Novel Use and Utility of Integrated Electronic Health Records to Assess Rates of Prediabetes Recognition and Treatment: Brief Report From an Integrated Electronic Health Records Pilot Study

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OBJECTIVE

This study uses novel methods to examine the frequency of diagnosis and treatment of prediabetes in real-world clinical settings using electronic health record (EHR) data.

RESEARCH DESIGN AND METHODS

We identified a cohort of 358,120 adults with incident prediabetes (fasting plasma glucose [FPG] 100–125 mg/dL or glycated hemoglobin 5.7–6.4% [39–46 mmol/mol]) between 2006 and 2010 and examined rates of diagnosis and treatment in the 6 months after identification.

RESULTS

In the 6 months after identification of prediabetes, 18% of patients had their blood glucose levels retested; 13% received a physician diagnosis of prediabetes/hyperglycemia; 31.0% had prediabetes, diabetes, or lifestyle documented in the clinical notes; and <0.1% initiated metformin. Among patients with FPG 120–125 mg/dL, 31% were retested; metformin initiation remained <1%.

CONCLUSIONS

Documented rates of follow-up and treatment for prediabetes are low. EHR data may be a valuable tool to improve identification and treatment of prediabetes in the U.S.

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More than 25% of Americans have prediabetes (1). Clinical trials such as the Diabetes Prevention Program (DPP) have shown that lifestyle changes and metformin initiation can prevent or delay the onset of type 2 diabetes (2–4) and that these prevention efforts may be cost-effective and improve health outcomes (5,6). However, effective diabetes prevention strategies have been difficult to implement outside of the clinical trial setting (7), and patient-reported data suggest that screening and treatment for prediabetes within the general U.S. health care system are extremely limited (8). The increasing adoption of electronic health records (EHRs) and emphasis on their meaningful use suggest that EHRs are a potential tool to improve prediabetes care (9); yet, no studies have examined rates of follow-up care for prediabetes using EHR data. To address this lack of data on prediabetes care

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in real-world settings, this study takes a novel EHR-based approach to examining the clinical response to incident prediabetes-range blood glucose levels in an integrated health care delivery system.

RESEARCH DESIGN AND METHODS

This retrospective cohort study analyzed data from a large integrated health delivery system with more than three million members. The primary data source was the integrated EHR, which combines diagnosis, utilization, pharmacy, and laboratory records from across the care system. We identified all patients age ≥18 years with laboratory-defined prediabetes (fasting plasma glucose [FPG] 100–125 mg/dL or glycated hemoglobin [A1C] 5.7–6.4% [39–46 mmol/mol]) between 1 January 2006 and 31 December 2010 (10–11). In order to create an incident prediabetes cohort, we then excluded all patients who had tested in this range in the 2 years prior, as well as those with a preexisting diagnosis of diabetes or prediabetes during this period. Patients were required to have at least 2 years of continuous health plan enrollment prior to the index laboratory date (i.e., first elevated FPG or A1C value) and for 6 months post–index date. The small number of patients (<1%) who progressed to diabetes within the first 6 months after this first laboratory value was recorded were excluded.

Clinical response to the first prediabetes-range FPG or A1C value was determined by examining integrated EHR data in the 6 months after meeting prediabetes criteria. Documented responses tracked included retesting of blood glucose levels, a recorded diagnosis of prediabetes/hyperglycemia (ICD-9 code 790.2X), a metformin prescription fill, or a referral/visit to health education or nutritional services. We used text-string searches within the EHR clinical progress notes to look for documentation that the clinician discussed prediabetes or its management with the patient using these key search terms: exercise, physical activity, diet, nutrition, weight loss, lifestyle modification/change, healthy lifestyles, diabetes, and prediabetes.

We used multivariable logistic regression analyses to examine the relationship of a documented clinical response within 6 months with patient age, sex, race/ethnicity, index FPG or A1C laboratory value, and BMI. For the small number of patients with both an elevated FPG and A1C, the FPG value was used to classify prediabetes status. Regression results were converted into adjusted predicted percentages of patients in each demographic category. All analyses were performed using SAS, version 9.3. This study was approved by the institution's Institutional Review Board.

RESULTS

We identified 368,053 patients meeting our eligibility criteria for incident prediabetes: 50.1% of these patients were female, 57.1% were white, and 61.6% were ages 45–69 years (Table 1). Sixty-nine percent of patients had a baseline FPG value between 100 and 109 mg/dL.

A total of 43.5% of patients had evidence of a clinical response documented in the EHR within 6 months: 18% were retested for FPG or A1C levels, 13% were given a diagnosis of prediabetes, and a clinical EHR note related to prediabetes, diabetes, health behavior, and self-management was made for 31% of patients. Less than one percent of patients initiated metformin, and <5% were referred to or attended health education, wellness, or lifestyle programs.

Clinical response was greater in patients with higher FPG/A1C values, with the highest responses among patients whose initial FPG value was 120–125 mg/dL. After adjustment for demographic and clinical characteristics using multivariable regression, 31% of these patients were retested; 36% had prediabetes, diabetes, or lifestyle mentioned in the clinical notes; and 25% received a prediabetes diagnosis. Less than <1% of these patients initiated metformin.

As a sensitivity analysis, we calculated the rates of documented clinical response at 12, 24, and 36 months of follow-up, respectively; the patterns observed during this time frame were very similar to those observed at 6 months, with only slightly higher levels of a clinical response in each time period (data not shown).

CONCLUSIONS

This novel study is the first to describe the use of EHR-based measures for prediabetes identification, follow-up, and treatment. We found that <50% of patients had documented clinical follow-up in the EHR. In general, those patients with the highest immediate risk of progression to diabetes (based on higher baseline blood glucose levels and higher BMI) were somewhat more likely to receive follow-up. However, despite evidence from the DPP that metformin use in prediabetes patients may slow progression to diabetes, metformin use was low (<1%) and did not increase among those at highest risk. While some caution in adopting metformin may be due to a reluctance to "medicalize" prediabetes, future research should address barriers to metformin initiation among prediabetes patients and their providers and identify ways to target patients who may potentially benefit from its use.

A key barrier to the wider adoption of lifestyle interventions and metformin use may be a lack of strong evidence-based guidelines for primary care providers on appropriate care paths for prediabetes. Current American Diabetes Association evidence-based guidelines for prediabetes care do not specify metformin initiation for all patients, recommend a specific lifestyle program, or address elevated risk for cardiovascular disease in these patients within primary care settings (10,11). In addition, many lifestyle programs (such as that implemented by the DPP) and nutrition counseling are not broadly available as a covered benefit, which may be an additional barrier to their adoption and use. Additional research should address which types of evidence-based prediabetes care guidelines are most effective at improving outcomes and how to best encourage widespread adoption of practical evidence-based prediabetes care by patients, clinicians, and health systems (12).

This study has a few limitations. We used EHR data from an integrated delivery system to define follow-up care

Table 1—Clinical response to prediabetes within 6 months

	Eligible patients (*N*, %)*	Follow-up FPG or A1C (%)	Mention of lifestyle or pre-DM in notes (%)	Metformin initiation (%)	Pre-DM diagnosis recorded (%)	Referred to or attended nutrition or health education class (%)	Record of any of the five clinical responses (%)
Unadjusted rate	358,120 (100.0)	17.7	31.0	0.13	13.1	1.2	43.5
≥6 adjusted rates†							
Sex							
Female	179,543 (50.1)	17.9	31.1	0.09	11.6	1.2	44.0
Male	178,577 (49.9)	16.5	30.7	0.02	11.3	0.9	42.8
Age categories (years)							
18–44	70,855 (19.8)	14.5	30.6	0.21	11.1	1.5	42.0
45–69	220,634 (61.6)	17.0	31.1	0.04	12.0	1.1	43.2
≥70	66,631 (18.6)	21.5	30.7	0.01	10.2	0.7	45.8
Race/ethnicity							
White	204,482 (57.1)	17.8	30.1	0.04	10.9	1.0	43.0
Hispanic	49,976 (14.0)	17.3	32.3	0.04	12.0	1.2	44.5
Asian	51,506 (14.4)	18.2	32.4	0.06	13.2	1.0	45.3
African American	21,991 (6.1)	16.8	32.7	0.03	11.2	1.2	45.0
Other/missing	30,165 (8.4)	12.4	30.4	0.04	11.5	1.1	40.0
FPG/A1C categories							
FPG 100–109 mg/dL	247,329 (69.1)	16.4	30.9	0.03	12.6	1.0	42.7
FPG 110–119 mg/dL	55,239 (15.4)	22.3	33.3	0.06	20.5	1.4	49.3
FPG 120–125 mg/dL	10,789 (3.0)	30.8	35.5	0.15	25.0	1.8	55.8
A1C 5.7–5.9% (39–41 mmol/mol)	32,749 (9.1)	12.6	27.3	0.05	1.6	0.9	36.3
A1C 6.0–6.2% (42–44 mmol/mol)	10,122 (2.8)	17.7	27.2	0.07	5.8	1.0	40.2
A1C 6.3–6.4% (45–46 mmol/mol)	1,892 (0.5)	22.7	26.9	0.16	11.7	1.5	45.0
BMI categories (kg/m^2)							
<25 (normal)	85,126 (23.8)	18.2	28.6	0.02	10.3	0.9	41.7
25–29 (overweight)	136,240 (38.0)	17.5	29.6	0.03	11.2	0.9	42.4
30–34 (class I obese)	81,116 (22.7)	16.6	32.4	0.06	12.1	1.1	44.3
35–39 (class II obese)	33,451 (9.3)	15.9	34.8	0.09	12.9	1.6	46.2
≥40 (class III obese)	22,187 (6.2)	16.1	37.3	0.12	13.4	2.4	49.1

*Eligible patients with each characteristic or clinical laboratory value in each row. †Obtained through multivariable logistic regression.

metrics for prediabetes; while some patients may have received care outside the system, utilization data for patients in this "closed" care system are complete for most patients and validated in numerous other research studies (13). While we searched text notes for all evidence of prediabetes counseling, notes may not document all prediabetes discussions between physicians and patients. We used one laboratory value to determine prediabetes status; however, we used retesting as a key follow-up measure to account for appropriate validation of prediabetes in clinical practice. Finally, our results are from one integrated system with high diabetes care quality (14) that regularly uses EHRs to measure quality (15); our results may not reflect care in other settings.

Our study suggests that documented rates of recognition and treatment for prediabetes are low. The study models the use of EHR-derived data to benchmark and monitor trends in prediabetes care—a strategy with the potential to guide the design of novel interventions to improve prediabetes identification and treatment nationally.

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