# Factors Associated With Intensification of Oral Diabetes Medications in Primary Care Provider-Patient Dyads: A Cohort Study

Shari Danielle Bolen, md, mph[1]
Eric Bricker, md, mph[2]
T. Alafia Samuels, md, mph, phd[3]
Hsin-Chieh Yeh, phd[1,4,5]
Spyridon S. Marinopoulos, md, mba[1]
Maura McGuire, md[1]
Marcela Abuid, md[6]
Frederick L. Brancati, md, mhs[1,4,5]

**OBJECTIVE** — Although suboptimal glycemic control is known to be common in diabetic adults, few studies have evaluated factors at the level of the physician-patient encounter. Our objective was to identify novel visit-based factors associated with intensification of oral diabetes medications in diabetic adults.

**RESEARCH DESIGN AND METHODS** — We conducted a nonconcurrent prospective cohort study of 121 patients with type 2 diabetes and hyperglycemia (A1C ≥8%) enrolled in an academically affiliated managed-care program. Over a 24-month interval (1999–2001), we identified 574 hyperglycemic visits. We measured treatment intensification and factors associated with intensification at each visit.

**RESULTS** — Provider-patient dyads intensified oral diabetes treatment in only 128 (22%) of 574 hyperglycemic visits. As expected, worse glycemia was an important predictor of intensification. Treatment was more likely to be intensified for patients with visits that were "routine" (odds ratio [OR] 2.55 [95% CI 1.49–4.38]), for patients taking two or more oral diabetes drugs (2.82 [1.74–4.56]), or for patients with longer intervals between visits (OR per 30 days 1.05 [1.00–1.10]). In contrast, patients with less recent A1C measurements (OR >30 days before the visit 0.53 [0.34–0.85]), patients with a higher number of prior visits (OR per prior visit 0.94 [0.88–1.00]), and African American patients (0.59 [0.35–1.00]) were less likely to have treatment intensified.

**CONCLUSIONS** — Failure to intensify oral diabetes treatment is common in diabetes care. Quality improvement measures in type 2 diabetes should focus on overcoming inertia, improving continuity of care, and reducing racial disparities.

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Although glycemic control reduces microvascular complications and may reduce macrovascular complications (1–3), diabetic patients commonly have inadequately controlled blood glucose (4–8). Recent evidence suggests that lack of intensification of diabetes medications in a timely fashion is a powerful explanatory factor (4–6,9–11). This decision to intensify treatment may be affected by several factors, such as patient adherence (12) and preference, competing medical demands (13), or provider attitudes and knowledge (14).

Identifying barriers and promoters of treatment intensification is a crucial first step toward developing strategies to improve blood glucose control in diabetic adults. Although many studies have documented lack of adequate glycemic control (4–8) and failures to intensify medications in subjects with diabetes (4–6,9–11), few studies have evaluated factors associated with treatment intensification besides glycemic control (13,15,16). Of these studies, two evaluated a variety of visit-based factors associated with intensification, but these had limited generalizability (13,15) and did not adjust for key confounders such as patient adherence (13). No study has focused in detail on a variety of visit-based factors in addition to patient and provider factors that might influence oral diabetes treatment intensification.

Therefore, we conducted a nonconcurrent prospective cohort study to identify novel barriers and promoters of intensification of oral diabetes medications in type 2 diabetic adults. We felt these visit-based factors may be more modifiable than durable patient and physician factors such as age or sex.

## RESEARCH DESIGN AND METHODS

— We studied a cohort of federal employees and their dependents with type 2 diabetes who received primary care at any of 16 sites of an academically affiliated managed-care program in Maryland. Individuals were classified as having diabetes if *1*) claims data showed ICD-9 codes 250.xx, 357.2, 362.0, 366.41, or 648.0 or *2*) electronic pharmacy data indicated that insulin or oral diabetes medications had been prescribed. Eligible subjects had made two or more primary care visits or one emergency room visit or had a hospital stay during the 24-month interval from 1 January 1999 to 31 December 2001. From this population of 1,120 diabetic patients, 411 patients were chosen by systematic random sampling using criteria based on the Health Plan Employer Data and Information Set sampling strategy. Of the 411, we focused on the 122 patients receiving oral diabetes medications and not on insulin at study start. Electronic pharmacy data were not available for 21 (5.1%) of

From the [1]Division of General Internal Medicine, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; the [2]Department of Medicine, Baylor Regional Medical Center at Plano, Baylor Healthcare System, Plano, Texas; the [3]Pan American Health Organization, Washington, D.C.; the [4]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; the [5]Welch Center for Prevention, Epidemiology, and Clinical Research, Johns Hopkins University, Baltimore, Maryland; and the [6]Department of Medicine, University of Massachusetts School of Medicine, Worcester, Massachusetts.
Corresponding author: Shari Bolen, sgolden4@jhmi.edu.
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From 1 July 1999 to 31 December 2001, these 122 patients with diabetes made 1,270 primary care visits. We excluded one patient and 142 visits for which blood glucose control was uncertain and 18 visits for which intensification status was uncertain. At 574 of the remaining 1,110 visits (in 121 unique patients who saw 55 primary care providers), glycemic control was poor enough (i.e., A1C ≥8%) to warrant treatment intensification. The A1C threshold of 8% for physician action is consistent with practice guidelines developed by the American Diabetes Association (17).

### Data collection

Data were collected from two main sources. From electronic files, we abstracted data on enrollment, utilization, laboratory results, and pharmacy use. From written medical records, two trained registered nurses used a standardized instrument to abstract data on medical history and visit-based clinical factors. A physician independently reviewed 98 (24%) of the 407 patient charts, with good agreement ($\kappa > 0.8$) for all objective measurements, including A1C. We grouped these data into three categories: *1*) patient-related factors, *2*) provider-related factors, and *3*) visit-related factors.

**Patient-related factors.** From medical records, we abstracted data on weight and height and cardiovascular comorbid conditions. From enrollment databases, we obtained age, sex, and race. Using the electronic pharmacy database, we calculated patient adherence according to an algorithm with number of pills and days supply developed by Steiner et al. (18). A score of 1.0 corresponds to 100% adherence and a score of 0.50 to 50% adherence. The score can exceed 1.0 (100%) if a patient refills a prescription early. From claims data, we determined comorbidity, using ICD-9 codes and patient demographics to create resource utilization bands (RUBs) (19). A higher RUB indicated higher patient comorbidity.

**Provider-related factors.** Using data from public web sites posted by the Maryland Board of Physicians and American Medical Association, we determined provider sex and graduation year (20,21).

**Visit-related factors.** From the laboratory database, we abstracted A1C, serum glucose, LDL cholesterol, and creatinine. We abstracted the most recent A1C before the index visit. From medical records, for each visit we abstracted data on prescription side effects; provider counseling regarding diet, exercise, medication adherence, glucose control, or smoking cessation; visit type (routine versus urgent); specialty referrals; and influenza and/or pneumonia vaccination.

We used the electronic appointment database to determine other visit-related factors including missed appointments, the interval between visits, and the number of appointments as well as whether the patient saw his or her regular primary care provider or not. The regular provider was the provider seen most frequently by the patient.

### Intensification of oral diabetes treatment

Using the electronic pharmacy database, we defined "intensification" as either *1*) filling a prescription for a new oral diabetes medication or *2*) filling a prescription for a higher dose of a previously prescribed medication, without a corresponding decline in dose of another oral diabetes medication within 1 month of the index visit (15).

### Statistical analysis

We used generalized estimating equations with an exchangeable correlation structure to construct unadjusted and partially adjusted (for patient age, race, sex, comorbidity using the RUBs, and glycemic control using A1C) logistic regression models for each of these variables. Because individual patients typically made about seven visits during 24 months, all models accounted for patient clustering. We used body weight stratified by sex as a marker of adiposity, because height was only available for 26% of patients.

We then used a two-step approach to develop the final multivariable model. First, we used our clinical judgment and prior literature to choose factors for the final model. These variables included having a routine visit, A1C, and patient age, race, sex, and comorbidity as measured by RUBs. A1C was handled as a categorical variable because there was a significant change in slope at 9%. We then constructed separate multivariable models for patient, provider, and visit characteristics.

In addition to variables included on the basis of clinical judgment, we also included in the final model several of the most statistically significant variables from each of the first-step models ($P < 0.05$). Clinic site was not included in these models because there were no statistically significant differences between clinic sites. Tests of significance were two-tailed, with an $\alpha$ level of 0.05. Analyses were performed using Stata (intercooled version 8.0; StataCorp, College Station, TX).

## RESULTS

### Patient, visit, and provider characteristics

Table 1 presents selected characteristics of 121 patients and their 574 hyperglycemic visits. Most were older white or African American men. These federal employees and their dependents were highly adherent to their oral diabetes medications. Approximately two-thirds had hypertension, and approximately one-quarter had coronary heart disease. They averaged seven primary care visits over 2 years. At baseline, approximately half of the patients were taking one or fewer oral diabetes medications.

The 55 primary care providers were mostly internal medicine (41%) or family practice (38%) physicians. Primary care providers intensified oral diabetes medications at only 128 (22%) of 574 hyperglycemic visits. Sixty-seven (52%) of these intensified prescriptions were filled within 24 h of the patients' appointment with their primary care provider, 19 (15%) were filled between 2 days and 1 week, 20 (16%) were filled between 1 and 2 weeks, and the remaining 22 (17%) were filled between 2 weeks and 1 month. When we dropped visits with an out-of-date A1C (>3 months old), intensification rates increased to 26%. If we used the medical record to determine intensification, the intensification rate rose to 32%.

Using the 574 index hyperglycemic visits, the mean A1C was 9.5%. Most of the visits were routine (66%, $n = 380$ visits) appointments with regular providers (53%, $n = 303$). Patients saw their regular provider at 61% of routine visits.

### Factors associated with treatment intensification

**Patient factors.** Table 2 shows associations between selected patient factors and intensification. Older age (odds ratio [OR] per 10 years 1.42 [95% CI 1.08–1.86]) and lower comorbidity (1.60 [1.00–2.57]) were moderately associated

**Table 1—*Selected characteristics of 121 patients with diabetes, their 55 primary care providers, and their 574 visits with suboptimally controlled glycemia***

| | |
|---|---|
| Patient characteristics | |
| *n* | 121 |
| Age (years) | 61 ± 8 |
| Age categories (%) | |
| 40–49 years | 9 |
| 50–59 years | 36 |
| 60–69 years | 41 |
| ≥70 years | 14 |
| Sex (%) | |
| Male | 61 |
| Female | 39 |
| Race (%) | |
| White | 55 |
| African American | 33 |
| Other or missing | 12 |
| Body weight (lb) | |
| Men | 226 ± 38 |
| Women | 191 ± 36 |
| Adherence score* | 1.02 ± 0.23 |
| Current or ex-smoker (%)† | 20 |
| Current or ex-alcohol use (%)† | 14 |
| Comorbid conditions/complications (%) | |
| Coronary heart disease | 21 |
| Stroke/transient ischemic attack | 8 |
| Hyperlipidemia | 55 |
| Hypertension | 66 |
| Retinopathy | 3 |
| Neuropathy | 5 |
| Nephropathy | 6 |
| Peripheral vascular disease | 8 |
| Taking ≥1 oral diabetes medications (%) | 54 |
| Primary care provider characteristics | |
| *n* | 55 |
| Year of graduation from medical school | 1,985 ± 9 |
| Provider sex (%) | |
| Male | 51 |
| Female | 42 |
| Missing | 7 |
| Provider specialty (%) | |
| Internal medicine | 41 |
| Family practice | 38 |
| Physician assistant, nurse practitioner, or resident | 15 |
| Missing | 6 |
| Visit characteristics | |
| *n* | 574 |
| A1C (absolute percentage points) | 9.5 ± 1.5 |
| Random serum glucose (mg/dl) | 215 ± 104 |
| Hyperglycemic visits to the primary care provider (over 24 months) | 5 ± 3 |
| Visit type (%) | |
| Routine visit | 66 |
| Urgent visit | 34 |
| <1 oral diabetes medication at time of visit (%) | 45 |
| Interval since the last visit (days)‡ | 52 (22–119) |
| Prescription side effects noted in the chart (%) | 6 |
| Patient counseled on diet (%) | 25 |
| Patient counseled on smoking (%) | 2 |
| Patient counseled on medication adherence (%) | 12 |

*Continued on facing page*

with intensification of diabetes medications in the partially adjusted model. Intensification was 31% less likely in African American compared with white patients, reaching borderline statistical significance in the partially adjusted model ($P = 0.08$). Income, sex, and medication adherence were not associated with intensification. Several other patient factors known to increase the risk of macrovascular or microvascular disease were not associated with intensification, including weight, alcohol use, smoking status, specific individual comorbidity such as coronary artery disease, 2-year mean LDL cholesterol and creatinine, and family history of heart disease (all $P > 0.05$; data not shown).

**Primary care provider factors.** No provider factors (including provider type, year of graduation from medical school, and sex) were significantly related to intensification of diabetes medications (all $P > 0.05$; data not shown).

**Visit-related factors.** Table 2 also shows associations between selected visit-related factors and intensification. Provider-patient dyads were about twice as likely to intensify treatment when the patients had moderate to severe hyperglycemia (A1C ≥9.0%) compared with mild to moderate hyperglycemia (A1C between 8.0 and 9.0%) (supplemental Fig. 1 [available in an online appendix at http://dx.doi.org/10.2337/dc08-1297]). Mean A1C values at the previous and current hyperglycemic visits were less strongly associated with intensification at the current visit (OR 2.31) than the A1C value from the current visit alone (1.83).

Other positive associations with the decision to intensify treatment included having a routine visit, taking more than one oral diabetes medication at the visit, receiving counseling on glucose control, having missed an appointment, or having a longer interval between visits. In contrast, provider-patient dyads were less likely to intensify oral diabetes medications if the A1C was measured >30 days before the visit and if the patient had more prior visits. Other visit factors including intensification at the prior hyperglycemic visit, diet and medication adherence counseling, referral to a diabetes-related specialist, and seeing one's regular provider were not associated with intensification.

## Final multivariable model

Many of the associations identified in the partially adjusted models persisted in the

**Table 1—*Continued***

| | |
|---|---|
| Patient counseled on glucose control (%) | 13 |
| Primary care provider type (%) | |
| Internal medicine | 58 |
| Family practice | 32 |
| Physician assistant, nurse practitioner, or resident | 8 |
| Missing | 2 |
| Patients seen by the regular provider at the visit (%) | 53 |

Data are means ± SD, %, or median (interquartile range). Suboptimally controlled glycemia was defined as an A1C ≥8%. *Mean adherence score of 1.0 means that the subject was 100% adherent. Subjects could have ≥100% adherence if they refilled their prescription early. †Current or ex-smoker defined as having smoking use listed on the problem list in the medical record. Current or ex-alcohol use defined as having alcohol use listed on the problem list in the medical record.

final multivariable model (Table 3). Race was the only patient factor that was marginally associated ($P = 0.05$) with intensification: provider-patient dyads appeared 41% less likely to intensify diabetes medications in African American patients compared with white patients, after adjustment for key confounders. Visit-related factors independently associated with treatment intensification were higher A1C, having a routine visit, having A1C measured within 30 days before the visit, having fewer prior visits, having a longer interval between visits, and taking more than one oral diabetes medication at the time of the visit. No provider characteristics were independently associated with intensification (data not shown); however, interprovider variance was 19% when assessed in a multilevel model. When we drop the 171 visits at which A1C was out of date (>3 months old), similar point estimates are seen, although some variables lose statistical significance because of lack of power.

**CONCLUSIONS** — In this highly adherent cohort of hyperglycemic adults with diabetes, failure to intensify treatment for diabetes was a common problem: primary care provider-patient dyads intensified treatment at only 22% of visits when blood glucose was elevated. Several visit-related factors and one potential patient-related factor appeared to influence the decision to intensify treatment. Provider-patient dyads were more likely to intensify treatment at routine visits and in patients with worse hyperglycemia, taking more oral diabetes medications, having fewer prior visits, or having longer intervals between visits but seemed less likely to intensify treatment in African American patients compared with white patients.

The main strength of our study was the availability of detail at the level of the individual clinic visit, made possible by standardized data abstraction from medical records linked to available electronic databases. Unlike most previous studies, this level of detail allowed us to investigate specific, modifiable visit-based factors.

Nonetheless, several limitations should be considered when these results are interpreted. First, because we used pharmacy records to identify intensification, we probably missed some episodes when the provider recommended intensification but the patient declined or significantly delayed filling the prescription. Although our patient population was otherwise highly adherent, the intensification rate of 22% that we observed was slightly lower than rates in other studies (ranging from 32 to 57%) (10,12,13,15,16). The lower-than-expected intensification rate may be due to several factors: *1*) delay by patients in filling a prescription by >1 month, *2*) differences in study design (i.e., length of time allowed for intensification such as 3 months–1 year after a visit) (12,16), and/or *3*) study population differences (10).

Second, our data were collected from 1999 to 2001 and may not be fully generalizable to the present day. Systems changes such as electronic medical records and increased awareness of clinical inertia, for instance, might alter intensification rates yet would be unlikely to affect the factors we found associated with intensification such as glycemic control and time since last measured A1C. In fact, physician rates of intensification were still low (33–43%) in two recently conducted studies (12,13). Also, our choice of patients from a single managed-care provider enhanced convenience at the possible expense of generalizability. However, our study sample was racially diverse and included men and women who saw multiple providers at 16 different clinic sites.

Third, many of the visit-based factors were based on medical record review. Although we attempted to evaluate all clinical variables at the visit that could affect intensification, we were unable to capture everything. If a physician did not record anything related to prescription side effects in the medical record, then we coded this as no side effects. Also, the regular provider was defined as the provider most frequently visited. This assumption may have led to an underestimation of regular provider visits if a patient switched providers. This potential for misclassification along with the low rate of intensification may have biased some of these items toward the null of no significant effects (i.e., type II error).

Fourth, we were unable to assess visits to endocrinologists, so we were unable to determine the effects of comanagement on intensification. However, this type of comanagement appears to be uncommon in our sample, because we could find only two new referrals to endocrinologists during the 2-year interval. Finally, we were unable to assess some relevant provider and patient characteristics such as knowledge, beliefs, and attitudes about diabetes therapy.

Since 1980, at least two studies have evaluated specific visit-based factors associated with intensification of diabetes medications (13,15). Both showed that worse glycemic control was associated with treatment intensification (13,15). Berlowitz et al. (15) reported several positive associations with intensification of diabetes medications, including longer intervals between visits, A1C being obtained within the last 3 months, patients taking insulin, and patients having received supplies for self-monitoring of blood glucose. Parchman et al. (13) reported an inverse association between an increased number of patient concerns and intensification. The results from these two studies are generally consistent with our findings. We also found higher intensification with worse glycemic control, more recent A1C measurements, and longer intervals between visits.

In contrast with previous studies, we had access to more data at the level of the individual visit. These data yielded several novel observations. Provider-patient dyads were more likely to intensify diabetes treatment at a routine visit and in patients with fewer prior visits but may be less likely to intensify treatment for Afri-

**Table 2—*Association of selected factors with intensification of oral diabetes medications in a cohort of 121 adults with suboptimally controlled glycemia***

| Factors | Intensification | No intensification | Univariate model* | Partially adjusted model* |
|---|---|---|---|---|
| *n* | 128 | 446 | | |
| Patient-related factors | | | | |
| Age (per 10 years) | | | 1.18 (0.91–1.53) | 1.42 (1.08–1.86) |
| Sex | | | | |
| Male | 72 (56) | 246 (55) | — | — |
| Female | 56 (44) | 200 (45) | 0.96 (0.64–1.44) | 0.84 (0.57–1.23) |
| Race | | | | |
| White | 71 (56) | 226 (51) | — | — |
| African American | 40 (31) | 174 (39) | 0.73 (0.47–1.14) | 0.69 (0.46–1.05) |
| Other/unknown | 17 (13) | 46 (10) | 1.17 (0.63–2.19) | 1.30 (0.70–2.40) |
| RUBs | | | | |
| Low | 47 (37) | 118 (26) | 1.61 (1.02–2.54) | 1.60 (1.00–2.57) |
| Medium | 47 (37) | 186 (42) | — | — |
| High | 34 (26) | 142 (32) | 0.95 (0.59–1.54) | 0.88 (0.55–1.42) |
| Annual household income (USD) | | | | |
| <40,000 | 33 (26) | 117 (26) | — | — |
| 40,000–65,000 | 66 (52) | 205 (46) | 1.13 (0.70–1.84) | 0.95 (0.57–1.61) |
| >65,000 | 28 (22) | 121 (27) | 0.81 (0.46–1.45) | 0.78 (0.42–1.43) |
| Unknown | 1 (<1) | 3 (<1) | — | — |
| Adherence score | | | | |
| <0.80 | 23 (16) | 72 (18) | — | — |
| ≥0.80 | 104 (82) | 367 (81) | 0.89 (0.53–1.52) | 0.92 (0.55–1.55) |
| Unknown | 1 (2) | 7 (1) | 0.44 (0.05–3.95) | 0.37 (0.05–2.88) |
| Visit-related factors | | | | |
| Number of oral diabetes medications | | | | |
| <2 medications | 39 (30) | 218 (49) | — | — |
| ≥2 medications | 89 (70) | 228 (51) | 2.27 (1.47–3.48) | 2.18 (1.42–3.35) |
| Visit type | | | | |
| Urgent | 21 (16) | 173 (39) | — | — |
| Routine | 107 (84) | 273 (61) | 3.24 (1.96–5.38) | 2.90 (1.72–4.90) |
| Regular provider seen at visit | | | | |
| No | 58 (45) | 213 (48) | — | — |
| Yes | 70 (55) | 233 (52) | 1.12 (0.75–1.67) | 1.12 (0.75–1.66) |
| Counseled patient on diet | | | | |
| No | 86 (67) | 342 (77) | — | — |
| Yes | 42 (33) | 104 (23) | 1.60 (1.04–2.46) | 1.54 (0.99–2.41) |
| Counseled patient on medication adherence | | | | |
| No | 110 (86) | 394 (88) | — | — |
| Yes | 18 (14) | 52 (12) | 1.24 (0.69–2.20) | 1.10 (0.61–2.00) |
| Counseled patient on glucose control | | | | |
| No | 103 (80) | 396 (89) | — | — |
| Yes | 25 (20) | 50 (11) | 1.93 (1.14–3.27) | 1.79 (1.03–3.09) |
| Nonadherent between visits | | | | |
| No | 108 (84) | 404 (91) | — | — |
| Yes | 20 (16) | 42 (9) | 1.78 (1.00–3.16) | 1.87 (1.01–3.45) |
| Referred to diabetes-related specialist at visit† | | | | |
| No | 100 (78) | 383 (86) | — | — |
| Yes | 28 (22) | 63 (14) | 1.70 (1.03–2.79) | 1.65 (0.98–2.76) |
| Random serum glucose | | | | |
| <200 mg/dl | 47 (37) | 212 (48) | — | — |
| ≥200 mg/dl | 69 (54) | 181 (41) | 1.71 (1.12–2.62) | 1.42 (0.89–2.27) |
| Unknown | 12 (9) | 53 (12) | 1.01 (0.50–2.06) | 1.38 (0.66–2.86) |
| A1C | | | | |
| <9%‡ | 42 (33) | 236 (53) | — | — |
| ≥9%‡ | 86 (67) | 210 (47) | 2.31 (1.52–3.51) | 2.44 (1.60–3.74) |

*Continued on facing page*

**Table 2—*Continued***

| Factors | Intensification | No intensification | Univariate model* | Partially adjusted model* |
|---|---|---|---|---|
| Time since last A1C | | | | |
| ≤30 days | 79 (62) | 183 (41) | — | — |
| >30 days | 49 (38) | 263 (59) | 0.43 (0.29–0.64) | 0.45 (0.30–0.68) |
| Time since last visit | | | | |
| ≤30 days | 34 (27) | 141 (31) | — | — |
| 31–90 days | 36 (28) | 164 (37) | 0.90 (0.54–1.51) | 0.91 (0.53–1.56) |
| >90 days | 46 (36) | 120 (27) | 1.57 (0.95–2.61) | 1.53 (0.90–2.60) |
| First visit | 12 (9) | 21 (5) | 2.34 (1.05–5.22) | 1.96 (0.84–1.56) |
| Number of prior visits (per visit) | | | 0.93 (0.88–0.98) | 0.95 (0.90–1.00) |
| Intensification at prior visit§ | | | | |
| No | 63 (49) | 292 (65) | — | — |
| Yes | 22 (17) | 82 (18) | 1.45 (0.85–2.47) | 1.30 (0.75–2.25) |
| First visit/unknown | 43 (34) | 72 (16) | 2.98 (1.86–4.76) | 2.88 (1.77–4.69) |

Data are *n* (%) or OR (95% CI). Suboptimally controlled glycemia was defined as A1C ≥8%. *The univariate model is a crude OR of intensification of oral diabetes medications, which takes into account clustering by patient. The partially adjusted model is the OR of intensification of oral diabetes medications adjusting for age, sex, race, and comorbidity using resource utilization bands and most recent A1C before the visit. †Referral to a diabetes-related specialist could include any of the following: neurologist, podiatrist, nutritionist, ophthalmologist, nephrologist, or endocrinologist. ‡% equals absolute percentage points. §This variable is intensification at the prior suboptimally controlled visit. Prior intensification status was unknown for the first visit and was highly correlated with the number of prior visits ($r^2 = -0.4$, $P < 0.001$). Therefore, the number of prior visits was used in the final model as the more representative variable.

can American compared with white patients. To our knowledge, no one has evaluated the effects of continuity of care on intensification of diabetes medications. Routine visits appear to allow providers to focus on chronic illnesses such as diabetes over other issues. The two previous visit-based studies were unable to evaluate African American race because their patient populations were mainly white and Hispanic, respectively. Two other studies with fewer visit-level data showed conflicting results with regard to race. Grant et al. (12) reported a nonsignificant 16% decreased risk of intensification, and Rodondi et al. (16) reported a statistically significant decreased proportion of intensification, although they were unable to adjust for key confounders such as patient adherence. To our knowledge, ours is the first study to evaluate race in addition to other modifiable visit-based factors and key confounders such as patient adherence. However, it is difficult to fully adjust for socioeconomic issues and patient adherence. For instance, if delays in filling prescriptions or decisions not to fill a prescription vary by race, then the racial disparity may be due to differences in patient adherence not captured by our method of accounting for patient adherence based strictly on prescription filling patterns. The 38% decreased odds of intensification in African Americans is especially disturbing given the higher diabetes disease burden in African Americans (22–24). Last, having more prior visits was inversely associated with intensification. This finding may be explained by competing demands. The patient with more frequent visits may be dealing with other issues besides hyperglycemia. In fact, we found significantly more intensification after longer intervals between visits.

**Table 3—*Factors independently associated with intensification of oral diabetes medications at 562 visits with suboptimally controlled glycemia***

| Characteristics ($n$ = 562 visits for 119 patients)* | Adjusted OR (95% CI)* | *P* value |
|---|---|---|
| Patient factors | | |
| Age (per 10 years) | 1.29 (0.94–1.78) | 0.11 |
| Male sex (vs. female) | 0.98 (0.62–1.55) | 0.93 |
| Race | | |
| African American (vs. white) | 0.59 (0.35–1.00) | 0.05 |
| Other (vs. white) | 1.17 (0.57–2.37) | 0.67 |
| Comorbidity measure (RUB) | | |
| Low comorbidity (vs. medium) | 1.17 (0.68–2.02) | 0.56 |
| High comorbidity (vs. medium) | 0.95 (0.56–1.62) | 0.85 |
| Income (per $1,000) | 0.99 (0.98–1.01) | 0.42 |
| Adherence score (≥80% vs. <80% adherent) | 0.89 (0.49–1.60) | 0.69 |
| Visit factors | | |
| A1C (≥9% vs. <9%) | 2.24 (1.40–3.58) | 0.001 |
| Time since last A1C (>30 vs. ≤30 days)† | 0.53 (0.34–0.85) | 0.008 |
| No. oral diabetes medications (≥2 vs. <2) | 2.82 (1.74–4.56) | <0.001 |
| Routine visit (vs. urgent) | 2.55 (1.49–4.38) | 0.001 |
| No. prior visits (per visit) | 0.94 (0.88–1.00) | 0.05 |
| Interval between visits (per 30 days) | 1.05 (1.00–1.10) | 0.05 |

Suboptimally controlled glycemia was defined as A1C ≥8%. *ORs have been adjusted for all other variables in the model and take into account clustering by the patient. Because of missing data, only 562 of the 574 visits (119 of 121 patients) have been analyzed in the final model. †Results change only minimally when we use time since last A1C as a continuous variable as opposed to a categorical variable.

Four studies may have evaluated the association of other patient characteristics with intensification and showed mixed results (12,13,15,16). Grant et al. (12) focused on evaluating the relationship between baseline patient adherence to initial diabetes medications and subsequent intensification in the face of hyperglycemia over the next year and found higher in-

tensification in the more adherent patients. We did not find an association between intensification and patient adherence, but our ability to detect an association was probably limited by the generally high adherence rate of our study sample. Berlowitz et al. (15) did not report finding any significant patient factor, but it is not clear which patient factors they evaluated. Parchman et al. (13) also reported no significant associations between patient demographic factors and intensification of glycemic medications. Rodondi et al. (16) reported a significant association between younger age, dyslipidemia, hypertension, and female sex and intensification of diabetes medications. The absolute differences were small (<5–10% between groups), and these differences were not supported in the other studies with smaller sample sizes. Conflicting results may be due to differences in adjustment, power to detect small differences, and/or differences in patient populations. We did not find a significant association between age, sex, comorbidity, and intensification once we adjusted for other important modifiable visit-based factors such as having a routine visit.

No prior studies evaluated the association of provider characteristics with intensification. However, a 1995 survey/interview subject to self-report bias assessed provider attitudes toward diabetes care and reported several potential barriers: lack of adequate time/resources, hypoglycemia concerns, lack of hyperglycemic symptoms, and treatment frustration (14). Although we were unable to evaluate provider attitude, knowledge, or beliefs, we found no associations between provider demographics and type with intensification. Interprovider variance in intensification was 19% in a multilevel model, and the specific components of this variance will need further investigation.

In summary, failure to intensify oral diabetes medications is a common problem in diabetes care. Failure is less likely at routine visits and in patients with worse hyperglycemia, fewer prior visits, longer intervals between visits, and use of more oral diabetes medications. However, failure may be more likely for African Americans. Quality improvement measures in type 2 diabetes should be focused on overcoming inertia, improving continuity of care, and reducing racial disparities.

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