Population Health Approach for Diabetic Patients With Poor A1C Control

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Background: Diabetes is frequently monitored as part of quality programs and initiatives. The glycated hemoglobin (A1C) test and corresponding values are often used as quality metrics, and patients with values of 9.0% or above (9+) tend to utilize intensive resources. However, this strategy may be missing more profound opportunities to improve quality.

Objectives: To analyze A1C outcomes in 2 ways: (1) year over year for patients identified as diabetic and (2) from test to test.

Methods: This study was conducted using data on more than 23,000 patients identified as having diabetes and included A1C laboratory results extracted from electronic medical records.

Results: The percentage of patients with poorly controlled diabetes (9+) is increasing annually, but there is sizable turnover within the population—meaning that new uncontrolled patients replace those whose outcomes improve. More than half (57.5%) of patients have their first 9+ score on their first test. And for those with a prior 9+ result, only 16.8% have 3 consecutive 9+ scores after their initial 9+ test. For all patients, the longer the interval between tests, the greater the probability that the next test result will be 9+.

Conclusion: Instead of focusing resources only on the highly dynamic and relatively small subpopulation of patients with 9+ scores, a better option may be ensuring that all patients get regular testing according to appropriate protocols. This total population-based approach would engage all diabetic patients inside and outside practice walls to optimize provider ability to impact health outcomes.

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For author information and disclosures, see end of text.

Diabetes is a common chronic condition and one of the leading causes of disability and death in the United States. It is also one of the most costly conditions because of serious complications that result in hospitalization and intensive use of resources.[1,2] The American Diabetes Association has identified glycated hemoglobin (A1C) standards that are tracked by the National Committee on Quality Assurance. Among these recommendations are (1) that all diabetic patients should have the A1C test completed at least 2 to 4 times per year depending on the status of the disease and (2) that the A1C value should be less than 7.0%.[1-5]

Both the Diabetes Control and Complications Trial and the United Kingdom Prospective Diabetes Study showed that if people with diabetes can lower their A1C number by any amount, they will likely reduce their risk of developing complications.[6-8] It has also been shown that a 1-point reduction in A1C lowers the risk of complications such as eye, kidney, and nerve disease by 40% and that 40% of the cost of diabetes is associated with the cohort whose A1C values are 9.0% or above (9+).[3,9] The research consistently shows that effective glycemic control is important to the health and well-being of people with diabetes. Accordingly, the national meaningful use initiative and many pay-for-performance, patient-centered medical home, and accountable care organization arrangements explicitly utilize the percentage of patients with 9+ A1C results as a key quality metric linked to financial incentives.

However, the results of this study indicate that the population of patients at risk for a 9+ score is much larger than the current populations of patients with a 9+ score. In effect, the results suggest that a broader population-based approach—beyond just focusing on the current 9+ cohort—will be required to prevent individual patients from migrating to the 9+ threshold and reduce the overall rate of 9+ patients.

METHODS

This study utilized a retrospective design to analyze A1C results for a diabetes population. It relied on billing and electronic medical record (EMR) data from several large, multispecialty group practices located in the continental United States. Three distinct periods were evaluated: year 1 (March 2009 to

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Based on the findings of this study, provider organizations need to develop 2 critical population health management core competencies to impact overall rates of poor diabetes control. Organizations must have the ability to:

- Identify and monitor the health status of the entire population, not just those patients whose glycated hemoglobin score indicates poor control.
- Proactively reach out to their entire population between office visits so that patients waiting too long to get retested are motivated to have that testing done earlier.

February 2010); year 2 (March 2010 to February 2011); and year 3 (March 2011 to February 2012).

Patients were identified as having diabetes using a modified Healthcare Effectiveness Data and Information Set approach, utilizing billing data extracted from practice management systems. The patient identification algorithm required 2 or more office visit encounters on different days with a diagnosis code of diabetes over a 2-year time period. Each practice required 4 years of billing data from March 2008 to February 2012 to identify patients independently for all 3 study years.

The A1C laboratory results were extracted from a variety of EMR systems. We required that practices have 4 years of laboratory results from March 2008 to February 2012. Multiple custom A1C result codes were utilized by individual practices. After the data were extracted from the EMRs, the individual A1C codes from all practices were mapped to a common coding structure to allow aggregation of the data.

We analyzed A1C outcomes in 2 ways: (1) year over year for patients identified as diabetic and (2) from test to test. For the former, the last test of the individual study year was used as the patient's A1C value: a "last-test-of-the-year" approach. Most reporting agencies evaluate and report the last score of the reporting period.[3,4] For each year in the study, we grouped the A1C results into 6 bands corresponding to conventional guidelines and standards of care: <6, 6 to <7, 7 to <8, 8 to <9, 9+, and no test.[2,3]

In evaluating A1C results leading up to and after a 9+ score, we utilized a test-to-test approach whereby all tests were considered, not just the last test of the year. Overall, there were 181,227 total A1C tests during the time period from March 2008 to February 2012. To control for tests with potential data entry errors, we removed any test for which the result was less than 3 (36 tests) or greater than or equal to 20 (34 tests).

We studied 4 primary outcomes related to test-to-test A1C results: (1) persistence of a 9+ result after an initial 9+ test, (2) the first test number on which 9+ results occurred, (3) how long patients waited between A1C tests, and (4) how length of time between all tests affected future results.

Both the persistence and first 9+ analyses depended on identifying the initial 9+ result. To calculate this, we chronologically ordered all A1C tests by patient using laboratory data from March 2008 to February 2012 and assigned a number (ie, 1, 2, 3, and so on) to each consecutive test. As the A1C test measures glucose levels over a 3-month period, we removed tests that occurred within 30 days of the next test (see the Discussion section). This step removed 11,149 tests (6.2% of the total A1C tests).

For the persistence analysis, we measured the percentage of patients with consecutive 9+ results after an initial result in the 3-year study period, requiring that patients have at least 3 subsequent tests after their initial 9+ result. In evaluating when the first 9+ test occurred, we analyzed both the 3-year study time period and the full 4-year time period for which we had laboratory results.

In analyzing time between tests, we first identified the most recent A1C test for all patients identified as diabetic during the last 2 years of the study period. In total, 23,381 patients were identified in all 3 years of the study and 21,656 in the last 2 years. We then calculated the number of days between the most recent A1C test and February 28, 2012 (the end of the study period). In this analysis, the cutoff for a late test for patients with a most recent A1C value of less than 8 was 180 days, and for patients with a most recent value of 8 or more, it was 90 days.

Finally, to analyze how time between tests related to future 9+ A1C results, we utilized a logistic regression analysis to measure the odds of having a 9+ result on the next test for 2 groups of patients: those tested regularly and a reference group tested 90 or more days late. We allowed that regular testers could be tested within 30 days of the cutoff dates described above, and narrowed the definition of late testers to include only those who were tested 90 or more days after their late test cutoff. Again, we removed tests occurring within 30 days of the last test.

RESULTS

Last Test of the Year

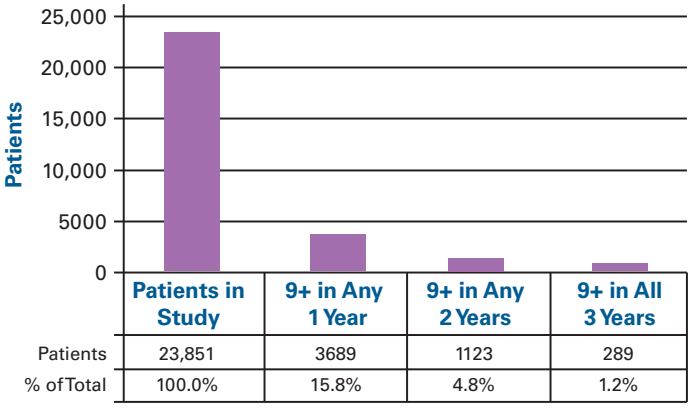
A1C Trends for All Patients. Table 1 shows A1C results for all patients identified as having diabetes in years 1, 2, and 3. Although the percentage with no test dropped from 19.1% in year 1 to 18.4% in year 3, the percentage of patients with poorly controlled A1C (9+) increased annually from 8.8% to 10.5%. A deeper dive into the data illustrated that uncontrolled A1C levels were unlikely to remain uncontrolled year over year. Out of all 23,381 study patients, just 1.2% had a 9+ score in all 3 years (Figure 1).

Table 1. Three-Year A1C Trends (2009 to 2012)

	Year 1 (2009-2010)		Year 2 (2010-2011)		Year 3 (2011-2012)	
A1C Value	**Patients**	**% of Total**	**Patients**	**% of Total**	**Patients**	**% of Total**
<6	1859	11.5	2044	11.6	1894	9.7
6-<7	5604	34.5	5944	33.8	6400	32.8
7-<8	2981	18.4	3207	18.2	3835	19.6
8-<9	1266	7.8	1448	8.2	1771	9.1
≥9	1423	8.8	1634	9.3	2044	10.5
No test	3092	19.1	3321	18.9	3589	18.4
Total	**16,225**	**100.0**	**17,598**	**100.0**	**19,533**	**100.0**

A1C indicates glycated hemoglobin.

Figure 1. Patients With A1C Results of 9.0% or Above in 1, 2, or All 3 Test Years



A1C indicates glycated hemoglobin.

The next sections of this study drill down further into the characteristics of the population with uncontrolled A1C levels.

Where Were the 9+ Patients the Year Before? The turnover among patients with 9+ A1C scores is further illustrated in **Figures 2A** and **2B,** which track the prior year results of patients with 9+ scores using the last-test-of-the-year methodology. In both years 2 and 3, 28% to 30% of patients with a 9+ result had *no test* the prior year and another 28% to 29% of the patients graduated up to the 9+ group from the 7 to 9 test bands. The population with uncontrolled A1C levels was evolving and dynamic, not a subset that could be managed in isolation from the rest of diabetic population.

Test-to-Test Results

How Persistent Was a 9+ Result From Test to Test? **Figure 3** illustrates that patients were not likely to remain at 9+ from test to test, instead migrating out of the 9+ band. For patients with at least 3 consecutive tests after the first 9+ result, 40.4% had a 9+ score on the following test. By the third test after the first 9+ result, only 16.8% remained. In short, patients rapidly progressed out of the 9+ band after the first result indicating uncontrolled A1C.

When Did Patients Have Their Initial 9+ Result? The majority of patients with a 9+ score had the first uncontrolled score on their first test. **Figure 4A** shows the results for patients whose first test (with any result) occurred during the full 4 years of available laboratory data. Almost 60% of patients with a 9+ result had their first 9+ score on their first test. **Figure 4B** shows that the percentage grew higher still when only patients who had a first test during the 3-year study period were considered: 75% had their first 9+ score on their first test. The majority of patients with uncontrolled diabetes did not have an A1C test until their A1C levels were already uncontrolled.

How Long Did Patients Wait Between Tests? For all patients identified as diabetic in the last 2 study years, **Figure 5** shows the percentage that were more than 1 day, 30 days, and 90 days late for their next test. Of the 21,656 total patients, 44.0% were 1 or more days late for their next test and 30.2% were more than 90 days late. These results indicate that there is considerable opportunity to ensure that patients get regular A1C tests.

Figure 2A. Patients in Year 2 With Prior Year A1C Scores of 9.0% or Above (n = 1634)

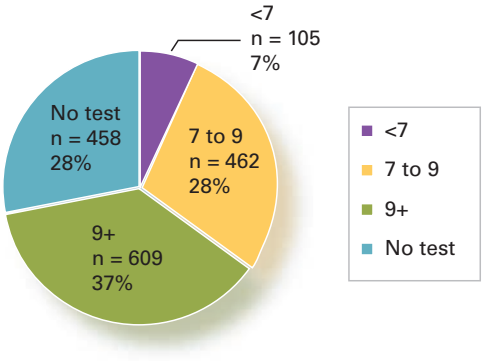
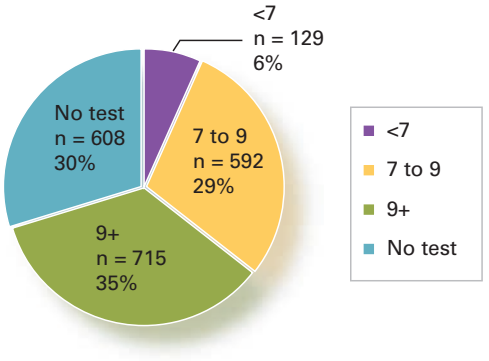
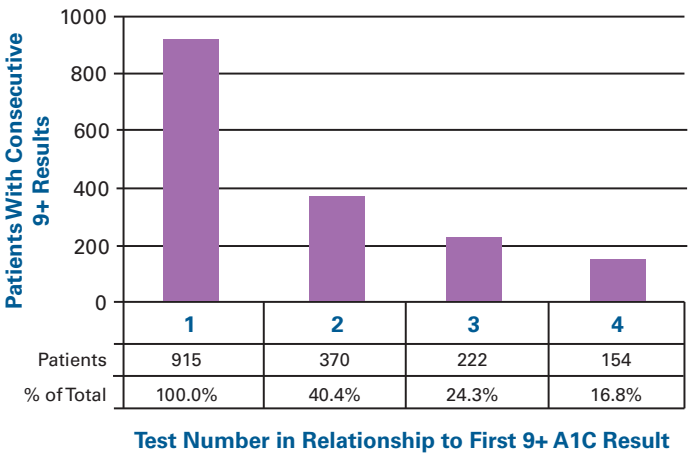


Figure 2B. Patients in Year 3 With Prior Year A1C Scores of 9.0% or Above



A1C indicates glycated hemoglobin.

Figure 3. Consecutive A1C Scores of 9.0% or Above in Patients With First Test Between March 2009 and February 2012 and at Least 4 Consecutive Tests



A1C indicates glycated hemoglobin.

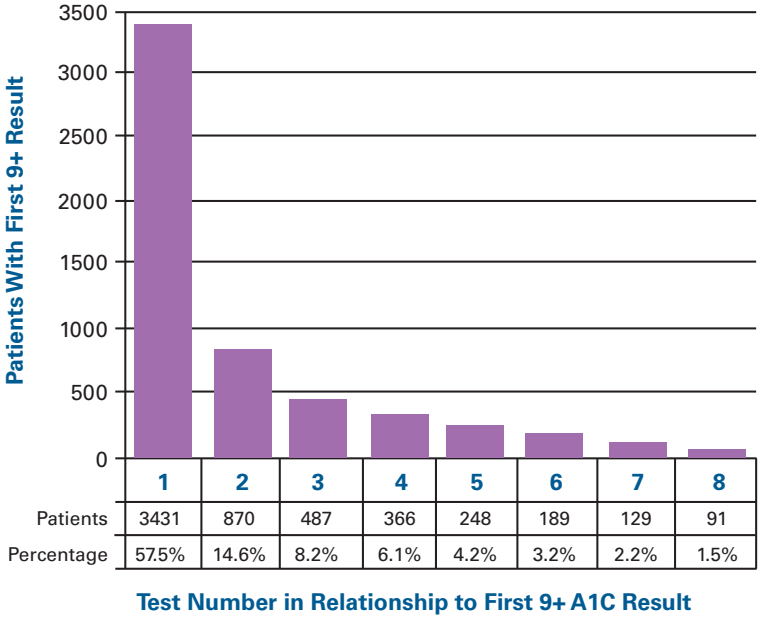
Were Late Testers More Likely to Have 9+ Results? Table 2 shows that in any study year, patients who were 90 or more days late for their next test were significantly more likely to a have a 9+ result than those tested regularly. In fact, the lower the prior test band, the higher the probability of having a 9+ result on the next test. Late testers with an A1C score of 6 to 7 on their last test were almost 5 times as likely to have a 9+ score on their next test as the reference group of regular testers. In comparison, late testers with an A1C score of 9+ on their last test were about 1.5 times more likely to have a 9+ score on their next test as regular testers. Diabetic patients were more likely to have a score indicating uncontrolled A1C on their next test if they did not get tested regularly.

DISCUSSION

The incremental investigative approach used in this study indicates that focusing only on patients with 9+ scores is not likely to be an effective strategy for reducing overall rates of poor diabetes, for 2 main reasons:

- ***The occurrence of a 9+ score appeared to be short term rather than persistent.*** In each study year, the pool of patients with a 9+ score varied considerably, with only about 30% of the 9+ population in any year having been uncontrolled in the prior year. The short-term nature of 9+ results was also evident when considering A1C results on a test-to-test basis: only

■ **Figure 4A.** Test Number of First A1C Result That Was 9.0% or Above in Patients With First Test Between March 2008 and February 2012



	1	2	3	4	5	6	7	8
Patients	3431	870	487	366	248	189	129	91
Percentage	57.5%	14.6%	8.2%	6.1%	4.2%	3.2%	2.2%	1.5%

A1C indicates glycated hemoglobin.

16.8% of patients had 3 consecutive 9+ scores after their first 9+ score.

- ***Most patients with a 9+ result on any test had it on their first test.*** This outcome was observed in 2 different analyses. First, across all 4 years for which A1C laboratory results were available, 57.5% of patients with a 9+ result on any test had it on their first test. When we limited the outcomes to just the 3-year study period, the number increased to 75.0%. Providers will be challenged to reduce the percentage of patients with uncontrolled A1C results if the first time they learn about uncontrolled results is on the first test.

In practical terms, practices have to continue reaching out to patients with persistently poorly controlled diabetes. In addition, they must engage many additional patients with poorly controlled diabetes every year.

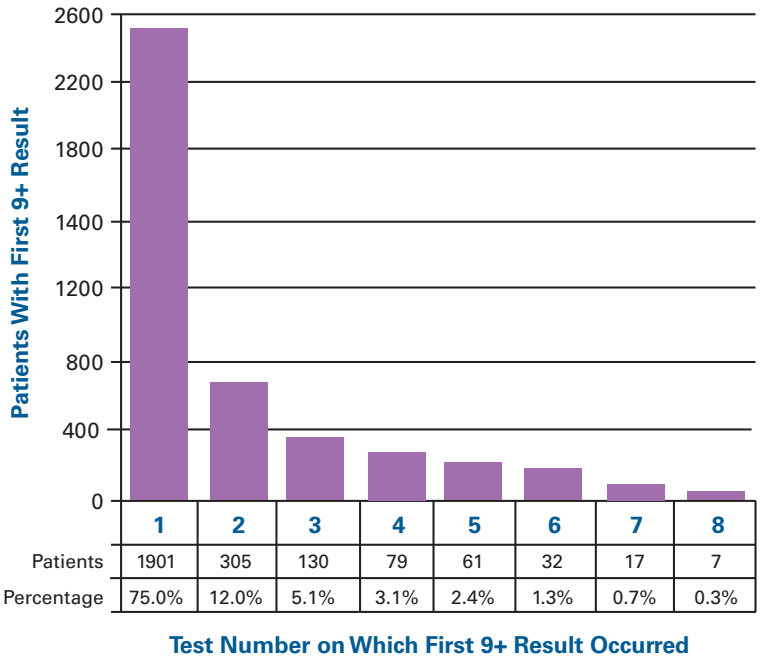
Overall, the results suggest that the current approach may already be working for patients once they have a 9+ score, as they rapidly progress to a lower score following a 9+ result. This is not to say that practices should discontinue monitoring patients with 9+ scores. However, given that the majority of uncontrolled patients did not have 9+ A1C scores the year before indicates that the focus of attention should be broadened.

A primary strategy for improving A1C outcomes may be to encourage regular testing for diabetic patients according to standards recommended by the American Diabetes Association. For patients with a prior test, our research shows that no matter the prior score, those who are 90 or more days late for their next test have a higher probability of a 9+ score on their next test. There are many potential reasons for this result: one possibility is that regular testing is an indication of compliance with provider treatment plans.

For diabetic patients without a prior test, the key appears to be earlier identification to combat the phenomenon of patients who have a 9+ score on their first test. For organizations concerned that such a recommendation would lead to increased costs, the fasting plasma glucose test is a low-cost option for identifying patients with diabetes. The American Diabetes Association guidelines indicate that patients with a fasting plasma glucose level of equal to or more than 126 mg/dL have diabetes.[2] For all patients identified with diabetes, considerable opportunity exists to improve compliance with regular testing: 44% of patients in this study are late for the next A1C test.

Because this study relied on laboratory data stored in EMRs, it was subject to 2 primary data limitations. First, we did not know for sure that we were analyzing all A1C outcomes, because patients could have had tests that were not entered into the EMR. Second, tests that occurred prior to the time period for which we had laboratory results were not included in the study. Therefore, the test we identified as the patient's first test might not actually have been their first test.

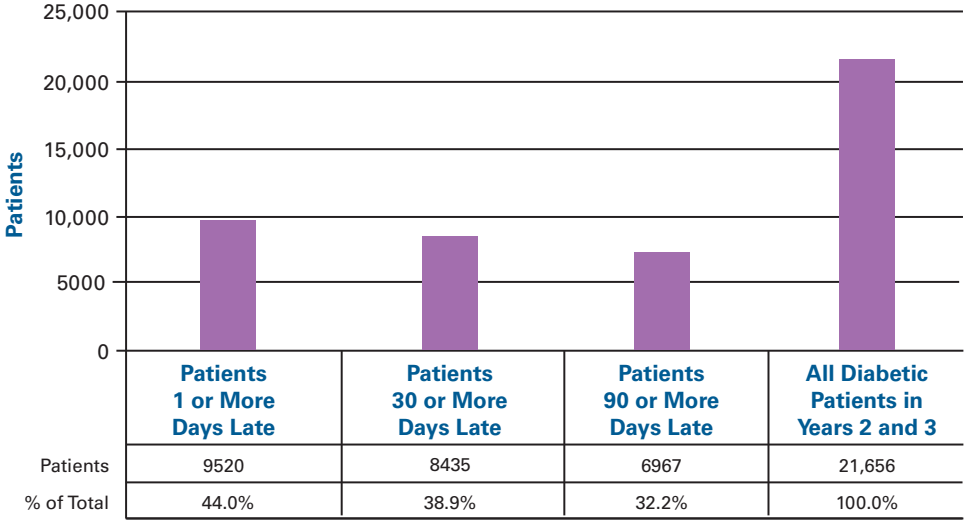
Figure 4B. Test Number of First A1C Result That Was 9.0% or Above in Patients With First Test Between March 2009 and February 2012



	1	2	3	4	5	6	7	8
Patients	1901	305	130	79	61	32	17	7
Percentage	75.0%	12.0%	5.1%	3.1%	2.4%	1.3%	0.7%	0.3%

A1C indicates glycated hemoglobin.

Figure 5. Overall Percentage of Patients Late for A1C Test, for All Patients Identified as Diabetic at Any Time During Years 2 and 3 in the Study Period



	Patients 1 or More Days Late	Patients 30 or More Days Late	Patients 90 or More Days Late	All Diabetic Patients in Years 2 and 3
Patients	9520	8435	6967	21,656
% of Total	44.0%	38.9%	32.2%	100.0%

A1C indicates glycated hemoglobin.

Another methodologic item of note is that in the persistence and probability of 9+ results analyses, we removed those tests that occurred within 30 days of the test before. An A1C result measures glucose levels over the preceding 3 months. The rationale for our approach was that any test that occurred within 30 days of the test before it meant either that the earlier test was not considered reliable or that there was not enough time for test results to change. Overall, the average length of time between tests was 4 days for the tests removed from these analyses, and the average difference in A1C test results was 0.0353.

Table 2. Probability of AIC Score of 9% or Above for Regular and Late Testers

A1C Value and Test Group	AIC Score of 9% or Above	Other Score	Total No. of Patient Tests	Proportion With AIC Score of 9% or Above	Odds Ratio (95% CI)	*P*
<6						
Three months late	22	1366	1388	1.6%	6.24 (3.31-11.79)	<.01
On time	17	6591	6608	0.3%		
Subtotal	39	7957	7996	0.5%		
6-<7						
Three months late	142	3538	3680	3.9%	4.78 (3.84-5.95)	<.001
On time	197	23,472	23,669	0.8%		
Subtotal	339	27,010	27,349	1.2%		
7-<8						
Three months late	252	1495	1747	14.4%	3.69 (3.16-4.31)	<.001
On time	674	14,765	15,439	4.4%		
Subtotal	926	16,260	17,186	5.4%		
8-<9						
Three months late	588	1434	2022	29.1%	2.07 (1.82-2.35)	<.001
On time	687	3464	4151	16.6%		
Subtotal	1275	4898	6173	20.7%		
≥9						
Three months late	1442	863	2305	62.6%	1.49 (1.34-1.65)	<.001
On time	2186	1945	4131	52.9%		
Subtotal	3628	2808	6436	56.4%		

A1C indicates glycated hemoglobin; CI, confidence interval.
Logistic regression analysis of prior A1C test band and the odds of having a score of 9% or above if next test occurred 3 or more months after the recommended guideline.

Thus, the primary tests affected by this approach were those that happened quickly after the prior test. Overall, the difference in scores was modest, indicating that the likely impact of including these tests would be to reduce the number of patients migrating to a lower test band in the persistence analysis.

A final limitation is that our study relied on modified Healthcare Effectiveness Data and Information Set criteria to identify patients with diabetes. Because patients had diabetes diagnoses on 2 different office visits does not necessarily mean that they have diabetes. Additional opportunities for better patient identification include utilizing A1C results, fasting plasma glucose levels, and problem lists stored in the EMR.

This study suggests that in order to effectively manage the health of patients with diabetes, there is a need to develop population health management strategies that consider more than just those patients who currently have poorly controlled diabetes based on A1C scores.[10-15] We have consistently found that health improvement efforts are focused only on acute patients with gaps in care who appear in the office. As this study shows, the real risks are the patients who are not appearing in provider offices and those who wait until their condition is exacerbated to an acute phase to seek treatment.

In addition to letters and manual phone calls often used by practices, automated outreach communications are a way to educate more patients on the importance of regular A1C testing and to inform patients when the tests are due. These population-based tools have been shown to be effective in other studies[10,16,17] and can be designed to monitor the population in accordance with guidelines, using levels of A1C to determine the frequency of tests and then adjusting the message accordingly.

CONCLUSION

The results of this study have demonstrated that the population of diabetic patients at risk for a 9+ score is larger

than the current 9+ cohort. The implication of these findings is that provider organizations would be well served to develop 2 critical population health management core competencies:

- The ability to identify and monitor the health status of the entire population, not just those patients with poorly controlled diabetes based on their A1C score.
- The capacity to proactively reach out to the entire population of diabetic patients between office visits so that patients waiting too long to get retested are motivated to have that testing done earlier.

We recognize that many practices and organizations today do not have the ability to identify and monitor every patient in their population who may need attention because of reporting capabilities, data reliability and timeliness, and limited staff resources for patient outreach and support. Nevertheless, this monitoring is what will likely be required to take advantage of the findings of this study.

Further, for organizations developing or running patient-centered medical home and accountable care organization models and pursuing meaningful use incentives, a total population approach to reporting, patient identification, and outreach is becoming necessary for success. In other words, utilizing the subject of this study as an example, focusing on the patients with poor A1C control in any given time period may not yield the overall clinical or financial results sought because the solution to managing diabetes lies in a more comprehensive plan that incorporates interventions for patients at risk of developing poorly controlled diabetes, as well as those already in this category.

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