<0.0001	1.041 (1.036–1.046)	<0.0001	1.052 (1.049–1.056)	<0.0001
With provider feedback	2.634 (2.524–2.749)	<0.0001	0.56 (0.529–0.593)	<0.0001	2.304 (2.225–2.385)	<0.0001
Hospitalizations in the preceding 12 months	0.935 (0.917–0.954)	<0.0001	0.926 (0.905–0.947)	<0.0001	0.972 (0.955–0.989)	0.002

DBP, diastolic blood pressure; NA, not applicable; OR, odds ratio; SBP, systolic blood pressure. [a]Age >74 years served as the comparison group. [b]Recorded as the primary language. [c]Median household income by zip code by $10,000. [d]SBP by 10 mmHg. [e]DBP by 10 mmHg. [f]BMI by 1 kg/m^2. [g]Parameterized as a natural logarithm.

need confirmation. Data available for analysis only included hospitalizations and ED visits at institutions within a single health care system. Health care utilization outside this system was not included, and as a result, the reported frequencies of ED visits and hospitalizations are likely underestimates. We also did not have information on whether medication reconciliation was accurate, other patient safety metrics, and other processes of care relevant to patients with diabetes, such as foot or eye examinations. The study did not include an econometric analysis and, therefore, could not determine cost-effectiveness of medication reconciliation. Finally, because the study was limited to two academic medical centers in eastern Massachusetts, the findings may not be generalizable outside these settings. Future directions of research could include investigations of whether other approaches to medication reconciliation (e.g., attestation to reconciliation of an entire list of medications by means of a single checkbox) have a similar relationship with patient outcomes. An important area of study would be whether reconciliation of other classes of medications (e.g., anticoagulants, opioids) has a similarly pronounced relationship with ED visits or hospitalizations.

In conclusion, this analysis shows that higher rates of reconciliation of diabetes medications are associated with lower health care utilization in the acute hospital setting, the most expensive kind. At the same time, the finding of a significant increase in medication reconciliation rates after institution of individual performance feedback demonstrates how these higher rates can be achieved. These results, therefore, provide actionable information to both individual providers and health care system administrators about reconciliation of diabetes medications.

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