Screening for Type II Diabetes Mellitus in the United States: The Present and the Future

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ABSTRACT: The number of individuals being diagnosed with type II diabetes in the United States is increasing. The screening tests for diabetes are able to detect the vast majority of diabetics. However, they do not represent the high-risk individuals who may be prone to diabetes at an earlier age. This brief communication looks at the current screening practices and the gaps in the guidelines.

KEYWORDS: type II diabetes, screening, diabetes guidelines

Introduction
Type II diabetes mellitus can be diagnosed with an abnormal glycohemoglobin test (hemoglobin A1c%), oral glucose tolerance test, or fasting plasma glucose test.1 The 2014 National Diabetes Statistics Report estimated that 37% of American adults, aged 20 years and older, were in the prediabetic range from 2009 to 2012 and 9.3% of the United States population had diabetes.2 Additionally, half of those who do present with type 2 diabetes have already developed clinical complications at the time of diagnosis.3 Diabetes causes more blindness, renal disease, and amputations than any other preventable disease. The estimated burden on the health-care system is around 245 billion dollars.2,4 Therefore, it is imperative to diagnose the disease when an individual transitions from being disease free to the asymptomatic state. This lead time can provide an opportunity to reduce long-term sequelae and implement lifestyle and pharmacological interventions to reduce health-care expenditures ultimately.

Screening: Current Recommended Practices
Screening is the process by which asymptomatic individuals who are at high risk of the disease are identified for further investigation.4 An fasting blood glucose (FBG) ≥ 126 mg/dL is diagnostic for diabetes and warrants retesting. A 75-g oral glucose tolerance test is also suitable and screening is positive with a 2-hour postload value of ≥200 mg/dL. Values ≥200 mg/dL are repeated on a different day to confirm diagnosis of diabetes. The A1c test is also a valuable tool for diagnosis of diabetes and A1c > 5.6 indicates impaired glucose tolerance.5 Genetic screening for diabetes is of little value in clinical practice.6

In United States, different societies and task forces have recommended varying guidelines for screening for Type 2 diabetes mellitus as presented in Table 1. Despite these guidelines for earlier screening, there are individuals who are not clinically diagnosed until at least a decade after subclinical disease.7 This is likely due to a combination of ineffective screening guidelines, inadequate implementation of the guidelines, and late presentation of disease. These guidelines, like all other screening tools in the medical community, are employed by many practitioners to target high-risk populations (Table 1). The United States Preventative Services Task Force (USPSTF) revised in its 2008 guidelines for screening in asymptomatic adults with sustained blood pressure > 135/80 or obese adults aged between 40 and 70 years.8,9 The American Diabetes Association (ADA) recommends screening based on body mass index (BMI) ≥ 25 kg/m² in addition to risk factors. Individuals aged ≥45 years are recommended to be screened regardless of risk factors. Likewise, in children aged 10 years and older, ADA advocates for screening if obesity is present in addition to two risk factors. Criterion that is established as a risk factor includes family history, race/ethnicity, insulin resistance comorbidities, and maternal history of gestational diabetes during the child’s gestation.10 The American Association of Clinical Endocrinologists (AACE) expands their criteria to include individuals with singular risk factors for diabetes as screening criteria.11 The International Diabetes Federation (IDF) recommends against universal screening for diabetes.12

Screening: Gaps in Current Practices
There is a growing concern that the current screening guidelines might be inadequate. Recently, Bullard et al suggested...
screening should be based on prevalence of diabetes and available resources

**SCREENING RECOMMENDATION**

- Physical inactivity
- Hypertension
- HDL < 35 mg/dL or TG > 250 mg/dL
- First degree relative with diabetes
- High risk race/ethnicity
- Asian Americans with a BMI of ~23 kg/m²
- Women who have delivered child >9 lbs or with gestational diabetes
- A1c ≥ 5.7%, impaired fasting glucose (IFG) or impaired glucose tolerance (IGT)
- Other: acanthosis nigricans, PCOS, history of coronary vascular disease (CVD)

**Role of family history.** It is estimated that an individual with one parent diagnosed with diabetes before the age of 50 years has a 1 in 7 chance of developing the disease. This number increases to 1 in 2 for those with both parents carrying the disease. There is good evidence that universal screening for individuals with a positive family history should begin at a much earlier age prior to the onset of diabetes in their immediate family members. However, this is rarely done. A report of the Expert Committee recommends earlier age of screening for individuals with first-degree relatives with diabetes, but the exact age is not mentioned. A 1999 cross-sectional study of 972 diabetics of three ethnicities at the University of Singapore found an earlier age of diagnosis (mean of seven years) in individuals with positive family history when compared with patients without familial history (CI 95%, <0.01). It concluded that family history is an independent factor in predicting age at diagnosis in type II diabetes. Therefore, in a given population, the mean sojourn time in order to gain lead time bias is roughly 8–12 years. There are no guidelines that specify when earlier screening should be carried out in individuals with a family history of diabetes.

**Role of ethnicity.** The ADA notes the highest rate of diagnosed diabetes by ethnicity in minority populations, especially in the Native Americans, where the prevalence is 33%. This is followed by non-Hispanic Blacks (13.2%) and Hispanics (12.8%). Recent research found that BMI-adjusted prevalence of diabetes in Asian Americans (Far East, South East, and Indian descent) was ~60% higher than in non-Hispanic Whites. Therefore, Asian Americans are at a higher risk of diabetes at a lower BMI. This led to ADA adjusting its diabetic screening guidelines to include testing Asian Americans at a BMI of 23 kg/m² or greater. While the ADA and AACE includes ethnicity, the USPSTF guidelines have neglected to include this high-risk population.
Role of genetics. As noted above, the aggregation of diabetes in familial and ethnic group patterns has a lot to do with genetic inheritance. However, the polygenic inheritance and lack of clear evidence limits the use of genetic testing in clinical practice.6

Role of smoking. Smokers have increased insulin resistance. Smoking is believed to be linked to increased glycosylation of hemoglobin. One study showed an average decrease of hemoglobin A1c of 0.7% after smoking cessation.23 No current guidelines include smokers in the screening criteria.

Role of age. Approximately 0.35% of the diabetic population is of age 20 years or younger.24 In a recent press release, the ADA recognizes that in adults, 20–44 years of age, the rate of undiagnosed diabetes is 60% higher than the general adult population, yet it fails to include these individuals in its screening parameters.25 It is also important to note that the guidelines suggest screening in obese individuals who have other risk factors, but there are no recommendations in individuals with the sole risk factor of obesity. Likewise, if an individual has risk factors but is not obese, they are also not high-risk candidates to be screened routinely unless they are 10–18 years of age or ≥40 years of age. This provides gateway for individuals to be potentially missed by routine diabetic screening. As such, should we be initiating screening using a risk calculator to provide an estimate of early screening using familial history, race, ethnicity, and age among other risk factors? What would the implications of this, if any, be? This calls for further probability modeling and cost analysis.

Need for national benchmarks. A better system is needed to diagnose the 8.1 million asymptomatic diabetic Americans and the 76 million with prediabetes.3 USPSTF outlines screening that is focused on obesity and does not take into account the large array of risks, other than cardiovascular that predispose an individual to diabetes. It also does not take into account the population younger than 40 years of age or older than 70 years who continue to be diagnosed with diabetes. Similarly, the ADA outlines a strict parameter for screening, excluding the millions who are still at risk. There are no good studies which analyze the usage of the ADA and the USPSTF guidelines in the diagnosis of specific subpopulations. Data on physician use of these guidelines is also scarce. With growing emphasis on patient-centered medical home and pay for performance model of repayment, the need for national benchmarks of guideline usage and their pragmatic efficacy is paramount.

Where Do We Go From Here?
In summary, the studies to date suggest that evidence on the reliability of diabetic screening guidelines is poor. The guidelines fail to provide a broad umbrella for screening in those who are at highest risk. There is much debate regarding universal screening versus individualized screening. Earlier screening that is universal would increase the likelihood of diabetes to be detected, yet increasing anxiety and health-care expenditure.

On the other hand, the continued use of guidelines for recommending screening is coupled with lack of sensitivity and specificity. These recommendations do not provide coverage for the cost of screening in some individuals who are at greater risk.

The authors here recommend further equitable study of different high-risk populations as noted above. Meanwhile, prediabetes should also come to focus when screening for diabetes. Other than the ADA that recognizes prediabetic screening, the USPSTF, IDF, or the AACE advises screening for prediabetes. Physicians should consider the following:

- Screening for prediabetes in all individuals aged 35 years and older, regardless of BMI or hypertension.
- Individuals with glucose in the prediabetic range should be rescreened every year.
- Individuals with a family history of diabetes should be tested 7–10 years prior to the onset of diabetes in their first-degree relative.
- Smokers should also be tested much earlier than the general population due to increased insulin resistance.
- Ethnicities of high insulin resistance, such as Asian Americans, African-Americans, Native Americans, and Pacific Islanders, should be tested at an earlier age, regardless of BMI. From the current screening measures, the authors recommend the use of the ADA or the AACE guidelines for screening for diabetes.

Further high-quality studies that focus on earlier screening in otherwise asymptomatic patients in specific subpopulations are needed. In developing protocols for screening, diabetes can be detected at an earlier stage to decrease cardiovascular mortality and inevitably control this epidemic.

Author Contributions
Conceived and designed the experiments: AA. Analyzed the data: AA. Wrote the first draft of the manuscript: AA. Contributed to the writing of the manuscript: AA, SA, AW. Agree with manuscript results and conclusions: AA, SA, AW. Jointly developed the structure and arguments for the paper: AA, SA, AW. Made critical revisions and approved final version: AA, AW. All authors reviewed and approved of the final manuscript.

REFERENCES
1. Standards of medical care in diabetes-2013. Diabetes Care. 2013;36(1):511–566.
2. Centers for Disease Control and Prevention. National Diabetes Statistics Report: Estimates of Diabetes and Its Burden in the United States. 2014. Atlanta, GA: U.S. Department of Health and Human Services; 2014.
3. Desphande AD, Harris-Hayes M, Schootman M. Epidemiology of diabetes and diabetes-related complications. Phys Ther. 2008;88:1254–1264.
4. Screening for Type 2 Diabetes. Report of a World Health Organization and International Diabetes Federation Meeting. 2003. Available at http://www.who.int/diabetes/publications/en/screening_mnc03.pdf. Accessed April 2016.
5. Screening for Diabetes. American Diabetes Association. Diabetes Care. 2002; 25(1):521–524.
6. Lysenko V, Laukoo M. Genetic screening for the risk of type 2 diabetes. Worthless or valuable? Diabetes Care. 2013;36(2):5120–5126.
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7. Harris MI, Klein R, Welborn TA, Knuiman MW. Onset of NIDDM occurs at least 4–7 yr before clinical diagnosis. Diabetes Care. 1992;15:815–819.

8. United States Preventive Services Task Force. Screening for Type II Diabetes Mellitus in Adults. 2008. Available at http://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/diabetes-mellitus-type-2-in-adults-screening

9. Final Recommendation Statement. Abnormal Blood Glucose and Type 2 Diabetes Mellitus Screening. United States Preventive Services Task Force. 2015. Available at http://www.uspreventiveservicestaskforce.org/page/Document/Recommendation-StatementFinal/screening-for-abnormal-blood-glucose-and-type-2-diabetes

10. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2010;33:62–69.

11. Handelsman Y, Bloomgarden ZT, Grunberger G, et al. American Association of Clinical Endocrinologists and American College of Endocrinology: clinical practice guidelines for developing a diabetes mellitus comprehensive care plan—2015. Endocr Pract. 2015;21:1–87.

12. Clinical Guidelines Task Force. Global Guideline for type II diabetes. International Diabetes Federation; 2012. Available at https://www.idf.org/sites/default/files/IDF%20T2DM%20Guideline.pdf. Accessed April 2, 2016.

13. Bullard KM, Ali MK, Imperatore G, et al. Receipt of glucose testing and performance of two US diabetes screening guidelines, 2007–2012. PLoS One. 2015;10:e0125249. doi:10.1371/journal.pone.0125249.

14. Sheehy AM, Flood GE, Tuan WJ, Liu JI, Coursin DB, Smith MA. Analysis of Guidelines for screening diabetes mellitus in an ambulatory population. Mayo Clin Proc. 2010;85(1):27–35.

15. Ochoa PS, Terrell BT, Vega JA, et al. Identification of previously undiagnosed diabetes and prediabetes in the inpatient setting using risk factor and hemoglobin A1c screening. Ann Pharmacother. 2014;48:1434–1439.

16. Simmons RK, Echouffo-Tcheugui JB, Sharp SJ, et al. Screening for type II diabetes and population mortality over 10 years (ADDITION-Cambridge): a cluster-randomised controlled trial. Lancet. 2012;380:1741–1748.

17. Genetics of Diabetes. American Diabetes Association. 2013. Available at http://www.diabetes.org/diabetes-basics/genetics-of-diabetes.html. Accessed May 2014.

18. Hong CY, Chia KS. Age at Diagnosis and Family history in type II Diabetes: Implications for Office Screening. Royal New Zealand College of General Practitioners; 1999.6. Available at https://www.nzxgpp.org.nz/assets/documents/Publications/Archive-NZFP/June-1999-NZFP-Vol-26-No-3/NZFP-JUN1999-Ye-Hong-Age.pdf

19. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the Expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2002;25(suppl 1):S5–S20. Available at http://care.diabetesjournals.org/content/25/suppl_1/5.full

20. Kuo HS, Chang HJ, Chou P, Teng L, Chen TH. A Mark chain model to assess the efficacy of screening for non-insulin dependent diabetes mellitus (NIDDM). Int J Epidemiol. 1999;2882:233–234.

21. Spanakis EK, Golden SH. Race/ethnic difference in diabetes and diabetic complications. Curr Diab Rep. 2014;14(6):814–823.

22. Hsu WC, Araneta MRG, Chiang JL, Fujimoto W. BMI cut points to identify at-risk Asian Americans for type II diabetes screening. Diabetes Care. 2015;38(1):150–158.

23. Gunton JE, Davies L, Wilmshurst E, et al. Cigarette smoking affects glycemic control in diabetes. Diabetes Care. 2002;24:796–797.

24. Statistics About Diabetes. American Diabetes Association. 2014. Available at http://www.diabetes.org/diabetes-basics/statistics/

25. Alexandria V. The American Diabetes Association Disappointed in Scope of New Screening Guidelines for Type 2 Diabetes and Pleased with Expansion of Lifestyle Interventions. American Diabetes Association; 2015. Available at http://www.diabetes.org/newsroom/press-releases/2015/uspstf-new-screening-guidelines-for-type-2-diabetes.html?referrer=https://www.google.com/