

# Adherence to Laboratory Test Requests by Patients With Diabetes: The Diabetes Study of Northern California (DISTANCE)

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**L**aboratory testing of blood and urine provides essential objective evidence for making clinical decisions in diabetes care management.<sup>1</sup> Testing is important not only for routine monitoring but also for determining the necessity and consequences of treatment intensification, which may be needed to achieve clinical goals<sup>2,3</sup> or detect adverse drug reactions to prevent clinical harm.<sup>4</sup>

Routine tests of glycosylated hemoglobin (A1C), low-density lipoprotein cholesterol (LDL-C), serum creatinine (SC), and urinary albumin (UA) levels are recommended for patients with diabetes.<sup>5</sup> Rates of testing in diabetes care are routinely reported in journals<sup>6</sup> or published by health plans as quality measures (eg, Healthcare Effectiveness Data and Information Set), with variations and disparities noted. For example, Schmittiel et al<sup>7</sup> found that measurement of A1C and LDL-C levels within 6 months after treatment intensification occurred less than half the time. Racial/ethnic disparities in A1C testing have also been reported in population-based studies,<sup>8,9</sup> although differences are greatly attenuated or absent in managed care settings with fully insured patients.<sup>10</sup> Nonadherence to laboratory test requests could contribute to higher rates of poor diabetes control among vulnerable patient populations. However, it is unknown whether disparities in rates of testing are attributable to variations in ordering by providers or to differences in laboratory test attendance by patients after a test is ordered.

This article examines adherence to clinical laboratory test requests. We calculated rates of laboratory test attendance by patients with diabetes after provider referral in an electronic medical record (EMR) system. We hypothesized that a small segment of the patient population fails to fulfill laboratory test orders and that nonfulfillment would not vary by type of test. We further hypothesized that vulnerable subgroups (eg, racial/ethnic minority groups or those with less education, lower income, limited English fluency, or inadequate health literacy) would be at highest risk of nonutilization because of latent barriers (eg, lack of transportation or inadequate understanding

of the clinical importance of laboratory tests), as well as subgroups with low trust in their provider or poor patient-provider communication.

**Objectives:** To estimate rates and predictors of clinical laboratory test completion by patients with diabetes after provider referral.

**Study Design:** Prospective cohort study.

**Methods:** Among 186,306 adult members with diabetes in Kaiser Permanente Northern California, we searched the electronic medical records (July 1, 2008, to June 30, 2009) of each patient for the first outpatient order to obtain the following laboratory tests commonly used to measure risk factor control or adverse effects of pharmacotherapy: levels of glycosylated hemoglobin, low-density lipoprotein cholesterol, serum creatinine, urinary albumin, or creatine kinase (the latter only among persons using statins). We measured laboratory test attendance as completion of an order (including time to results) within 6 months of the referral date and looked for variations by subgroups.

**Results:** Laboratory test attendance ranged from 86% for glycosylated hemoglobin level to 73% for serum creatinine level. Time to laboratory test attendance was a median of 7 to 11 days and a mean of 25 to 30 days. Laboratory test attendance was more likely for women and older patients or for orders after a face-to-face provider visit and was less likely for orders by a pharmacist. However, most variations (even by laboratory copayment) were small or not clinically substantive. In subanalyses, we observed no clinically significant variations by race/ethnicity, socioeconomic status, trust in provider, or patient-provider communication and found no association with depressive symptoms, health literacy, or English fluency.

**Conclusion:** The fact that 1 in 7 patients did not complete laboratory tests within 6 months of the provider referral may help explain why healthcare services seem to fall short of optimal diabetes care.

(*Am J Manag Care.* 2011;17(5):339-344)

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### Take-Away Points

One in 7 patients in this diabetes registry cohort did not complete laboratory tests within 6 months after provider referral; this may help explain why healthcare services seem to fall short of optimal diabetes care.

■ The median time from referral to laboratory test attendance was at least 1 week, and the mean time was almost 1 month.

■ No substantive race/ethnicity or other social differences in laboratory test attendance were observed; this suggests that disparities in rates of testing that have been observed among population-based studies may be attributable to variations in referral rather than patient adherence.

fillment. Each patient could be counted in more than 1 laboratory test cohort.

Our outcome of interest was patient laboratory test attendance at a Kaiser laboratory within 6 months of each identified test order. To measure laboratory test attendance, we identified the first test result after a given order and used the date that the specimen (blood or urine) was collected as the attendance

## METHODS

This study was conducted among patients in the diabetes registry at Kaiser Permanente Northern California (hereafter Kaiser). We identified a cohort of 186,306 adult patients with diabetes having continuous health plan membership from July 1, 2008, to December 31, 2009. At Kaiser, electronic order entry for laboratory tests (a component of the EMR) facilitates analysis of patient adherence to laboratory test orders by tracking separately (1) the provider's order to the laboratory for each test and (2) the patient's adherence to the provider's request to attend the laboratory and provide specimens. Kaiser is a closed system, laboratory test orders are not transferred outside of Kaiser, and paper laboratory test slips are no longer used, so we were able to accurately capture the outcome for 100% of the cohort. Patients merely go to any Kaiser laboratory, where the laboratory test order awaits, and the ordered test will be conducted on the specimens provided.

In this cohort, we searched the EMRs of each patient for the first occurrence between July 1, 2008, and June 30, 2009, of an outpatient laboratory test order for the following tests of interest: levels of A1C, LDL-C, SC, or UA. To contrast routine diabetes tests with a test that might be more urgent, we also tracked creatine kinase (CK) testing among patients using statins (dispensed within the previous 6 months); this test is often ordered to detect an asymptomatic adverse effect of a medication or, more commonly in this clinical environment, to diagnose a possible adverse reaction among symptomatic patients.

We used individual laboratory test orders and laboratory panel orders (eg, diabetes panel and lipid panel) to capture orders for each test. We excluded standing orders (estimated to be about 5% of the A1C test cohort), which cannot be easily ascertained because they do not appear as new orders in the system; we excluded any order with an expected completion date (estimated to be 9% of the A1C test cohort), for which the provider has entered a future date for order completion and presumably has requested the patient to attend the laboratory around that future date (ie, not immediately). Therefore, all included orders were eligible for immediate ful-

fillment. We censored follow-up at 6 months after the order date, although some orders may be valid for up to 1 year; because we do not know when the provider intended that the patient would attend the laboratory, we assumed that 6 months was a generous window for completion. Therefore, laboratory test attendance was affirmative if a result was entered within 6 months. We calculated laboratory test attendance as a percentage of laboratory test orders that were completed and counted the number of days between order and attendance.

We evaluated differences by sex, age, type of provider and visit (face to face vs other), and laboratory copayment. In sub-analyses of patients who had participated in the 2005-2006 Diabetes Study of Northern California (DISTANCE) survey ( $n = 20,188$ ),<sup>11</sup> we further evaluated differences by race/ethnicity, annual income, educational attainment, employment status, depressive symptoms,<sup>12</sup> health literacy,<sup>13</sup> English fluency, trust in provider,<sup>14</sup> and patient-provider communication (a patient reports that the provider explains things in a way the patient can understand).<sup>15</sup> This study was approved by the Institutional Review Board of the Kaiser Foundation Research Institute.

## RESULTS

Laboratory test attendance ranged from a high of 86% for A1C (138,017 tests) to a low of 73% for SC (139,962 tests) (Table 1). Time to laboratory test attendance was a median of 7 to 11 days and a mean of 25 to 30 days. Laboratory test attendance for CK, which we assumed might have some urgency, had a pattern identical to that for A1C. Survival curves of open laboratory test orders for each test were largely indistinguishable (data not shown).

In unadjusted analyses, women were slightly more likely than men to attend laboratory testing, but the male-female differences were minimal (<2% for any laboratory test) ( $P < .05$ ). Older patients ( $\geq 65$  years) were more likely to attend laboratory testing than younger patients (age range, 19-34 years) ( $P < .001$ ); the rate difference was 12% to 17%. Orders resulting from face-to-face visits were more likely to result in laboratory test attendance ( $P < .05$ ), although differences

## Diabetes Laboratory Test Adherence

**Table 1.** Laboratory Test Attendance (July 1, 2008, to June 30, 2009) Among 186,306 Adult Patients With Diabetes

Variable	Laboratory Test Order				
	Glycosylated Hemoglobin	Low-Density Lipoprotein Cholesterol	Serum Creatinine	Urinary Albumin	Creatine Kinase
<b>With ≥1 order during 12-mo window, No.</b>	138,017	137,685	139,962	103,386	20,136
<b>Attended laboratory within 6 mo of order, No. (%)</b>	118,957 (86.2)	114,872 (83.4)	102,699 (73.4)	87,159 (84.3)	16,929 (84.1)
<b>Time elapsed from order to laboratory test completion, d</b>					
Median	9	11	9	7	9
Mean (SD)	28 (39)	29 (40)	30 (43)	25 (38)	27 (38)
<b>Laboratory Test Completion Rates, No. (%)</b>					
<b>Sex</b>					
Female	57,727 (86.5)	55,410 (83.6)	50,150 (74.1)	43,462 (84.9)	8382 (84.7)
Male	61,230 (85.9) <sup>a</sup>	59,462 (83.3)	52,549 (72.7) <sup>a</sup>	43,697 (83.7) <sup>a</sup>	8547 (83.5) <sup>b</sup>
<b>Age, y</b>					
19-34	2566 (73.1)	2294 (67.3)	2075 (61.7)	2067 (71.4)	123 (75.0)
35-50	18,704 (79.3)	17,909 (76.0)	15,018 (65.8)	14,163 (77.3)	2103 (76.8)
51-64	43,965 (84.9)	42,655 (82.4)	36,855 (71.4)	32,674 (83.0)	6240 (83.0)
≥65	53,722 (90.8) <sup>a</sup>	52,014 (88.2) <sup>a</sup>	48,751 (78.4) <sup>a</sup>	38,255 (89.4) <sup>a</sup>	8463 (87.2) <sup>a</sup>
<b>Visit type</b>					
Face to face	62,115 (89.1)	57,299 (86.0)	57,227 (76.4)	45,063 (87.9)	9833 (84.7)
Other	56,842 (83.2) <sup>a</sup>	57,573 (81.1) <sup>a</sup>	45,472 (69.9) <sup>a</sup>	42,096 (80.8) <sup>a</sup>	7096 (83.2) <sup>b</sup>
<b>Provider type</b>					
Physician	110,387 (86.4)	106,419 (83.6)	95,981 (73.6)	81,766 (84.6)	15,837 (84.1)
Pharmacist	3799 (79.3)	4445 (78.8)	2962 (66.2)	2218 (73.2)	639 (83.8)
Nurse	4413 (86.6)	3695 (83.3)	3370 (73.8)	2881 (84.2)	439 (82.8)
Other	358 (85.8) <sup>a</sup>	313 (84.4) <sup>a</sup>	386 (82.1) <sup>a</sup>	294 (85.2) <sup>a</sup>	14 (93.3)
<b>Laboratory copayment<sup>c</sup></b>					
No	83,592 (86.2)	80,363 (83.3)	71,817 (73.5)	61,316 (84.2)	11,948 (84.5)
Yes	35,245 (86.2)	34,384 (83.7)	30,781 (73.2)	25,756 (84.6)	4966 (83.1) <sup>b</sup>

<sup>a</sup> $P < .001$ ,  $\chi^2$  test.

<sup>b</sup> $P < .05$ ,  $\chi^2$  test.

<sup>c</sup>Cell totals may not sum to column totals because of missing laboratory copayment data.

were small (6%-13%). Orders entered by a pharmacist were less likely to be completed (1%-7% lower). There was no evidence that laboratory copayments were a significant barrier to laboratory test attendance.

In subanalyses among patients who had completed the DISTANCE survey, no laboratory test completion rates differed substantively across any of the factors we considered (<7% difference for any test), although some differences reached statistical significance (eg, variations in LDL-C test-

ing rates were statistically significant, with the lowest rates among persons of white race/ethnicity) (Table 2). Some social patterns were not as predicted (eg, greater educational attainment, higher annual income, and employment had some association with lower laboratory test attendance), but no differences were large enough to be considered clinically substantive. We observed no statistically significant differences in laboratory test attendance among patients by depressive symptoms, health literacy, or English fluency.

■ **Table 2.** Subanalyses Among 20,188 Patients Who Completed the Diabetes Study of Northern California (DISTANCE) Survey

Variable	Laboratory Test Order				
	Glycosylated Hemoglobin	Low-Density Lipoprotein Cholesterol	Serum Creatinine	Urinary Albumin	Creatine Kinase
<b>With ≥1 order during 12 mo-window, No.</b>	12,456	12,171	12,345	9294	1866
<b>Attended laboratory within 6 mo of order, No. (%)</b>	10,925 (87.7)	10,373 (85.2)	9180 (74.4)	8029 (86.4)	1588 (85.1)
<b>Laboratory Test Completion Rates, No. (%)<sup>a</sup></b>					
<b>Race/ethnicity</b>					
African American	2019 (88.4)	1880 (85.8)	1698 (76.0)	1427 (86.8)	299 (87.7)
Asian	1352 (89.1)	1277 (87.0)	1099 (73.6)	922 (87.5)	191 (84.5)
White	2230 (85.8)	2127 (83.1)	1938 (73.7)	1611 (83.7)	310 (84.0)
Filipino	1416 (88.9)	1346 (87.1)	1159 (75.0)	1027 (88.1)	215 (84.0)
Latino	1971 (87.6)	1894 (85.2)	1662 (74.3)	1564 (86.6)	286 (85.6)
Multiracial	1147 (87.4)	1088 (84.2)	981 (74.4)	884 (87.6)	166 (84.3)
Other or unknown	790 (88.0) <sup>c</sup>	761 (85.3) <sup>c</sup>	643 (72.5)	594 (86.0) <sup>c</sup>	121 (84.6)
<b>Annual income, \$</b>					
<15,000	925 (87.8)	873 (85.8)	803 (76.5)	661 (86.5)	139 (88.0)
15,000 to <50,000	3397 (88.7)	3213 (85.8)	2877 (75.3)	2500 (87.8)	509 (86.4)
50,000 to <100,000	3291 (87.1)	3144 (84.8)	2790 (74.5)	2457 (85.7)	470 (84.2)
>100,000	1644 (87.0)	1558 (84.3)	1333 (72.2) <sup>c</sup>	1191 (84.8) <sup>c</sup>	235 (83.3)
<b>Educational attainment</b>					
<High school	1695 (88.5)	1645 (86.8)	1420 (74.2)	1314 (88.4)	254 (87.0)
High school or GED	3001 (87.0)	2832 (84.1)	2574 (74.8)	2181 (86.0)	404 (84.5)
Some college	2713 (88.3)	2551 (86.0)	2285 (75.0)	2005 (86.6)	404 (85.4)
College graduate	3273 (87.4)	3115 (84.6) <sup>c</sup>	2700 (73.5)	2359 (85.5)	485 (84.5)
<b>Employed</b>					
Yes	4955 (85.7)	4706 (83.4)	3712 (84.8)	4052 (72.0)	670 (83.5)
No, retired, homemaker, student, other	4344 (89.9) <sup>b</sup>	4119 (87.1) <sup>b</sup>	3149 (88.5) <sup>b</sup>	3754 (76.7) <sup>b</sup>	686 (86.7)
<b>Depressive symptoms<sup>d</sup></b>					
None	4408 (87.7)	4193 (85.9)	3647 (73.4)	3195 (86.3)	608 (86.5)
Mild	1555 (87.4)	1468 (83.9)	1317 (74.0)	1159 (87.0)	248 (82.9)
Moderate or severe	866 (87.6)	816 (84.4)	741 (77.1)	648 (87.2)	137 (85.1)
<b>Health literacy<sup>e</sup></b>					
Yes	4480 (87.4)	4246 (84.9)	3766 (74.2)	3278 (86.4)	641 (85.0)
No	3175 (88.7)	3007 (86.4)	2656 (75.0)	2337 (87.5)	485 (85.4)
<b>English fluency<sup>f</sup></b>					
Yes	6922 (88.1)	6542 (85.6)	5811 (74.6)	5066 (87.0)	1011 (84.9)
No	592 (86.8)	572 (85.9)	479 (73.7)	440 (86.8)	92 (87.6)
<b>Trust in provider<sup>g</sup></b>					
Yes	5745 (88.7)	5460 (86.3)	4840 (75.3)	4221 (88.1)	884 (85.7)
No	2350 (88.1)	2221 (85.6)	1979 (75.4)	1692 (85.4) <sup>c</sup>	329 (86.6)
<b>Provider explains things clearly<sup>h</sup></b>					
Yes	6712 (88.2)	6377 (85.8)	5623 (74.6)	4931 (87.4)	1018 (85.3)
No	1320 (89.2)	1246 (86.8)	1130 (77.4) <sup>c</sup>	958 (86.8)	181 (87.0)

GED indicates general equivalency diploma.

<sup>a</sup>Cell totals may not sum to column totals because of missing survey responses.

<sup>b</sup> $P < .001$ ,  $\chi^2$  test.

<sup>c</sup> $P < .05$ ,  $\chi^2$  test.

<sup>d</sup>Based on PRIME-MD Patient Health Questionnaire 8 score of none (0-4), mild (5-9), or moderate or severe (>9).<sup>12</sup>

<sup>e</sup>Patient never or rarely needed help understanding written health materials.<sup>13</sup>

<sup>f</sup>Patient never had difficulty getting healthcare because of limited English proficiency.

<sup>g</sup>Patient always felt trust and confidence in the provider.<sup>14</sup>

<sup>h</sup>Patient felt that the provider usually or always explains things clearly.<sup>15</sup>

## DISCUSSION

To our knowledge, this is the first large study to use EMR-based laboratory test orders to estimate rates of laboratory test attendance by patients who are given a provider referral. A significant proportion of patients (14%-27%) did not attend the laboratory within 6 months, and the time to laboratory test attendance varied little by test, even when comparing routine A1C tests with potentially urgent CK tests. We observed no substantive social disparities in laboratory test attendance. Although we cannot generalize these results that were observed in a managed care setting to other populations, our findings suggest that any disparities in rates of clinical testing may be attributable to variations in referrals rather than patient adherence. Much has been made of the concept of clinical inertia, the finding that medication changes are not made in a prompt manner, but delays in attending laboratory testing represent another barrier to timely care. Clinical action cannot be taken on laboratory tests that have not been completed.

We observed that older patients attended laboratory testing at higher rates than younger patients, perhaps in part because older patients have more appointments (possibly because of advanced disease) and more opportunities to attend the laboratory when they are at the medical center or have fewer competing demands (especially among those who are not employed). Patients were more likely to attend the laboratory if the test order was entered during a face-to-face visit, suggesting that the provider may have engaged in shared decision making or emphasized the importance of the laboratory test. These findings imply that primary care providers have an important role in increasing patient adherence to laboratory testing for chronic disease care.

Our hypothesis that the study results would not vary by type of laboratory test was largely correct. However, our other hypotheses about variations by socioeconomic status were not supported; such differences were not substantive and often reflected laboratory test attendance contrary to our prediction (eg, higher socioeconomic status was associated with lower laboratory test attendance). Moreover, we observed no substantive or statistically significant differences by patients' depressive symptoms, health literacy, or English fluency.

Kaiser reported annual testing rates in 2009 among commercial and Medicare members for A1C of 91.4% and 95.1%, respectively, and for LDL-C of 89.2% and 94.5%, respectively.<sup>16</sup> This indicates that a high proportion of patients in this health plan attend the laboratory within 1 year. It is unclear how providers handle the lapse in data for those who fail to attend the laboratory. Of greater concern are patients who repeatedly fail to complete requested laboratory tests. In the Translating Research Into Action for Diabetes (TRIAD) study, Gregg et al<sup>17</sup>

reported that 11.6% of patients had persistent gaps ( $\geq 3$  years) for lipid testing; the rate was 4.2% for A1C level. Consistent with our findings, race/ethnicity, educational attainment, trust in provider, and depressive symptoms were not associated with persistent gaps in laboratory testing; however, income was associated with laboratory attendance.

This study has some limitations. Not all laboratory test orders are accounted for, as we excluded standing orders and orders with expected dates; therefore, we cannot make any conclusions about rates of ordering laboratory tests but only about rates of completing specific laboratory tests. Furthermore, when a patient goes to the laboratory, all open orders should be completed. However, we do not know which test, if any, motivated the patient to attend or to what extent the patient was aware of outstanding orders. With electronic ordering, there is no paper laboratory test order for the patient to carry as a reminder (or to lose). Therefore, we suspect that patients may go to the laboratory when they know there are 1 or more open orders but not necessarily to fulfill an order for a specific test. We do not know what instructions, if any, the provider may have given the patient about when to go to the laboratory, so we cannot make any conclusions about how quickly the patients attended. We do not know if patients in this study completed the ordered laboratory work after the 6-month observation window; therefore, a portion of laboratory tests considered not completed could have been later completed, albeit in an untimely fashion. In subanalyses among patients contacted for the DISTANCE survey, nonresponse bias may be present, but the overall lack of variations minimizes this concern.

In conclusion, most patients with diabetes attended the laboratory for commonly ordered tests within 6 months of a provider referral. The fact that 1 in 7 patients did not complete laboratory tests within 6 months of the provider referral may help explain why healthcare services seem to fall short of optimal diabetes care. Understanding the frequency with which laboratory test orders are fulfilled, by whom, and why would facilitate interventions and quality improvement efforts to maximize the effectiveness of these referrals; the results herein suggest new avenues for innovative research focused on overcoming barriers to optimal diabetes care. Further research is needed to understand the clinical implications of uncompleted laboratory tests.

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**Funding Source:** This work was supported by grants RC1DK086178, R01DK080726, and R01DK65664 from the National Institute of Diabetes and Digestive and Kidney Diseases. The Diabetes Research and Training Cen-

ter was also supported by grant P60DK20595 from the National Institutes of Health.

**Author Disclosures:** The authors (HHM, MMP, US, DS, AF, NEA, ASA, AJK) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (HHM, US, ASA, AJK); acquisition of data (HHM, MMP, ASA, AJK); analysis and interpretation of data (HHM, MMP, US, DS, AF); drafting of the manuscript (HHM, AF, NEA); critical revision of the manuscript for important intellectual content (MMP, US, DS, NEA, ASA, AJK); statistical analysis (MMP); obtaining funding (HHM, DS, ASA, AJK); administrative, technical, or logistic support (HHM, NEA); and supervision (AJK).

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