

# Opportunistic Screening for Diabetes in Routine Clinical Practice

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**OBJECTIVE** — Since 1997, the American Diabetes Association has recommended that nondiabetic individuals  $\geq 45$  years of age be screened for diabetes at least every 3 years. We sought to characterize the frequency, methods, and results of diabetes screening in routine clinical practice.

**RESEARCH DESIGN AND METHODS** — We studied opportunistic screening in nondiabetic members of a health maintenance organization  $\geq 45$  years of age who were assigned to a large, integrated, academic health care delivery system. Screening was defined as the first glucose, HbA<sub>1c</sub>, or oral glucose tolerance test (OGTT) performed between 1 January 1998 and 31 December 2000. Chart review was performed to determine the prevalence of diabetes risk factors and to describe follow-up.

**RESULTS** — Of 8,286 nondiabetic patients  $\geq 45$  years of age, 69% ( $n = 5,752$ ) were screened. The frequency of screening was greater in patients with one or more primary care visits and increased with age. Women were more likely to be screened than men, and patients with at least one diabetes risk factor were more likely to be screened than those without risk factors. Random plasma glucose was the most common screening test (95%). Four percent ( $n = 202$ ) of those screened had abnormal results. Only 38% ( $n = 77$ ) of those with abnormal results received appropriate follow-up, and 17% ( $n = 35$ ) were diagnosed with diabetes within 6 months of screening. The yield of screening was very low (0.6%, 35 of 5,752).

**CONCLUSIONS** — Despite frequent screening and appropriate targeting of high-risk patients, follow-up of patients with abnormal results is uncommon and the yield of screening is low. Interventions are needed to help physicians recognize and provide appropriate follow-up for patients with potentially abnormal random glucose levels.

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In 2001, 16.7 million Americans were diagnosed with diabetes (1). Unfortunately,  $\sim 5.4$  million Americans with diabetes remained undiagnosed (2). In 1997, the American Diabetes Association (ADA) Expert Committee on the Diagnosis and Classification of Diabetes Mellitus

recommended that all nondiabetic individuals  $\geq 45$  years of age be screened for diabetes at 3-year intervals as a part of their routine medical care (opportunistic screening). The ADA recommended that screening be performed with either fasting plasma glucose levels or oral glucose

tolerance tests (OGTTs) (3). Currently, under the direction of Secretary of Health and Human Services Tommy Thompson, a consortium of federal agencies is exploring the feasibility of a major new “detection initiative” to find the 5.4 million Americans with undiagnosed diabetes.

Support for diabetes screening is not based on randomized, controlled clinical trials but on observational data. Analyses of mass screening programs in the former East Germany found that people diagnosed with diabetes as a result of screening had better outcomes than those presenting spontaneously with diabetes (4). More recently, support for screening has come from the U.K. Prospective Diabetes Study, which demonstrated that those presenting with lower fasting plasma glucose levels (and presumably earlier in the course of disease) had fewer microvascular and macrovascular outcomes and lower mortality (5).

Despite the recommendations of the ADA and the evidence supporting screening, little is known about the methods and extent of diabetes screening in routine clinical practice (6). We performed a retrospective analysis of the opportunistic diabetes screening performed within the University of Michigan Health System (UMHS) for the 3-year period following the 1997 release of the ADA recommendations. During this time period, no formal diabetes-screening program was in place. Our goal was to assess glucose testing in routine clinical practice as performed for diabetes screening or other purposes.

## RESEARCH DESIGN AND METHODS

We performed a retrospective study of the diabetes screening performed for the M-CARE health maintenance organization members assigned to the UMHS for primary care. M-CARE is a 200,000 member managed care organization wholly owned by the UMHS that offers health maintenance organization, point-of-service, Medicare, and Medicaid product lines. The protocol was reviewed and approved by the M-CARE Research Review Committee and the UMHS Institutional Review Board. The UMHS Fac-

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**Abbreviations:** ADA, American Diabetes Association; OGTT, oral glucose tolerance test; UMHS, University of Michigan Health System.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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Table 1—Prevalence of screening, screening methods, and abnormal screening results by age and sex

	Nondiabetic members	Screened	Screening method [n (% of screened)]					Abnormal screening result [n (% of screened)]
			Random plasma glucose	Fasting plasma glucose	HbA <sub>1c</sub>	Random whole blood glucose	OGTT	
Women								
Age 45–54 years	2,570	1,712 (67)	1,602 (93)	63 (4)	26 (2)	14 (1)	7 (0)	38 (2)
Age 55–64 years	1,049	783 (75)	751 (96)	18 (2)	6 (1)	7 (1)	1 (0)	24 (3)
Age ≥65 years	903	786 (87)	758 (96)	16 (2)	7 (1)	5 (1)	0 (0)	21 (3)
Total	4,522	3,281 (73)	3,111 (95)	97 (3)	39 (1)	26 (1)	8 (0)	83 (3)
Men								
Age 45–54 years	2,062	1,186 (58)	1,114 (94)	25 (2)	31 (3)	15 (1)	1 (0)	49 (4)
Age 55–64 years	932	637 (68)	610 (96)	15 (2)	6 (1)	4 (1)	2 (0)	18 (3)
Age ≥65 years	770	648 (84)	617 (95)	15 (2)	14 (2)	2 (0)	0 (0)	52 (8)
Total	3,764	2,471 (66)	2,341 (95)	55 (2)	51 (2)	21 (1)	3 (0)	119 (5)
Women and men								
Age 45–54 years	4,632	2,898 (63)	2,716 (94)	88 (3)	57 (2)	29 (1)	8 (0)	87 (3)
Age 55–64 years	1,981	1,420 (72)	1,361 (96)	33 (2)	12 (1)	11 (1)	3 (0)	42 (3)
Age ≥65 years	1,673	1,434 (86)	1,375 (96)	31 (2)	21 (2)	7 (0)	0 (0)	73 (5)
Total	8,286	5,752 (69)	5,452 (95)	152 (3)	90 (2)	47 (1)	11 (0)	202 (4)

Data are n (%).

ulty Group Practice members include ~184 primary care physicians in 22 locations. The patient population included M-CARE members ≥45 years of age as of 1 January 1998, with continuous enrollment through 30 June 2001. M-CARE members with known diabetes as of 1 January 1998 (as determined by the M-CARE Diabetes Registry) were excluded from the study. Diabetes screening was defined as the first measure of glycemia performed between 1 January 1998 and 31 December 2000. Electronic laboratory data were searched for all measurements of glycemia (fasting plasma glucose, random plasma glucose, fasting whole blood glucose, random whole blood glucose, HbA<sub>1c</sub>, and OGTT) whether obtained individually or as part of a laboratory panel. The frequency and results of screening were then analyzed by age-group and sex. The prevalence of other diabetes risk factors (race/ethnicity; overweight or obesity; hypertension; dyslipidemia; polycystic ovarian disease; previous diagnosis of impaired glucose tolerance, impaired fasting glucose, or gestational diabetes; and family history of diabetes in parents or siblings) was determined by review of electronic medical records. The number of visits to primary care providers (internal medicine, family medicine, and obstetrics/gynecology) was compared for screened and unscreened subjects.

Medical record review was performed

for all subjects screened by fasting plasma glucose ( $n = 152$ ), random plasma glucose with values 130–159 mg/dl ( $n = 132$ ), random plasma glucose with values >159 mg/dl ( $n = 56$ ), random whole blood glucose ( $n = 47$ ), HbA<sub>1c</sub> ( $n = 90$ ), and OGTT ( $n = 11$ ). For individuals with random plasma glucose levels <130 mg/dl ( $n = 5,264$ ), a random sample of 198 records was reviewed. No one was screened with fasting whole blood glucose. For unscreened subjects, a random sample of 150 subjects aged 45–54 years, 75 subjects aged 55–64 years, and 75 subjects aged ≥65 years was reviewed.

Further medical record review was performed for all individuals with abnormal screening results to determine if appropriate follow-up was performed or if a diagnosis of diabetes was made within 6 months of screening. Abnormal screening values were defined as fasting plasma glucose ≥110 mg/dl, random plasma glucose ≥130 mg/dl, random whole blood glucose ≥130 mg/dl, HbA<sub>1c</sub> ≥6.4%, or 2-h OGTT ≥140 mg/dl. Appropriate follow-up was defined as documentation of recognition of the abnormal screening in the medical record, including a comment about the result being abnormal, i.e., a diagnosis of impaired fasting glucose, impaired glucose tolerance, or diabetes; referral to a dietitian; and/or performance of a definitive diagnostic test (fasting plasma

glucose, OGTT, or HbA<sub>1c</sub>) within 6 months of screening.

All risk factor estimates were weighted by the inverse probability of selection within each sampling stratum so that the results were representative of the entire population. Descriptive statistics were obtained using mean and SD for continuous variables and frequencies and proportions for categorical variables. Differences between groups were assessed with the  $\chi^2$  test. Multiple logistic regression analysis was used to describe risk factors associated with screening.  $P < 0.05$  was defined as the limit of statistical significance. All statistical analyses were performed using SAS software version 6.12 (SAS, Cary, NC).

**RESULTS**— We identified 8,286 nondiabetic patients ≥45 years of age who were continuously enrolled in the health maintenance organization for 3 years. The mean age was  $56 \pm 10$  years, and 55% were women. Eighty-one percent of patients were Caucasian, 6% were African American, and 3% were Asian. Race was unknown for 10%. Overall, 5,752 subjects (69%) were screened for diabetes over the 3-year period (Table 1). Random plasma glucose was the most common screening method (95%). Only 3% were screened by fasting plasma glucose, 2% by HbA<sub>1c</sub>, 1% by random whole blood glucose, and <1% by OGTT (Table 1).

Table 2—Frequency of follow-up of abnormal screening results within 6 months by age and sex

	Screened	Abnormal screening result [n (%)]	6 months' follow-up [n (% of abnormal)]		6 months' follow-up [n (% of screened)]
			Appropriate follow-up	Diagnosis of diabetes	Diagnosis of diabetes
Women					
Age 45–54 years	1,712	38 (2)	12 (32)	7 (18)	7 (0)
Age 55–64 years	783	24 (3)	9 (38)	3 (13)	3 (0)
Age ≥65 years	786	21 (3)	11 (52)	5 (24)	5 (1)
Total	3,281	83 (3)	32 (39)	15 (18)	15 (0)
Men					
Age 45–54 years	1,186	49 (4)	21 (43)	9 (18)	9 (1)
Age 55–64 years	637	18 (3)	7 (39)	5 (28)	5 (1)
Age ≥65 years	648	52 (8)	17 (33)	6 (12)	6 (1)
Total	2,471	119 (5)	45 (38)	20 (17)	20 (1)
Women and men					
Age 45–54 years	2,898	87 (3)	33 (38)	16 (18)	16 (1)
Age 55–64 years	1,420	42 (3)	16 (38)	8 (19)	8 (1)
Age ≥65 years	1,434	73 (5)	28 (38)	11 (15)	11 (1)
Total	5,752	202 (4)	77 (38)	35 (17)	35 (1)

Screened subjects were significantly more likely to have made one or more primary care visits over 3 years than unscreened subjects (91 vs. 85%,  $P = 0.001$ ). Screening increased with age (63% for age 45–54 years, 72% for age 55–64 years, and 86% age ≥65 years;  $P = 0.001$ ). Women were more likely to be screened than men (73 vs. 66%, respectively;  $P = 0.001$ ). Screened subjects were more likely to have diabetes risk factors than unscreened subjects: high-risk (nonwhite) race or ethnicity (7 vs. 6%;  $P = 0.04$ ), overweight or obese (9 vs. 7%;  $P = 0.02$ ), hypertension (31 vs. 6%;  $P = 0.001$ ), dyslipidemia (22 vs. 10%;  $P = 0.001$ ), previous diagnosis of abnormal glucose tolerance (but not diabetes) (2 vs. 0%;  $P = 0.001$ ), and family history of diabetes (9 vs. 5%;  $P = 0.001$ ). Only one woman with polycystic ovarian syndrome was identified. Screened subjects of both sexes and all age-groups were more likely to have at least one diabetes risk factor than unscreened subjects ( $P = 0.001$ ). In multiple logistic regression analysis, only history of hypertension (odds ratio [OR] 3.96, 95% CI 2.53–6.19) and history of dyslipidemia (2.29, 1.49–3.55) were independently associated with screening.

Abnormal screening results were found in 3% of those screened by random plasma glucose, 4% of those screened by fasting plasma glucose, 6% of those screened by HbA<sub>1c</sub>, 6% of those screened by random whole blood glucose, and 0%

of those screened by OGTT. Overall, 202 subjects (4% of those screened) had abnormal screening results (Table 1). Among those subjects with abnormal screening results, appropriate follow-up was performed in 77 (38% of those with abnormal screening results). Those who received appropriate follow-up were more likely to have been scheduled for follow-up appointments than those who did not (92 vs. 66%,  $P = 0.001$ ) and were more likely to have kept the scheduled follow-up appointments (90 vs. 58%,  $P = 0.001$ ). Only 35 subjects (17% of those with abnormal screening results) were diagnosed with diabetes within 6 months of screening (Table 2). The yield of screened subjects with newly diagnosed diabetes was 0.6% (35 of 5,752 screened subjects).

**CONCLUSIONS**— Despite the recommendations of the ADA Expert Committee and the evidence supporting opportunistic screening, little is known about diabetes screening in routine clinical practice. For primary care patients in a large, academic, integrated health care delivery system, we found a high rate of diabetes screening over 3 years (69%). Seventy-one percent of those with one or more primary care visits and 59% of those without primary care visits were screened. Screening appeared to be appropriately targeted to those with diabetes risk factors and was significantly more common in older age-groups, in women,

in nonwhite racial groups, and in those with overweight or obesity, hypertension, dyslipidemia, history of glucose intolerance, and family history of diabetes. The increased screening in older subjects and women may reflect the higher rate of health care utilization among these groups. The increased screening among those with hypertension and dyslipidemia likely reflects the need to monitor electrolytes and renal and liver function in those receiving pharmacologic interventions.

Despite the ADA recommendations to screen for diabetes with fasting plasma glucose levels or OGTTs, we found that random plasma glucose is by far the most common screening method (95%). This is likely due to the fact that random plasma glucose is included in standard chemistry panels obtained for reasons other than diabetes screening. It may also be due to the fact that random testing is more feasible than fasting testing. In clinical practice, patients are seen at all times of the day and obtaining fasting blood samples may be inconvenient.

We did not assess the frequency of urine glucose screening because the ADA has not recommended urine screening (3,6). Several studies have evaluated the performance of random glucose tests as screening tests for diabetes (7–10). In some studies, these tests have performed better than fasting tests, probably because people with undiagnosed diabetes are

more likely to have postprandial hyperglycemia than fasting hyperglycemia (9). To obtain optimal performance from random and postprandial tests, higher cut points are needed to account for the postprandial state (9,11). However, there are no widely accepted cutpoints to define positive random glucose screening tests for diabetes in nonpregnant adults (6). The ADA has recommended a random capillary whole-blood glucose cut point of 140 mg/dl, and Rolka et al. (8) have recommended a random capillary plasma glucose cut point of 120 mg/dl. We have recently suggested (7) that interpreting random capillary glucose levels in conjunction with postprandial time (self-reported number of hours since last food or drink other than water) and other simple risk factors performs better than any single static glucose cutpoint.

In our study, the rate of appropriate follow-up of abnormal screening results was low (38%), and screening led to a diagnosis of diabetes within 6 months in only 17% of those with abnormal screening results. The overall yield of screened subjects with newly diagnosed diabetes was very low (0.6% of those screened) and was certainly due in part to the low rate of follow-up. Lack of follow-up was associated with both physician factors (failure to schedule a follow-up appointment) and patient factors (failure to keep a scheduled follow-up appointment). The follow-up rate may have been low because clinicians may order glucose levels as a part of test panels and may not consider them as screening tests. In addition, they may interpret random plasma glucose levels <200 mg/dl as being normal. We have previously demonstrated (7) that 35% of subjects with random glucose levels  $\geq 130$  mg/dl have diabetes by OGTT testing. Interventions are needed to ensure that physicians make use of available data and recognize random glucose levels  $\geq 130$  mg/dl as abnormal and to encourage appropriate follow-up with diagnostic tests that can provide a definitive diagnosis including fasting plasma glucose levels and OGTTs.

Recent studies (12–16) have demonstrated that early interventions can prevent type 2 diabetes in patients with impaired glucose tolerance. The potential benefits of early intervention for dysglycemia further supports the importance of screening and proper interpretation and follow-up of abnormal screening results.

In summary, our data suggest that to facilitate diabetes prevention and to find the 5.4 million Americans with undiagnosed diabetes, two approaches are needed: screening and systematic follow-up of patients with abnormal screening results. Although there is a belief that more screening is needed, our data demonstrate that most patients are being screened with random glucose levels and that the screening is being appropriately targeted to high-risk individuals. Recognition that random glucose levels  $\geq 130$  mg/dl are abnormal, educational interventions, and improved clinical information systems and decision support are needed to ensure appropriate follow-up.

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