

Community-Based Screening for Diabetes in Michigan

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OBJECTIVE — To describe and evaluate a community-based diabetes screening program supported by the Michigan Department of Community Health.

RESEARCH DESIGN AND METHODS — Between 1 June 1999 and 31 December 1999, community screening for diabetes was conducted by voluntary organizations using a standard protocol, American Diabetes Association (ADA) questionnaires, and ADA capillary plasma glucose criteria.

RESULTS — A total of 3,506 individuals were screened, 14% of whom did not meet criteria for screening. Of the 3,031 individuals appropriately screened, 57% were classified as being at high risk based on the ADA questionnaire and 5% had positive screening tests based on ADA capillary plasma glucose criteria. Despite systematic follow-up, the screening program's yield of individuals with undiagnosed diabetes was <1%.

CONCLUSIONS — Community screening for diabetes conducted according to ADA recommendations was extremely inefficient at identifying individuals with undiagnosed diabetes. The ADA diabetes screening questionnaire resulted in many false positive tests, and the ADA criteria for positive plasma glucose tests likely missed a substantial portion of individuals with undiagnosed diabetes. Relying on biochemical tests such as random plasma glucose, changing the criteria for a positive plasma glucose test, targeting racial and ethnic minority groups, and targeting medically underserved individuals might improve the yield of community-based diabetes screening.

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Screening may be defined as the use of rapidly applied tests or examinations to presumptively identify individuals with unrecognized disease in order to permit timely intervention (1). Despite the lack of rigorous documentation of the benefits of screening for diabetes, many organizations have embraced it (2). Before the publication of the American Diabetes Association's (ADA's) recent position statement on screening for dia-

betes (3), the Michigan Department of Community Health (MDCH) Diabetes Control Program, through its Diabetes Outreach Networks (DONs), offered training and tools and facilitated and evaluated community screening for diabetes conducted by voluntary organizations in Michigan (4,5). Six regional DONs cover the entire state. The objective of the DON program is to reduce the burden of diabetes on individuals, their families, their

communities, and the health care system. To meet this objective, DONs identify diabetes care, education, and support resources within the local community; establish a regional advisory council to advise on planning, operation, and evaluation; develop collaborative partnerships with health care providers to promote the delivery of diabetes care according to current clinical recommendations, research, and standards; sponsor and provide professional education and public awareness activities; and collect, analyze, and report data on the services provided by the networks and their partner agencies (4,5).

In this study, we describe and evaluate the diabetes screening activities conducted by local agencies and supported by the DONs between 1 June 1999 and 31 December 1999. The analyses describe the screening programs, target populations, actual percent of individuals with positive screening tests, follow-up for those screened, and percent of individuals identified with newly diagnosed diabetes. To explain potential reasons for the low yield, we applied an independently derived and validated multivariate logistic regression model to data from the screening program to estimate the prevalence of undiagnosed diabetes in the population screened and to compare the estimated prevalence of undiagnosed diabetes to the observed prevalence (6).

RESEARCH DESIGN AND METHODS

Before the publication of ADA's recent position statement on screening for diabetes (3), the DONs, under the guidance of the MDCH Diabetes Control Program, worked with their regional advisory councils and with local community organizations to promote, facilitate, and evaluate community-based diabetes screening. For the most part, screening was conducted by hospitals, county health departments, and home health agencies as part of community awareness and outreach programs. In a number of instances, screening was conducted by work site wellness vendors as part of comprehensive work site wellness programs. The DONs offered education

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Abbreviations: ADA, American Diabetes Association; DON, Diabetes Outreach Network; MDCH, Michigan Department of Community Health; OR, odds ratio.

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

in all aspects of screening, including capillary glucose testing, quality control, and infection control, and provided triplicate data collection forms for risk assessment, interpretation, feedback, and evaluation.

All subjects provided written informed consent. Each individual was screened only once. The triplicate data collection form obtained individual identifiers (name, address, city, state, zip code, and telephone number), demographics (age, sex, race, and ethnicity), medical history (history of diabetes, current pregnancy), the number of hours since the individual last ate or drank anything other than water (postprandial time), and whether the individual had a personal physician or source of primary health care. The form also incorporated the "Take the Test. Know the Score" diabetes screening instrument distributed by the ADA. The form provided spaces to record the capillary glucose screening test result and a space to indicate whether the test was whole blood or plasma calibrated. Finally, the form provided a summary assessment and recommendation and a space to indicate the results of any follow-up contact, including the date the screened individual was contacted, whether he or she received further evaluation and testing, and whether he or she was diagnosed with diabetes.

MDCH collected the forms without any individual identifiers from the DONs for all screenings conducted between 1 June 1999 and 31 December 1999. Data were collected through 30 June 2000 to permit as complete follow-up as possible. MDCH then sent the forms to the Michigan Diabetes Research and Training Center where all data were entered in duplicate into a Microsoft Excel database. Capillary whole blood glucose values were converted to plasma glucose values by multiplying by 1.14 (7). Means and SDs were assessed for continuous variables, and frequencies and proportions were assessed for categorical variables. Differences among groups and the odds ratios (ORs) were assessed with the χ^2 test. Screening capillary plasma glucose levels were interpreted by the DONs according to ADA and MDCH recommendations. Positive screening tests were defined as random capillary plasma glucose ≥ 160 mg/dl or fasting capillary plasma glucose ≥ 126 mg/dl (8).

To independently assess the likelihood of previously undiagnosed diabetes,

a predictive equation was applied to the screening data. The equation was developed with multiple logistic regression analysis using data collected from 1,032 Egyptian subjects and was validated using data collected from 1,065 American subjects (6). The equation's sensitivity was 65% and its specificity was 96% (6). All statistical analyses were performed using SAS software version 6.12 (SAS Institute, Cary, NC). $P < 0.05$ was defined as the limit of statistical significance.

RESULTS— All subjects provided written informed consent. In the 7 months between 1 June 1999 and 31 December 1999, the local agencies screened 3,506 individuals as a part of 127 separate screening events. The number of individuals screened in the six DON regions ranged from 57 to 1,261, and the number of individual screening events conducted by various agencies ranged from 3 to 55. Most individuals were screened at hospital sites ($n = 1,202$, 34%). A substantial number of individuals were also screened at health fairs ($n = 429$, 12%), shopping centers ($n = 311$, 9%), work sites ($n = 249$, 7%), community centers ($n = 224$, 7%), and other sites ($n = 1,071$, 31%).

Of the 3,506 individuals screened, age was missing for 444 (13%). Of those reporting age, 57 (2%) were age < 20 years, 658 (21%) were ages 20–44 years, 1,033 (34%) were ages 45–64 years, and 1,314 (43%) were age ≥ 65 years. Sex was missing for 133 (4%). There were 2,112 (63%) women and 1,261 (37%) men. Race and ethnicity were missing for 187 (5%) subjects. There were 2,979 (90%) white subjects, 120 (4%) black subjects, 83 (2%) Native-American subjects, 78 (2%) Hispanic subjects, and 59 (2%) subjects of other races or ethnicities. Health care data were missing or unknown for 243 (7%) subjects. There were 2,955 (91%) subjects who reported that they had a personal physician or source of primary health care and 308 (9%) subjects who reported no primary care physician or source of primary health care.

Of the 3,506 individuals screened, 475 (14%) were inappropriately screened based on published guidelines for screening. Rates of inappropriate screening did not differ by DON. Those inappropriately screened included 57 subjects (2% of total population screened) who were age < 20 years, 51 subjects (1%) who were currently pregnant, and 367 subjects

Table 1—Characteristics of the appropriately screened population

Variable	
<i>n</i>	3,031
Age (years)	58 \pm 17
Female sex (%)	63
White (%)	90
Have PCP or source of primary care (%)	91
Diabetes risk score (%)	
0–2	3
3–9	40
≥ 10	57
Mean \pm SD	10 \pm 4
Fasting glucose	
<i>n</i>	330
< 126 mg/dl (%)	95
≥ 126 mg/dl (%)	5
Mean \pm SD (mg/dl)	95 \pm 23
Capillary random glucose	
<i>n</i>	2,701
< 100 mg/dl (%)	51
100–129 mg/dl (%)	33
130–159 mg/dl (%)	11
≥ 160 mg/dl (%)	5
Mean \pm SD (mg/dl)	106 \pm 33

Data *n*, %, or means \pm SD. PCP, primary care physician.

(11%) who reported a medical history of established diabetes. Individuals screened at work sites (25%), community centers (16%), and hospitals (13%) were more likely to report previously diagnosed diabetes than those screened at shopping malls (9%), health fairs (4%), and other sites (8%).

Table 1 describes the characteristics of the 3,301 subjects age ≥ 20 years who were not pregnant and did not have a history of diabetes who were appropriately screened. In general, subjects who were appropriately screened tended to be female and white and have a personal physician. The characteristics of appropriately screened subjects did not differ by DON or screening site. The mean diabetes risk score (as determined by the ADA screening instrument, "Take the test. Know the score") was 10 and $> 57\%$ of the subjects had a high risk score of ≥ 10 . Only 11% of subjects were fasting (postprandial time ≥ 8 h).

Only 153 (5%) of the appropriately screened subjects had fasting capillary plasma glucose levels ≥ 126 mg/dl or random levels ≥ 160 mg/dl. Individuals who

screened positive were significantly more likely to be nonwhite (OR 1.73, CI 1.07–2.79) and were more likely to report having no personal physician or source of primary health care (OR 1.36, CI 0.82–2.27). Follow-up was attempted for 106 (70%) of those who screened positive and was successful for 53 (50%). The yield of diagnosed diabetes was, however, very low. The proportion successfully followed was 53 (2%) and the proportion diagnosed with diabetes was 14 (0.5%). In general, rates of successful follow-up and diagnosis did not differ by DON or screening site (data not shown).

To explain the low prevalence of positive screening tests, we applied the predictive equation to the screening program data. The estimated prevalence of undiagnosed diabetes as determined by the predictive equation was 11%. This prevalence was consistent with the results of the Third National Health and Nutrition Examination Survey (9).

CONCLUSIONS— Screening for diabetes has been a popular activity among local community organizations. Hospitals, home health agencies, and county health departments frequently conduct diabetes screening to increase awareness and provide education about diabetes and to promote and advertise their services and programs. Early identification and treatment of individuals with previously undiagnosed diabetes is only one of many objectives.

Our evaluation of diabetes screening conducted by local community organizations with guidance from the DONs and MDCH demonstrated that most individuals screened were at high risk based on questionnaire screening scores and age. At the same time, however, most individuals were at low risk based on race and ethnicity (90% white) and based on the fact that most (91%) reported having a primary care physician or access to routine medical care. In addition, it is apparent that criteria for screening were often not rigorously applied: ~2% of those screened were age <20 years, 1% were pregnant, and 11% reported previously diagnosed diabetes. Although the latter is a relative contraindication to “screening,” it could certainly be argued that addi-

tional monitoring of glycemic control and education are a health benefit.

The ADA screening instrument, “Take the Test. Know the Score,” identified 57% of individuals as being at higher risk for previously undiagnosed diabetes, suggesting a high false-positive rate. The prevalence of positive capillary plasma glucose screening tests was only 5%. With appropriate training and support from the DONs and MDCH, the screening conducted by voluntary community organizations demonstrated good rates of attempted and successful follow-up. Unfortunately, the yield (the proportion of appropriately screened subjects found to have previously undiagnosed diabetes) was poor: <1%. Other community-based diabetes screening programs using both the ADA screening instrument (10) and measured glucose levels have also demonstrated a low yield of individuals with undiagnosed diabetes (2,11,12).

To further investigate the low prevalence of positive screening tests and low yield, we applied a multivariate logistic regression equation to estimate the prevalence of undiagnosed diabetes in the population. Compared to the ADA criteria, the equation identified more subjects with undiagnosed diabetes (11 vs. 5%). This suggests that the ADA plasma glucose criteria are set too high and miss a substantial portion of nonfasting individuals with undiagnosed diabetes.

Based on these results and the ADA’s updated position statement on screening in diabetes, MDCH has elected not to support community screening for diabetes. Improved definition of a positive test, relying on biochemical testing such as random plasma glucose, targeting racial and ethnic minority groups, and targeting medically underserved individuals with no primary care physician, no insurance, or no access to routine health care could substantially improve the yield of community-based diabetes screening. Further studies are needed to demonstrate these potential benefits before wide-spread community screening can be recommended.

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