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# Implementing A Prediabetes Screening Algorithm To Improve Identification And Referrals In Primary Care

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# Implementing a prediabetes screening algorithm to improve identification and referrals in primary care

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By

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**Abstract**

Almost half (49%) of the United States population has prediabetes or type 2 diabetes. Type 2 diabetes has many associated comorbidities and is the seventh leading cause of death in the United States. It is also the most expensive chronic condition in the nation. Identifying patients with prediabetes allows for early intervention to prevent or delay the onset of type 2 diabetes. The objective of this quality improvement project was to develop and implement a screening algorithm in the primary care setting using the Prediabetes Risk Test and point of care HemoglobinA1c testing to improve identification of patients with prediabetes and increase referrals to lifestyle intervention. Over the 12-week implementation period, fifteen patients were identified as having prediabetes, three agreed to a referral to lifestyle intervention, and one was started on metformin. This was a marked increase compared to two prior recent years. The algorithm was feasible and effective at improving identification of prediabetes, in addition to improving staff and provider knowledge and retention. Future studies should include a broader patient population in a variety of locations with longitudinal follow-up. Updating the Prediabetes Risk Test to specify physical activity for future studies may also be beneficial.

Keywords: Prediabetes, screening algorithm, risk test, point-of-care hemoglobinA1c

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## Abbreviations

ADA – American Diabetes Association

APRN – Advanced Practice Registered Nurse

CDC – Centers for Disease Control

DNP – Doctor of Nursing Practice

DO – Doctor of Osteopathic Medicine

DPP – Diabetes Prevention Program

EHR – Electronic health records

FBG – Fasting blood glucose

HbA1c - Hemoglobin A1c

IDF – International Diabetes Federation

LPN – Licensed Practical Nurse

MA – Medical Assistant

MD – Medical Doctor

NGSP – National Glycohemoglobin Standardization Program

NIDDK - National Institute of Diabetes and Digestive and Kidney Diseases

OGTT – Oral glucose tolerance test

PDSA – Plan-Do-Study-Act

POC - Point of care

REDCap – Research Electronic Data Capture

USPSTF – United States Preventative Services Task Force

WHO – World Health Organization

# Chapter 1

## Introduction

More than 80% of the 96 million adults living with prediabetes in the United States (U.S.) are unaware of their condition (Centers for Disease Control and Prevention [CDC], 2022d & Duan et al., 2021). Recent studies suggest that 26-50% of patients with prediabetes will progress to type 2 diabetes within five years if left unmanaged (Echouffo-Tcheugui & Selvin, 2021; International Diabetes Federation [IDF], 2021; Richter et al., 2018). There is evidence to suggest that known complications of diabetes such as retinopathy, neuropathy, nephropathy, increased risk of cardiovascular disease and increased all-cause mortality can be present in patients with prediabetes as well (Cai et al., 2020; CDC, 2022g; Echouffo-Tcheugui & Selvin, 2021; International Diabetes Federation, 2020). In addition, prediabetes and type 2 diabetes come with a significant financial toll. Type 2 diabetes is the most expensive chronic condition in the nation with direct and indirect costs exceeding $327 billion dollars per year (CDC, 2022b; Dall et al., 2019). Prediabetes further encumbers the healthcare system with an additional $43.4 billion dollars annually (Dall et al., 2019; O'Connell & Manson, 2019). As evident from the above, this prevalent disease increases the risk of negative health outcomes and places significant burden on the healthcare system.

Prediabetes and type 2 diabetes are global health concerns as the estimated prevalence of each is projected to rise around the world, mirroring rising rates of obesity and inactivity (CDC, 2022a; Echouffo-Tcheugui & Selvin, 2021). Risk factors for prediabetes and type 2 diabetes include being overweight or obese, family history of diabetes, history of gestational diabetes, limited physical activity, age > 45 years, smoking, and high blood pressure or cholesterol (CDC, 2022c). Intensive lifestyle-change programs have been successful at reducing the risk of progression to type 2 diabetes by 28-58% and long-term studies show reduced diabetes incidence after 10-15 years (Diabetes Prevention Program Research Group, 2015; Echouffo-Tcheugui & Selvin 2021; National Institute of Diabetes and Digestive and

Kidney Diseases [NIDDK], 2021). Treatment with the medication metformin can also reduce the risk of developing type 2 diabetes, though lifestyle intervention is almost twice as effective at reducing risk (NIDDK, 2021; Albright & Gregg, 2013). While effective prevention strategies exist, providers must successfully screen and identify individuals with prediabetes to allow for early intervention to prevent or delay the progression to type 2 diabetes and its myriad complications.

**Problem Statement**

Almost half of the US population (49%) has prediabetes or type 2 diabetes (CDC, 2022d). Obesity and inactivity are on the rise which are established risk factors for prediabetes and type 2 diabetes (CDC, 2022a). Projections estimate that, by 2030, 107.7 million people in the U.S. will have prediabetes, and the total economic cost of diabetes will reach $622.3 billion dollars annually (Rowley et al., 2017). In addition to the significant financial burden, the burden on individuals must be considered. Individuals with unidentified--and consequently untreated--prediabetes who go on to develop type 2 diabetes, face years of medication therapy, increased healthcare utilization, absenteeism, reduced productivity, disability, and increased risk of morbidity and mortality (Dall et al., 2019; Cai et al., 2020). Diabetes is currently the 7$^{th}$ leading cause of death in the U.S. (CDC, 2022d). Fortunately, prevention strategies such as lifestyle change programs, weight loss, and medication therapy, have been proven to be effective at decreasing the risk of developing type 2 diabetes (NIDDK, 2021; Albright & Gregg, 2013; Barry et al., 2017). Furthermore, long term studies of the Diabetes Prevention Program randomized control trials show persistently lower rates of type 2 diabetes in the lifestyle intervention and metformin groups (34% and 18% respectively) when compared to placebo (Diabetes Prevention Program Research Group, 2009). Thus, to address this public health crisis, healthcare providers must improve their screening processes to ensure that those with prediabetes are identified in a timely manner such that intervention with referral to lifestyle intervention can take place. This DNP project developed and implemented a screening algorithm that utilized a validated

screening tool, point of care HbA1c testing, and referral recommendations to improve the identification of adults with prediabetes and increase referrals to lifestyle intervention.

**Significance**

Prediabetes is an asymptomatic hyperglycemic state that increases the risk for cardiovascular disease, all-cause mortality, and developing overt type 2 diabetes (Cai et al., 2020). A significant number of individuals progress to type 2 diabetes and the resultant overall burden on patients, providers, and the healthcare system is substantial (Echouffo-Tcheugui & Selvin, 2021; Richter et al., 2018). Reducing the risk of progression to type 2 diabetes with lifestyle modifications or medication has been proven effective, however this can only occur if providers are successful at identifying and treating individuals with prediabetes.

Definitions and screening guidelines for prediabetes vary by society and organization. The American Diabetes Association (ADA) recently updated their recommendations for screening to begin at age 35 for all people (ADA Professional Practice Committee, 2023b), while the United States Preventative Services Task Force (USPSTF) recommends screening adults ages 35-70 who are overweight or obese, and the American Association of Clinical Endocrinology (AACE) recommends screening any adult who is overweight or obese (Jonas et al., 2021). Data show however, 38-80% of those eligible for screening are not screened, only 5-25% are given a diagnosis when prediabetes is identified, and 0-23% are referred for behavior intervention when prediabetes is identified (Blonde et al, 2022; Brunisholz et al., 2021; Echouffo-Tcheugui & Selvin, 2021; Evron et al., 2019; Mainous et al., 2016; Mainous et al. 2022; Nhim et al, 2018; Obinwa et al., 2020; Thomas et al., 2021). This evidence highlights numerous missed opportunities to identify and intervene early in this disease process.

Identification of individuals with prediabetes allows for early intervention aimed at preventing or delaying the progression to type 2 diabetes. Lifestyle-change programs are the most effective intervention and have been successful at delaying the progression to type 2 diabetes by 36-58% (NIDDK, 2021, Duan et al., 2021; Glechner et al., 2018). This effect was

durable, with long term outcome studies showing a lower cumulative incidence of type 2 diabetes over 10-15 years (Diabetes Prevention Program Research Group, 2009; National Institute of Diabetes and Digestive and Kidney Diseases, 2021). While lifestyle change programs have been proven effective, it is evident that providers must improve their screening processes to ensure that at-risk individuals are identified and subsequently referred to these beneficial programs.

## Background

### Review of the Literature

The review of literature aimed to answer the PICO question: Does implementing a screening tool or algorithm in the primary care setting improve identification of adult patients with prediabetes and increase referral to lifestyle intervention? Multiple electronic databases were utilized for the search including PubMed, Ovid Medline, CINAHL, and Scopus. Key terms used in the search included “prediabetes” OR “prediabetic state” OR “prediabetic” OR “impaired fasting glucose” OR “impaired glucose tolerance.” These key terms were searched along with “screening” OR “mass screening” OR “opportunistic screening” OR “screening algorithm,” OR “screening tool” OR “identification,” and was limited to “adults,” and studies published within the last 10 years. A total of 3,960 articles were identified. An additional 43 studies were identified by examining the reference lists of selected articles. After duplicates were removed and titles were screened, 297 abstracts were assessed. Though the search was limited to the last 10 years, commonly referenced, and highly regarded studies were also included in the final literature review due to their significant contribution to the subject matter. Ninety-four articles were selected for full-text review and 28 were included in the review of literature and matrices. Studies selected for inclusion were peer reviewed and conducted in the U.S. Exclusion criteria included studies that did not pertain to the primary care or outpatient setting, studies that focused on only one subset of the population or patients with a specific disease, were not generalizable to the U.S. population, and studies that did not relate to screening for prediabetes.

The searches were run from September 2021 through March 2023. Included articles were separated into two categories: those that centered on the barriers to prediabetes screening and those that explored solutions to improve screening and referral patterns. The search strategy is further illustrated in the PRISMA flowchart in Appendix A.

This review of literature will first present the definition(s) of prediabetes and the inconsistencies among current society guidelines and recommendations for screening. It will then examine the discrepancies between guidelines and current practice throughout the U.S. Subsequently, it will review the evidence supporting the need for improved screening and identification of prediabetes. Finally, it will examine the various solutions that have been studied to improve screening and referral practices.

**Prediabetes Definition and Screening Tests**

Prediabetes is a frequently used term that encompasses several variations of hyperglycemia or elevated blood sugar, including impaired fasting blood glucose and impaired glucose tolerance (CDC, 2022i; ADA Professional Practice Committee, 2023b). Prediabetes is best described on a continuum characterized by elevated blood sugar, falling in between normoglycemia and type 2 diabetes (Echouffo-Tcheugui & Selvin, 2021). The currently accepted screening tests for prediabetes include fasting blood glucose (FBG), oral glucose tolerance test (OGTT) and hemoglobinA1c (HbA1c) (ADA Professional Practice Committee, 2023b). The ADA defines prediabetes as a HbA1c of 5.7%-6.4%, FBG of 100-125mg/dl, or OGTT of 140-199mg/dl at the 2-hour time point (ADA Professional Practice Committee, 2023b). The World Health Organization (WHO) defines prediabetes as a FBG of 110-125mg/dl, or an OGTT of 140-200mg/dl. The WHO endorses HbA1c for diabetes diagnosis however they do not for individuals with suspected prediabetes. The International Expert Committee for Diabetes that includes members appointed by the ADA, IDF and the European Association of the Study of Diabetes have recognized HbA1c as a precise measure of hyperglycemia over time that is reliable and correlated with risk of retinopathy (Echouffo-Tcheugui & Selvin, 2021 &

International Expert Committee, 2009). The lack of a universal definition or screening test for prediabetes is a major barrier to screening individuals effectively.

The presence of several acceptable screening tests along with varied definitions of prediabetes, according to current guidelines, further complicates the screening process. A person may be considered to have prediabetes based on one test, but normoglycemia based on a different one (Barry et al., 2017; Echouffo-Tcheugui & Selvin, 2021). Though the tests are not equal with regards to sensitivity and specificity, the ADA does not recommend one test over another (Barry et al., 2017; ADA Professional Practice Committee, 2023b). Furthermore, the lack of global consensus on a consistent definition for prediabetes is a major challenge when attempting to estimate prevalence and ultimately determine a universal screening strategy.

Several factors need to be considered when choosing a screening test. FBG is inexpensive and provides quick results but is inconvenient because, by definition, the individual is required to fast (Echouffo-Tcheugui & Selvin, 2021). It can be described as a snapshot of an individual's blood sugar after an 8-hour fast. Like the FBG, the OGTT requires fasting. It is a 2-hour test that requires ingestion of a sugary drink (75 grams of glucose) to reveal how an individual processes glucose (ADA Professional Practice Committee, 2023b). FBG and OGTT can sometimes miss prediabetes if postprandial glucose or fasting blood glucose is the only abnormality alone. HbA1c testing on the other hand does not require fasting, has less pre-analytic instability, and less biological variability, though it is more expensive than FBG (ADA Professional Practice Committee, 2023b & International Expert Committee, 2009). Moreover, HbA1c provides a three-month average of blood glucose levels that can be useful to gauge over a longer time period. Data suggest that while providers screen more frequently with FBG, often as part of a panel, screening with HbA1c is more likely to result in a diagnosis (Evron et al., 2019). Although HbA1c could be considered the test of choice from a patient perspective, there are additional factors that need to be considered. Individuals with any alteration in red blood cell turnover such as anemia, hemoglobinopathies, and pregnancy may not have an accurate result

(ADA Professional Practice Committee, 2023b). The use of point of care (POC) testing, done in office with results in 1-10 minutes, for FBG and HbA1c has increased their availability and ease of use for screening. The ADA Standards of Care reports that all three tests are equally appropriate for diagnostic screening though notes their concordance to be imperfect (ADA Professional Practice Committee, 2023b).

**Prediabetes Screening Strategies**

A gap in screening for prediabetes exists, and the implications related to this are evident. Several prediabetes screening strategies have been studied and employed in practices throughout the U.S. Solutions to improve identification of prediabetes that have been studied include screening tools/risk scores, electronic health record (EHR) tools, opportunistic or systematic screening, or a combination of several of these strategies (Chima et al., 2020; Clark et al., 2021; Gamston et al., 2020; Holliday et al., 2019; Kirley et al., 2021; Nhim et al., 2018; Soher et al., 2016; Whitley et al., 2017, Zhang et al., 2015). Utilizing screening tools, either pen and paper or EHR-generated, to assess risk factors are easily accessible but inconsistently used (Clark et al., 2021; Gamston et al., 2020; Nhim et al., 2018; Soher et al., 2016). Provider unawareness of screening tools as well as knowledge of guidelines and recommendations for screening are barriers to their success (Echouffo-Tcheugui & Selvin, 2021; Hafez et al., 2017; Mainous et al., 2022; Obinwa et al., 2020; Thomas et al., 2021). Testing at routine health care visits (opportunistic screening), and systematic screening, have been explored and shown some success, though these require system-wide training (Soher et al., 2016; Whitley et al., 2017). Other successful strategies include technology programs such as retrospective chart queries and the creation of prediabetes registries that increase the identification of individuals with prediabetes and referrals to lifestyle change programs (Chima et al., 2020; Holliday et al., 2019; Kirley et al., 2021). The use of technology has shown to be beneficial for screening and increasing referrals, though a universal program has yet to be developed and adopted. A combination of more than one of these strategies, such as use of a risk test and opportunistic

screening or risk test and point of care testing, has also been posited as a solution (Holliday et al., 2019; Zhang et al., 2015).

**Screening Tools and Risk Tests**

Screening tools are not a new concept. They are used in many different areas of medicine to assist providers in easily identifying individuals at high risk for various conditions. The first screening tool for diabetes was developed by the ADA in 1993 and included simple questions that most people would know about themselves (CDC, 2021a). Since then, numerous tools have been developed to identify individuals at highest risk of developing type 2 diabetes, including the ADA screening tool, Finnish Diabetes risk score (FINDRISC), and the CDC risk test among others (Echouffo-Tcheugui & Selvin, 2021; Lim et al., 2020; Poltavskiy et al., 2016). The first tool looking specifically at prediabetes as an outcome was developed in 2008 (Heikes, et al., 2008). Each tool accounts for various risk factors such as age, gender, weight, family history, and physical activity to generate a score or risk category.

Commonly used diabetes screening tools in the U.S. are the ADA screening tool and CDC risk test. While these tools have been studied for their ability to successfully identify type 2 diabetes, there are fewer studies looking at outcomes specifically related to prediabetes. A 2014 systematic review of risk tests for prediabetes revealed gaps in validity and calibration: only seven of the 18 tools assessed were externally validated (Barber et al., 2014). Additionally, many tools were developed and tested on populations attracted by direct advertising or opportunity, thus limiting the generalizability of those tools (Barber et al., 2014; Gamston et al., 2020). A 2016 study of 9,391 adults, aged 20 years or older, directly comparing the ADA and CDC tools for the identification of prediabetes, found all predictors in the tools to be statistically significant, except for having a macrosomic (>9 lbs) baby (Poltavskiy et al., 2016). The ADA tool performed marginally better, with an area under the curve (AUC) of 0.77, compared to the AUC of 0.73-0.74 for the CDC tool, although this difference was not statistically significant (Poltavskiy et al., 2016). Similarly, in a comparison of the ADA Prediabetes Risk Test and the CDC

Prediabetes Screening Test, the combined sensitivity (81%) and specificity (70.2%) of the ADA Prediabetes Risk test was superior to that of the CDC Prediabetes Screening Test (sensitivity 85.7% and specificity 46.4%, $p = .004$) (Gamston et al., 2020). In 2021, the CDC adopted the ADA risk test. It is now known as the Prediabetes Risk Test and is endorsed by both organizations and several others as well (CDC, 2021a). Though various risk tests have been validated, their sensitivity and specificity are suboptimal for them to serve as the sole solution for screening (Poltavskiy et al., 2016; Zhang et al., 2015). Despite this, the ADA's Standards of Care still recommends either informal assessment of diabetes risk factors or the use of a screening tool, like the ADA risk test, to identify those in need of laboratory screening (ADA Professional Practice Committee, 2023b).

Prediabetes and diabetes screening tools can aid providers in quickly assessing an individual's risk factors, however there are several limitations. Many risk tools have not been externally validated and there are few that have looked at prediabetes outcomes specifically. Furthermore, risks tests have modest sensitivities and specificities, which contribute to missed diagnoses and false positive results (Poltavskiy et al., 2016; Zhang et al., 2015). While screening tools are easy to use and low cost, their imperfections must be considered when used as the sole measure for screening.

**Electronic Health Record Tools**

In addition to traditional questionnaire-based screening tests, EHR tools have been developed and successfully implemented to improve prediabetes screening. There is evidence to suggest that readily accessible EHR data (labs, body mass index [BMI], history) could be used to identify individuals who are high risk for or have prediabetes (Holliday et al., 2019). A large quasi-experimental, mixed-methods study looked at how implementing a diabetes prevention toolkit affected the identification of Medicare patients with prediabetes and referral to diabetes prevention programs (Holliday et al., 2019). The toolkit included an algorithm to query the EHR retrospectively to identify patients with prediabetes, based on HbA1c or FBG, and BMI

>25 kg/m$^2$ (Holliday et al, 2019). After implementation of the toolkit, the number of referrals to their local Diabetes Prevention Program increased from zero to 5,640 over a 15-month period (Holliday et al., 2019). A separate study looked at adapting the ADA risk score by eliminating physical activity and lowering the threshold for "high risk" from >5 to >4 (Chima et al., 2020). Readily accessible EHR data were used and individuals at high risk for prediabetes were easily identified (Chima et al., 2020). These studies suggest that utilizing various EHR tools can have a significant positive impact on prediabetes identification and subsequent referrals.

The use of technology can be helpful to identify high risk individuals and maintain a registry of patients to facilitate follow up and referrals. Many organizations maintain patient registries for various chronic conditions, such as congestive heart failure, to ensure evidence-based care and appropriate follow up. A 2021 study looking at outcomes after implementation of an EHR tool called Certified Electronic Health Records Technology (CEHRT), for 36 primary care providers in a single health system, found an in lifestyle change program referrals, from 20 at baseline to 293 post-implementation for patients with prediabetes (Kirley et al., 2021). Similarly, the number of patients screened for prediabetes after implementation of CEHRT was 2.5 times higher (Kirley et al., 2021). The use of technology, including EHR tools, have been shown to be beneficial in successfully identifying individuals at high risk for prediabetes as well as increasing referrals to appropriate prevention programs.

**Opportunistic or Systematic Screening**

Another strategy to improve identification of prediabetes is a concept known as opportunistic screening. This involves employing POC testing with FBG or HbA1c at routine primary care visits--whether preventative, follow-up, or for other problems. This type of screening may reach more patients who may not otherwise seek preventative care. An example would be testing a patient presenting with a respiratory complaint, who also meets screening criteria, with POC HbA1c during the visit. While this may reach more people, a significant challenge would be the amount of time added for screening to every such visit. A retrospective

analysis of data collected over a two-year period at five primary care practices looked at screening outcomes in 4,421 private practice patients (group 1) and 7,464 community health center patients (group 2) (Sohler et. al., 2016). The study included patients who did not have a preexisting diagnosis of prediabetes or diabetes, were eligible for screening based on ADA and USPSTF guidelines and had a point of care HbA1c test done at the time of the visit. While over 75% of patients were eligible for screening based on guidelines, only 21-23% were screened. Of those screened, 51% (group 1) and 63.1% (group 2) were identified as having prediabetes (Sohler et al., 2016). This represented a substantial number of patients with prediabetes who otherwise might not have been identified. However, there were a significant number of patients eligible for screening who were not ultimately screened (Sohler et al., 2016). Additional studies on this screening strategy need to be conducted to determine its feasibility in widespread implementation and ability to improve screening percentages.

Like opportunistic screening, a study comparing systematic screening with POC HbA1c and usual practice showed the former to be effective (Whitley et al., 2017). In this prospective longitudinal study, 184 patients in the systematic screening arm were offered free POC HbA1c testing if they were over age 45 and did not have a diagnosis of type 1 or type 2 diabetes, while 324 patients in the standard care arm had “usual care,” which often included a blood glucose as part of a standard laboratory panel for screening (Whitley et al., 2017). Systematically screening patients increased the chances for screening to occur, compared to standard practice ($p = .005$) (Whitley et al., 2017). Furthermore, there were 251 patients in the standard arm who were eligible for screening that were not screened. Systematic screening with POC HbA1c testing increased the likelihood of screening and afforded the opportunity for immediate education and management (Whitley et al., 2017). Larger scale studies utilizing systematic screening are needed to further assess outcomes and cost effectiveness.

**Combination Screening**

Various screening strategies have been proven beneficial in improving the identification of individuals with prediabetes though no one strategy alone has been universally adopted or recommended. The use of more than one strategy, combination screening, could be more effective at achieving this goal. Guidelines recommend assessment of risk, whether informal or with a risk test, followed by laboratory testing for those who are identified as high risk (ADA Professional Practice Committee, 2023b). Shifting the laboratory testing to the point of care improves access to testing and enables immediate decision making and intervention. A 2015 cross-sectional study of 3,386 patients evaluated the performance of a risk test (FINDIRSK) along with POC HbA1c testing to detect prediabetes or diabetes (Zhang et al., 2015). Using both the risk test and POC HbA1c testing increased sensitivity to 84.2% for diabetes and 74.2% for prediabetes (Zhang et al., 2015). Specificity also increased with this model, suggesting more accurate identification compared to either screening strategy alone (Zhang et al., 2015). Similar strategies, using a risk test and POC HbA1c testing, have been piloted in dental hygiene clinics and pharmacies and shown success at identifying patients with prediabetes and type 2 diabetes with referral back to primary care for management (Giblin et al., 2016; Genco et al., 2014 & Ward et al., 2022).

There is evidence that utilizing screening tools--through risk tests or questionnaires, electronic health record query, or opportunistic and systematic screening--improves the identification of patients with undiagnosed prediabetes and type 2 diabetes (Chima et al., 2020; Gamston et al., 2020; Holliday et al., 2019; Kirley et al., 2021; Soher et al., 2016; Whitley et al., 2017; Zhang et al., 2015). The most effective screening method is not yet clear, as larger studies evaluating the various screening methods in direct comparison, and in combination, have yet to be undertaken. Moreover, the lack of succinct screening guidelines and society recommendations, compounded by multiple differing definitions of prediabetes, remain barriers to consistent screening across practices and organizations around the world (ADA Professional

Practice Committee, 2023b; Echouffo-Tcheugui & Selvin, 2021; Jonas et al., 2021). Based on the studies included in this review, there are data to support the utilization of combination screening, with a validated risk test and POC HbA1c testing, at outpatient preventative care visits. This has the potential to improve the identification of individuals with undiagnosed prediabetes, who may ultimately benefit from preventative management with referral to lifestyle intervention (Clark et al., 2021; Nhim et al., 2018; Soher et al., 2016). This type of screening protocol could be implemented in a variety of primary care settings and altered, if needed, based on resources and patient population.

**Prediabetes Management**

In addition to improving screening and identification of individuals with prediabetes, there must be a plan for intervention. Intensive lifestyle-change programs like the landmark National Diabetes Prevention Program have been successful at reducing the risk of progression to type 2 diabetes by 58% at three years (NIDDK, 2021; Barry et al., 2017). Additional landmark randomized controlled trials in Finland, China and India have shown significant risk reduction with lifestyle-change programs as well (Echouffo-Tcheugui & Selvin, 2021). Lifestyle intervention is the mainstay of treatment for prediabetes, with weight loss being the most successful at reducing progression to type 2 diabetes (Ali et al., 2012). A systematic review of 28 U.S. based studies that applied the findings from the Diabetes Prevention Program in real world settings showed success with an average of 4% weight loss at 12 months which was clinically signification and showed sustained benefit (Ali et al., 2012). Including referrals as part of any screening plan is essential to ensure those patients identified as having prediabetes are managed effectively and can benefit from proven prevention measures.

## Project Model

The Plan-Do-Study-Act (PDSA) model or cycle is used to test whether a change leads to improvement (Institute for Healthcare Improvement, 2022). The model was used to guide this project. The first step of the model, *plan*, included completing a review of evidence on current

prediabetes screening practices across the U.S. as well as the solutions that have been studied to improve screening and referral to lifestyle intervention. Based on the evidence, a prediabetes screening algorithm that follows current guidelines was developed. The last part of the planning stage involved creating an education session for staff and providers. The next step of the model, *do*, involved providing the education session for staff and providers and then completing practice role plays using the developed algorithm and tool. Next, the prediabetes screening algorithm and Prediabetes Screening Tool were implemented in the primary care practice, with ongoing data collection over a 12-week period. Pre-implementation data from the corresponding time frame one and three years prior were collected from EHR reports as the comparison group. The *study* phase of the model involved comparing pre- and post- implementation data evaluating the number of patients screened, the number of patients identified as having prediabetes and the number of patients subsequently referred for lifestyle intervention. Comparing the data determined if the screening algorithm resulted in an improvement in prediabetes identification and referrals. In the final stage of the model, *act*, the findings were reviewed with participating providers, staff, and stakeholders to discuss successes, failures, and proposed improvements to the algorithm or workflow. The cycle can be repeated to test additional changes for improvement as needed.

## Organizational Description and Assessment

### *Description of the System*

The project site Healthcare system is a large multi-specialty group with over 700 providers in New England. The project implementation site is one of the Medical Group's primary care practices in a suburban town. The adult primary care practice is in a medical building that includes several specialty practice groups, an imaging department, and a blood draw station. There are 16 employees including two Medical Doctors (MD), one Doctor of Osteopathic Medicine (DO), two Advanced Practice Registered Nurses (APRN), one Office Manager, four Patient Service Coordinators, four Medical Assistants (MA), and two Licensed

Practical Nurses (LPN) who serve approximately 5,600 patients. Additional staff who are employed through the medical group and work off site include Medical Directors, Billing and Coding Specialists, and Information Technology staff among others. There is a practice-affiliated hospital within 30 miles and two additional hospitals affiliated with other networks approximately 10 miles away.

***Setting***

The current state of practice at the project site is comparable to the themes presented in the review of literature: inconsistent and insufficient screening practices along with provider knowledge gaps, and inadequate intervention once prediabetes has been identified (Echouffo-Tcheugui & Selvin, 2021; Hafez et al., 2017; Mainous et al. 2022). Several interventions to improve screening including the use of risk tests, POC testing, opportunistic screening, and EHR programs, have been successfully implemented into similar primary care settings (Holliday et al., 2019; Kirley et al., 2021; Soher et al., 2016; Whitley et al., 2017; Zhang et al., 2015). One of the system's primary foci in quality is diabetes care and management. Improving the identification of patients with prediabetes and prompting intervention may decrease the proportion of individuals who go on to develop type 2 diabetes. Implementing a prediabetes screening algorithm in this setting is feasible and would include education and workflow modifications for staff and providers. Currently, the practice utilizes two POC HbA1c testing machines (DCA Vantage Analyzer, Siemans Healthineers, Malvern, PA) for diabetes management visits. The MAs are trained in completing POC HbA1c testing, administering screening tests and imputing the information into the EHR, such as PHQ9 and GAD7 for depression and anxiety. Adding an additional screening test, the Prediabetes Risk Test, at annual physical exams would require an adjustment in workflow for MAs. This addition is realistic as MAs have shown competence in administering similar screening tests. A goal of scaling this algorithm implementation would be to create an EHR version of the Prediabetes Risk Test. Additional workflow modifications would need to be made by Providers to account for

the time needed to discuss results, counseling, and referral options. The available referral options specific to the project site include Lifestyle Medicine, Weight Management and Nutrition.

***Need***

There is great variation in how each provider in the medical group practices, with no practice- or organization-wide standard for prediabetes screening. The screening test most frequently ordered is FBG, often as part of a panel, at routine physical exams. It is common to encounter scenarios where patients who are found to have an elevated blood sugar, sometimes on several different occasions, go without any documentation of the condition, intervention, or further testing. When the abnormality and plan are documented, some variation of “work on diet, exercise and weight loss” is often written in progress notes with the similarly generic advice of “dietary modification.” Sometimes follow-up visits are not scheduled for a year and the abnormality is frequently forgotten or overlooked. These relative provider oversights and knowledge gaps, and lack of organizational policies, coupled with the increasing number of patients predicted to have prediabetes, highlight the need for intervention.

***SWOT***

There are several facilitating factors that will serve to support and maintain a change in practice. Internal strengths include having POC testing equipment already available with staff well trained in its use. The approval and assistance from upper management, including the Practice Manager, Regional Medical Director, and Regional Administrative Manager are necessary to help support and sustain change. Similarly, staff and provider acceptance will help to facilitate this change. Another important strength is having a Lifestyle Medicine Practice, Nutrition, and Weight Management specialty all within the organization to serve as referral destinations. Additionally, there is leadership attention to type 2 diabetes, with it being an important quality metric within the organization. Similarly, with the expected increase in the incidence of prediabetes and type 2 diabetes, there is a significant need for improved screening, which is an external opportunity. Additionally, with recent changes to billing and coding rules to

include time-based billing, counseling about lifestyle changes for prediabetes would be reimbursable, which could help support the drive for change.

Several barriers exist when considering the implementation of the screening algorithm. Internal weaknesses include a possible lack of acceptance among staff and providers, due to ingrained practice preferences or perceived infringement on autonomy, and a relative lack of time. Patients will need time to complete the Prediabetes Risk Test and providers will need dedicated time for risk test review, results discussion, and counselling. Paperwork fatigue is another potential barrier that must be considered. Patients are often bombarded with "paperwork" at the check-in desk (insurance, privacy, consent and history forms, etc.) such that they may lose interest along the way and potentially enter less robust data. While placing the responsibility of filling out an online tool on patients is an attractive option, health and computer literacy are major barriers to this approach that need to be mitigated to ensure the robustness of the data generated.

External threats to success exist and must also be considered. There is a lack of community resources, there are no local National Diabetes Prevention Programs, and there is a significant backlog and prolonged wait times for Nutrition consults. Additionally, multiple definitions of prediabetes and variations in guidelines could impact insurance reimbursement for screening tests. Another external threat to consider is co-pays for referrals to lifestyle change programs.

**Goals and Aims**

This DNP project developed and implemented a prediabetes screening algorithm in a primary care practice, utilizing a validated screening tool and point of care HbA1c testing, to improve the identification of adults with prediabetes and increase the number of referrals to lifestyle intervention. The project had the following aims:

1. Develop a prediabetes screening algorithm and provider education plan for the primary care setting that includes a validated prediabetes screening tool, POC HbA1c testing, and referral recommendations.
2. Implement the screening algorithm and evaluate the number of patients screened, the number of patients identified as having prediabetes, and the number of patients referred for lifestyle intervention before and after implementation.
3. Recommendations to sustain and scale the prediabetes screening algorithm include reviewing results with stakeholders and examining provider and staff feedback to revise the algorithm as needed.

# Chapter 2

## Methods

The inconsistent identification of prediabetes and resultant lack of intervention remains a problem in the primary care setting. To address this gap in practice, this DNP project developed a prediabetes screening algorithm based on ADA guidelines that included a validated screening tool, POC HbA1c testing, and referral recommendations that was implemented in a primary care practice. The goals of this initiative were to improve the identification of adults with prediabetes and increase the number of referrals to lifestyle intervention programs. Methods are outlined by aim below.

**Aim 1:** *Develop a prediabetes screening algorithm and provider education plan for the primary care setting that includes a validated prediabetes screening tool, POC HbA1c testing, and referral recommendations.*

To develop a prediabetes screening algorithm and Provider education plan, a review of literature was completed to identify the best evidence to use. The Prediabetes Risk Test was chosen as the screening tool for this algorithm based on a review of evidence as it has superior sensitivity and specificity and has been externally validated (Gamston et al., 2020; Poltavskiy et al., 2016). The CDC, NIDDK and American Medical Association endorse the use of the Prediabetes Risk Test along with the ADA which is the chief professional organization that provides evidence-based clinical practice guidelines for all components of diabetes care including screening.

The Prediabetes Risk Test (Appendix B Figure 2a) generates a score based on a brief assessment of risk factors that was used as a first step in the algorithm to determine patients at highest risk for prediabetes. The Prediabetes Risk Test consists of seven simple, direct questions and requires no calculations. A score of five or greater on the risk test indicates that a person is at high risk for prediabetes and warrants further evaluation (Bang et al., 2009). This cutoff yielded a sensitivity of 79% and a specificity of 67%, with a positive predictive value of

10% and a negative predictive value of 99% (Bang et al., 2009). The questions in the Prediabetes Risk Test were asked verbally by the MA during the rooming process. Interpreter services were available for any language. Additionally, the risk test was available to be printed in additional languages including Arabic, Bengali, Chinese, French, Haitian Creole, Italian, Japanese, Korean, Polish, Spanish, Tagalog, Urdu, and Yiddish (CDC, 2021b). Limited literacy was not an issue as patients with were asked the Prediabetes Risk Test questions verbally.

Other evidence identified and used in the algorithm included the chosen screening test, HbA1c, and ADA Standards of Care (2023) which defined reference ranges for determining the presence of prediabetes, guidelines for re-evaluation, and interventions based on screening and HbA1c results. HbA1c was chosen as the screening test for this algorithm over FBG and OGTT given its recognition by the International Expert Committee for Diabetes as a reliable measure of chronic hyperglycemia overtime that correlates with the risk of type 2 diabetes complications (International Expert Committee, 2009). In addition, it is a simple, easy to use test with fewer day to day fluctuations and it does not require the patient to fast for the test.

A project working team that included a Medical Assistant, Office Manager and Provider met to review the proposed algorithm and determine the best way to incorporate the risk test and POC HbA1c testing into the workflow for the project setting. This resulted in the plan for the risk test to be completed during the rooming process as opposed to having the paper risk test handed to the patient at check in to complete on their own.

The Prediabetes Risk test was integrated with the screening algorithm into a two-sided form, The Prediabetes Screening Tool, that was used by staff and Providers (Appendix B Figure 2b). The first step in the algorithm was for all patients ages 18 and older without a diagnosis of prediabetes or diabetes, who presented for routine physical exam with one of the four participating Providers to be asked the Prediabetes Risk Test questions during the rooming process. Following administration of the risk test, those determined to be high risk with a score of five or greater had POC HbA1c testing completed. This test was done in office using the

Siemens DCA Vantage Analyzer machine which meets the National Glycohemoglobin Standardization Program standards for use (Siemens Healthineers, 2022). It required the MA or LPN to complete a fingerstick to extract one microliter of blood that was drawn into a capillary holder which was then placed into a cartridge in the DCA Vantage Analyzer machine. Results were ready in 6 minutes. These results were documented in the EHR and written on the back side of the Prediabetes Screening Tool and given to the Provider.

In the next step of the algorithm, those with normal HbA1c results were informed of the result by the Provider and planned for repeat testing in three years to follow current ADA guidelines. Those who were identified as having prediabetes based on a HbA1c result of 5.7-6.4%, were recommend to have a referral to lifestyle intervention. Lifestyle intervention referral options included Lifestyle Medicine, Weight Management, or Nutrition within the organization or Nutrition at an outside organization. If the HbA1c was 6.5% or greater, consistent with type 2 diabetes, the Provider ordered confirmatory testing and treated based on current ADA guidelines. The provider checked the appropriate box on the back of the Prediabetes Screening Tool for corresponding HbA1c category and intervention and placed it in a lockbox in the medication room. The algorithm which outlines the above steps can be found in Appendix B Figure 3.

Education for staff and Providers took place during a one hour in-person education session that occurred on September 22, 2022 prior to the start of implementation. There were nine attendees including all three providers (MD, DO & APRN), three MAs, two LPNs and the Office Manager. The education plan for staff and Providers was developed to include all the necessary topical areas to successfully implement the algorithm. Additionally, updated national and worldwide prevalence rates of prediabetes and complications associated with unidentified and untreated prediabetes were included to create a sense of urgency and provide motivation for improvement. The education session was delivered by the Project Lead via a PowerPoint presentation and included the following areas related to prediabetes and diabetes:

- Prevalence of prediabetes and type 2 diabetes in the US and worldwide
- Risk factors for prediabetes
- Rates of progression to type 2 diabetes and its complications
- Current prediabetes screening guidelines and recommendations.
- Appropriate screening tests with reference ranges
- Benefits of lifestyle change programs and available referral resources
- Algorithm use and role review (Appendix C)
- Appropriate documentation and plan for reevaluation

Time was allotted for questions and answers both during and at the end of the education session. A multiple choice pre and post-test was given to all attendees to assess learning (Appendix D). The post-test was re-administered at the end of implementation to assess retention of knowledge. Role plays using the algorithm took place to validate learning and involved each staff member and Provider practicing their role (Appendix C). All attendees received a copy of the algorithm, patient education materials, and the Prediabetes Screening Tool as references.

**Aim 2:** *Implement the screening algorithm and evaluate the number of patients screened, the number of patients identified as having prediabetes, and the number of patients referred for lifestyle intervention before and after implementation.*

The evaluation plan consisted of comparing data from the 12-week implementation period to those from the corresponding 12-week period one year prior and three years prior (September – December 2019 & 2021). This timeframe was chosen to eliminate seasonal variation. The year 2020 was not included for comparison due to the ongoing COVID-19 pandemic and lack of consistency in routine visits during that time. Data comprised the number of patients who presented for routine physical exam, the number of patients identified as having prediabetes, and the number of patients with prediabetes referred for lifestyle intervention. The

comparison data was obtained through EHR reports and included the number of patients who presented for routine physical exam, the number of patients who received a new finding of prediabetes, or synonymous term including impaired fasting glucose, or impaired glucose tolerance, as well as the number of patients subsequently referred for lifestyle intervention. The denominator number of patients were all patients who presented for routine physical exam for the four participating providers. Implementation data was entered and managed using Research Electronic Data Capture (REDCap) by the Project Lead and extracted on a bi-weekly basis. REDCap is a secure web platform to support data capture for building and managing online databases and surveys (Harris et al., 2009; Harris et al., 2019; Patridge & Bardyn, 2018). Descriptive statistics were utilized to identify differences in prediabetes identification and lifestyle intervention referral before and after screening algorithm implementation. A one-way ANOVA using Tukey's HSD (Honestly Significant Difference) was done to compare pre- and post-education tests and pre-education and post-implementation tests.

Preparation:

- Education session(s) and practice role plays implemented.
- Screening algorithm flowcharts and referral options specific to the project site posted in the MA work area and LPN and Provider offices.
- Blank Prediabetes Screening Tools were kept in a folder in the MA work area. Copies were made as needed. Prediabetes Risk Tests in different languages were available to be printed from the following website: https://nationaldppcsc.cdc.gov/s/article/Prediabetes-Risk-Tests-1525314769238. Interpreter services was available for all languages for all patient visits.
- Patient education materials (Appendix E) from the ADA were placed in all exam rooms. They were replenished by the MA as part of the normal room stocking process.

Implementation:

- From 9/26/2022 through 12/16/2022 all patients age >18 without a diagnosis of prediabetes or diabetes who presented to the primary care project site for routine physical exam with any of the four participating providers were asked the Prediabetes Risk Test questions during the rooming process.
- POC HbA1c testing was completed by the MA/LPN for patients who scored a five or greater on the risk test. The MA/LPN performed the test and entered the results into the EHR and wrote them on the Prediabetes Screening Tool.
- Providers interpreted the HbA1c as normal, prediabetes or type 2 diabetes and intervened as indicated based on the algorithm.
- Completed Prediabetes Screening Tools were stored in a lockbox in the medication room. The Project Lead retrieved the completed Prediabetes Screening Tools twice a week and entered the following data into REDCap: risk test answers, HbA1c (if applicable), and intervention: if and where a referral was made or metformin started. The Prediabetes Screening Tools were then shredded.
- REDCap was utilized to extract de-identified data regarding of the number of patients with prediabetes identified and number of patients subsequently referred to lifestyle intervention on a bi-weekly basis. This information was posted on the staff huddle board throughout implementation for motivation and to encourage continued involvement. The Project Lead reviewed all providers schedules on a weekly basis to obtain the number of patients who presented for routine physical exam.

Evaluation:

- Comparison data were reviewed from the corresponding time frame one & three years prior from EHR reports and included the number of patients who presented for routine physical exam, all patients who received a new finding of prediabetes or synonymous

term (impaired fasting glucose or impaired glucose tolerance), as well as the number of patients subsequently referred for lifestyle intervention.

- REDCap was utilized to extract data on a biweekly basis during implementation
- At the end of the implementation period the de-identified data extracted from REDCap was compared to the comparison data evaluating the total number of patients who presented for routine physical exam with the four participating providers, the number of patients newly identified as having prediabetes as well the number of subsequent lifestyle intervention referrals for patients identified as having prediabetes.
- Descriptive statistics were used to identify if there were differences in prediabetes identification and lifestyle intervention referral before and after screening algorithm implementation. Chi Square tests were used to compare project versus practice demographics (Social Science Statistics, 2023a).
- Evaluation of provider and staff experience with the screening algorithm was done by anonymous survey following implementation (Appendix F). The post-test from the education session was re-administered post-implementation to assess retention of knowledge. A one-way ANOVA using Tukey's HSD (Honestly Significant Difference) was used to compare pre- and post-education and post-implementation test results (Social Science Statistics, 2023b).
- Field notes were kept by the Project Lead throughout the project implementation including notes from the project working group meetings/check-in meetings with staff and providers, feedback from staff and Providers, barriers or questions that arose, and suggestions for improvement.

**Aim 3:** *Recommendations to sustain and scale the prediabetes screening algorithm included reviewing results with stakeholders and examining provider and staff feedback to revise the algorithm as needed.*

**Sustainability**

- Reviewed feedback from post-implementation surveys and discussed feedback and project results with staff and providers at the monthly staff meeting following implementation. Reviewed successes, failures, and proposed revisions to the algorithm that could be beneficial.
- Communicated results via Zoom presentation with the Nursing Research Council for the organization and with key stakeholders including the Regional Administrative Director, Regional Medical Director and Medical Group President. Recommended a meeting with Information Technology to discuss options for incorporating the Prediabetes Risk Test into the EHR though a smart phrase or screening tab.

**Scalability**

- Reviewed results via Zoom presentation with key stakeholders including the Regional Administrative Director, Regional Medical Director, and Medical Group President to consider adapting the screening algorithm for use in additional primary care offices within the organization.
- Recommended incorporating prediabetes screening as a yearly health maintenance metric for the medical group that will provide reminders for staff and providers to screen at regular intervals.

**Project Timeline**

During the summer months, 6/1/2022-8/31/2022, the screening algorithm, Prediabetes Screening Tool, algorithm evaluation plan, and education plan for staff and providers were developed. Presentation and approval of project plans at the Project Site's Nursing Research Council occurred on 8/10/2022. Successful project defense at the Yale School of Nursing took place on 8/31/22. On 9/22/2022, the provider and staff education session took place with practice role plays immediately following the education session. One-on-one education sessions

occurred as new staff began work in the practice. Implementation of the QI project occurred from 9/26/22-12/31/22, as outlined above. See Appendix G for a Gantt Chart that depicts this timeline.

**Statement Related to Human Subjects**

This project was presented to the Yale School of Nursing IRB and was determined to be a quality improvement project and therefore exempt from requiring IRB approval. Additionally, the project site organization's Nursing Research Council deemed this project quality improvement. Ethical considerations included upholding patients' rights to confidentiality, privacy, and safety. All patient participants were given an information sheet about taking part in a quality improvement project. The completed Prediabetes Risk Tools did not have any personal health identifiers on them and were stored in a lockbox until they were retrieved by the Project Lead for data entry into REDCap. After data entry, the tools were shredded. All data were stored on REDCap and password protected. Additional ethical considerations included potentially identifying a condition without providing an intervention and barriers accessing resources including location, additional time off work, and co-pays for specialty visits.

# Chapter 3

## Systems Considerations and Implications

### Leadership and Stakeholder Engagement

The project lead developed and implemented a prediabetes screening algorithm at the primary care project site with the support of the organization, Regional Director, and Regional Medical Director. These were the primary stakeholders who gave approval for the project to take place. The other primary stakeholders were the patients who could be positively impacted by identifying a condition they were previously unaware of and providing intervention. Other important stakeholders included the staff and providers at the project site for which their support was essential to facilitate implementation of the screening algorithm. They had the benefit of improved knowledge and standard screening practice. The Practice Manager was also a key stakeholder and was actively involved in collaboration and communication about the project with the Project Lead and all staff and providers. Finally, ongoing support throughout all aspects of project development and implementation was provided by the School of Nursing Faculty Advisor See Appendix H for stakeholder engagement.

### Business & Financial Considerations

This quality improvement project had low overall costs, with the potential for savings long term. The project required office resources, most notably paper, as the Prediabetes Screening Tool was not integrated in the EHR for this project. For future cost savings, integrating the Prediabetes Screening Tool in the EHR could reduce costs. Additionally, having the education sheet for patients in the EHR that could be sent via MyChart would be another way to reduce costs. Other project-related costs included the time for education and training for staff and providers. The lunch period was utilized to limit disruptions to patient care, and all staff and providers were compensated for their time participating in the education session. Another potential cost included possible insurance refusal to cover Hemoglobin A1c testing, though this

did not occur during the project. Finally, the cost of binding the project manuscript must be considered in total projected costs.

This project has the potential for cost savings over time. By improving the identification of patients with prediabetes and prompting intervention, a smaller proportion of individuals may go on to develop type 2 diabetes. Type 2 diabetes is the most expensive chronic condition in the nation with direct and indirect costs exceeding $327 billion dollars per year (CDC, 2022b; Dall et al., 2019). Evidence demonstrates that patients with type 2 diabetes face years of medication therapy, increased healthcare utilization, absenteeism, reduced productivity, and disability, all of which increase cost (Dall et al., 2019; Cai et al., 2020). Similarly, as new payment models begin to emerge with quality and outcome-based reimbursement, reducing the number of patients who develop type 2 diabetes and ultimately the complications related to this could potentially improve reimbursement. In addition, by preventing or delaying the onset of type 2 diabetes with lifestyle intervention, there is the opportunity to improve the overall health of the community at large. Lifestyle change with healthy diet, exercise, and weight reduction are all interventions that will improve numerous other chronic conditions that are costly such as heart disease, stroke, and cancer. Tracking long-term patient outcomes of incidence of type 2 diabetes or other conditions associated with an unhealthy lifestyle could provide additional potential cost saving benefits. See Appendix I for graphic representation of project costs.

# Chapter 4

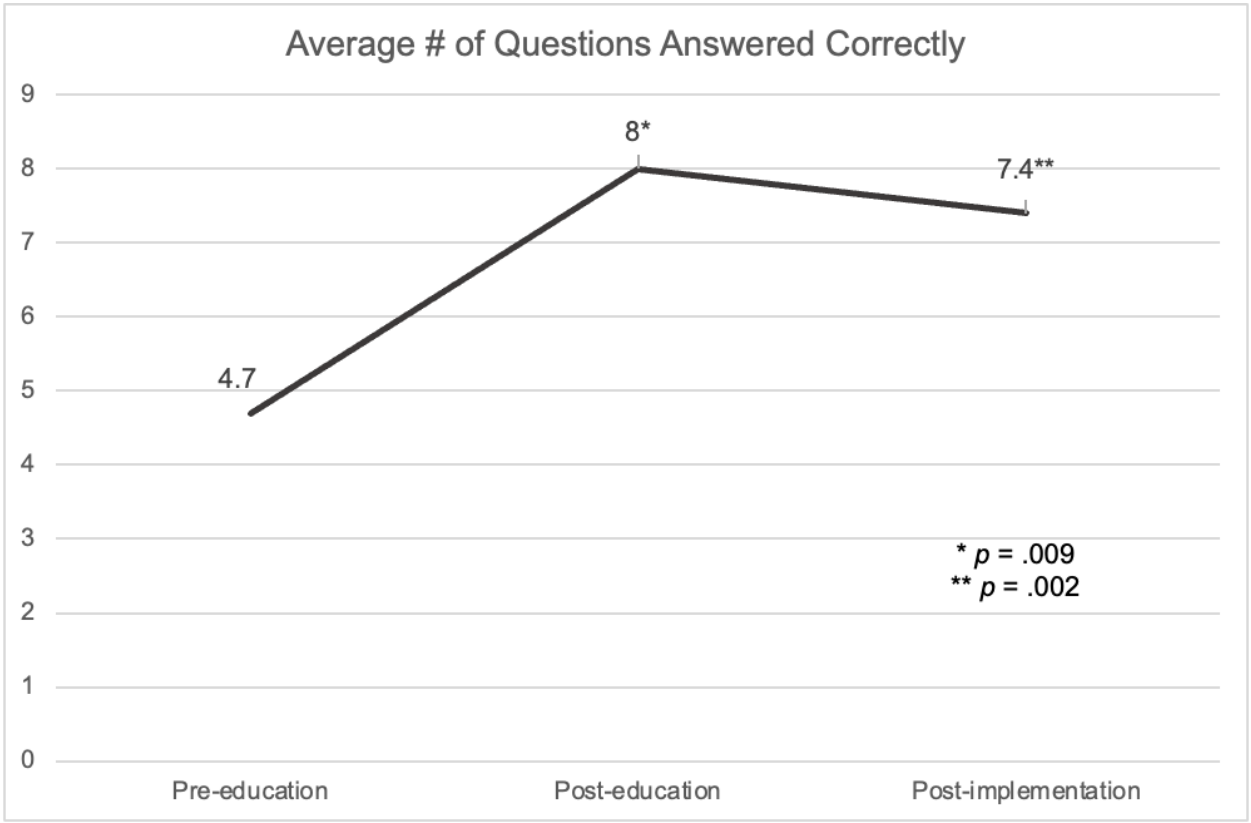
# Results

## Staff Education

Nine providers and staff members attended the education session. The anonymous pre- and post-test results showed an improved knowledge base following the education session and practice role play ($p$ = .009). When the test was readministered 12 weeks after the algorithm had been implemented, the results were consistent with retention of knowledge as they showed improvement from baseline ($p$ = .002). There was no difference ($p$ = .76) between the post-education test and post-implementation test. Figure 1 shows the results from the pre- and post-education test and post-implementation test. A copy of the test appears in Appendix D.

**Figure 1**

*Pre-Post Test Results*



**Demographics**

The practice where this project was done follows 5,636 patients, of whom 50% are 60 years old or older, 84% identify as Caucasian, and 53% identify as male. Over the 12-week implementation period 413 patients presented for routine physical exams. Of those, 316 patients completed the Prediabetes Screening Tool. Table 1 shows a comparison of the overall practice age and gender to those patients who were screened in the project and completed the Prediabetes Screening Tool. Due to the nature of the project, complete demographics on the project participants were not available for analysis.

**Table 1**

*Comparison of Practice vs. Project Age & Gender*

| **Age** | **Practice n (%)** | **Project n (%)** | **Project Compared to Practice** |
|---|---|---|---|
| *Under 39 years* | 1345 (24%) | 84 (27%) | +3% (*p* = NS) |
| *40-49* | 634 (11%) | 48 (15%) | +4% (*p* = NS) |
| *50-59* | 843 (15%) | 71 (22%) | +7% (*p* = .033) |
| *60 or older* | 2814 (50%) | 113 (36%) | -14% (*p* = <.008) |
| *Total* | 5636 | 316 | |
| **Gender** | **Practice n (%)** | **Project n (%)** | **Project Compared to Practice** |
| *Male* | 3019 (54%) | 170 (54%) | = |
| *Female* | 2617 (46%) | 146 (46%) | = |
| *Total* | 5636 | 316 | |

While the age distribution of the patients who were screened was less representative of the overall practice, the gender split of those who completed the Prediabetes Screening Tool mirrored that of the overall practice. Of those patients screened, three percent had a history of gestational diabetes (Figure 2), and 21% had a family history of a first degree relative, other than offspring, with diabetes (Figure 3). Twenty-eight percent had a history of hypertension

(Figure 4). Eighty-three percent of patients noted that they were physically active. Despite this, 67% of patients were considered overweight or obese based on BMI (Figure 5).

**Figure 2**

*History of Gestational Diabetes*

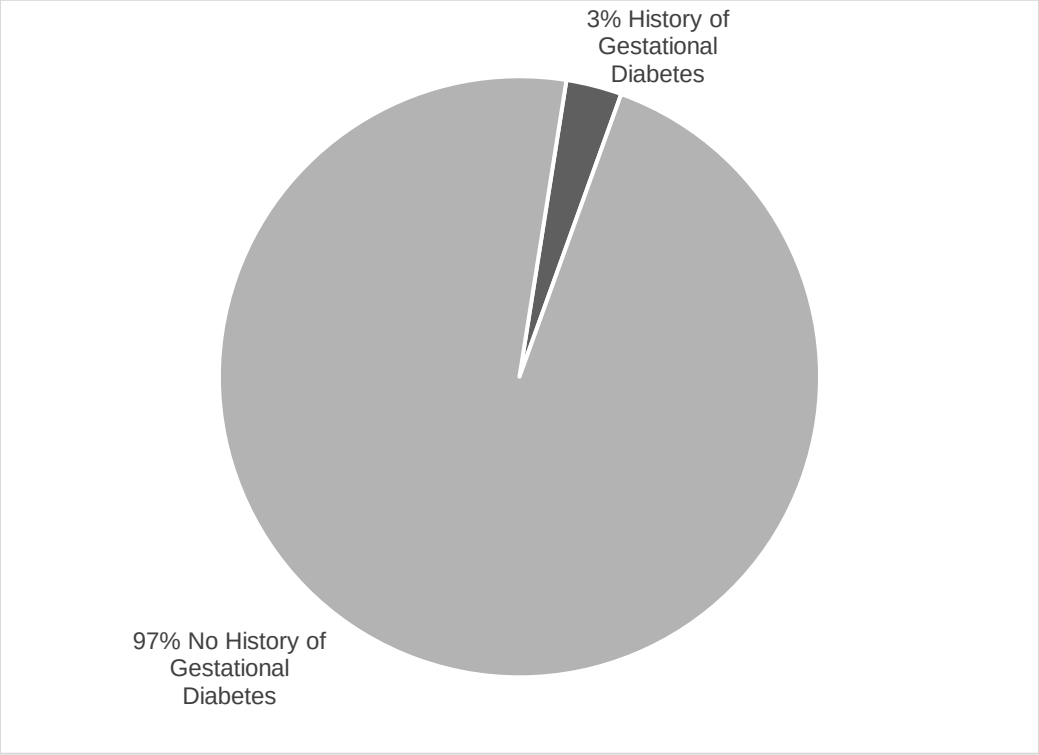


**Figure 3**

*Family History of First-Degree Relative, Other Than Offspring, with Diabetes*

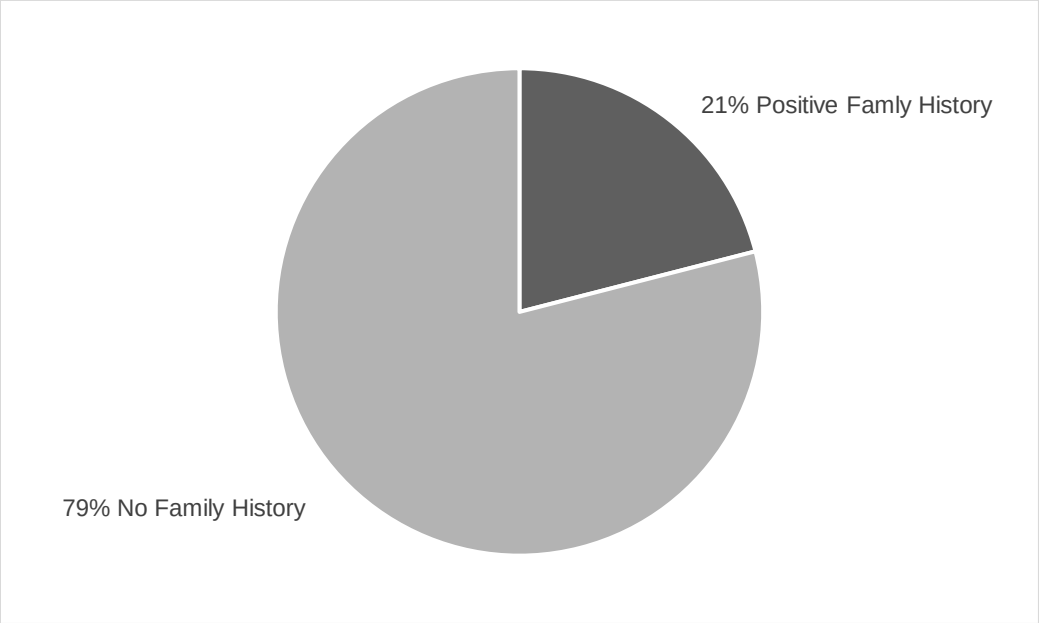



**Figure 4**

*History of Hypertension*

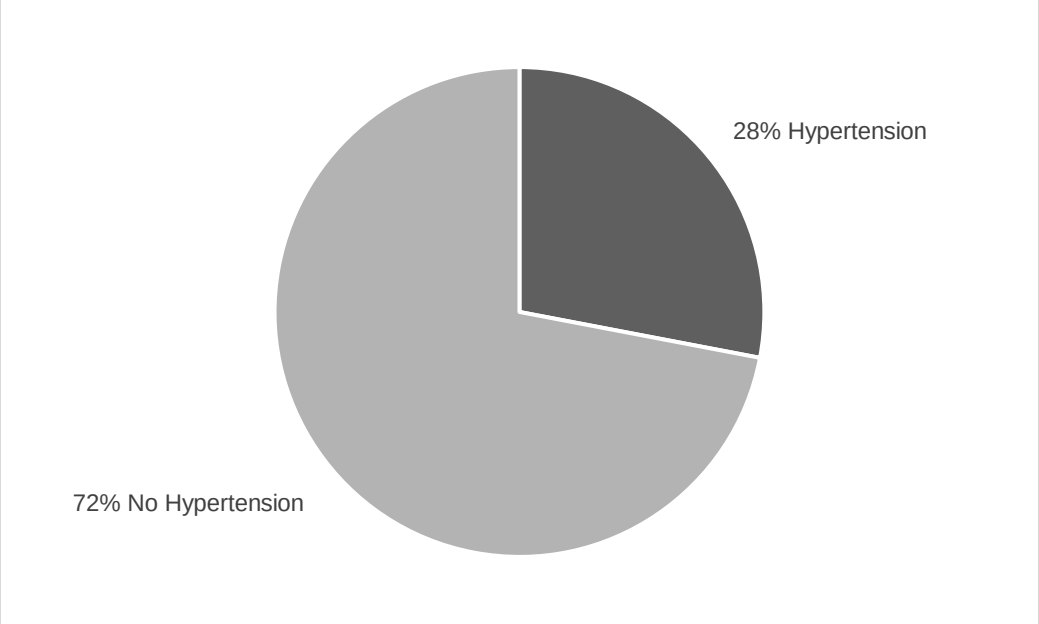
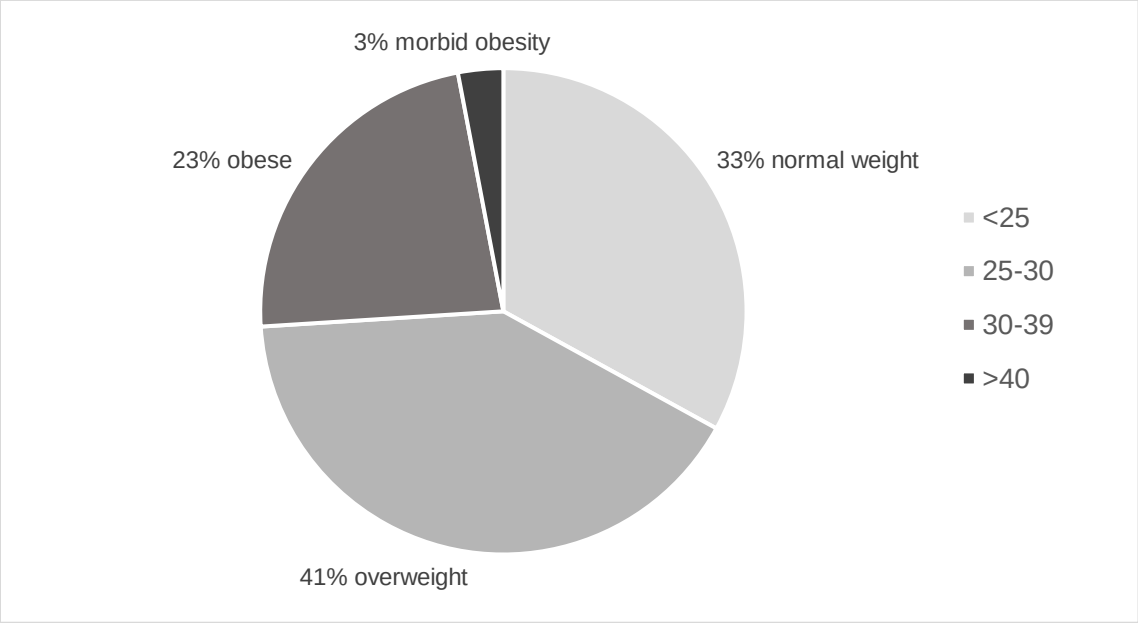


**Figure 5**

*BMI % of Patients Screened*

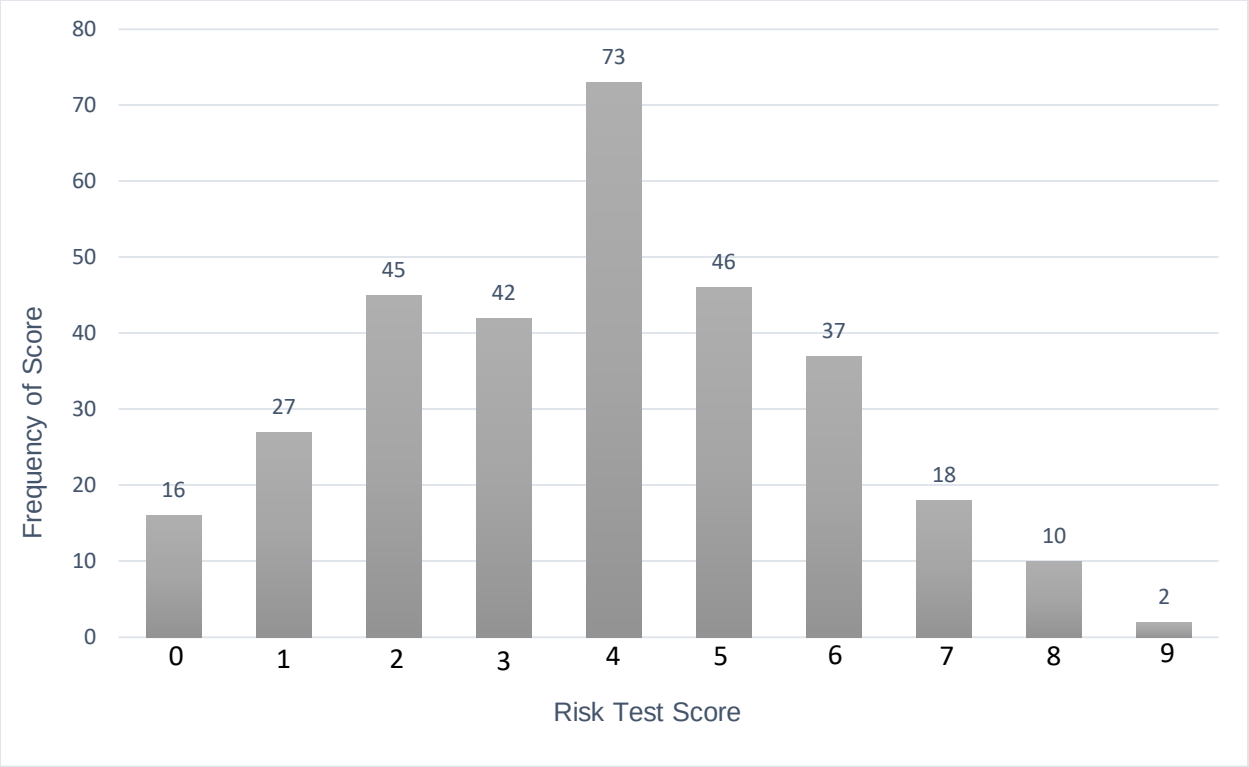



**Prediabetes Screening Outcomes**

Of the 316 patients screened with the Prediabetes Screening Tool, 112 (35%) were identified as high risk with a risk test score of five or greater. Sixteen patients had a risk test score of zero and two patients had the highest score of nine. The most frequently recorded score was four, with 73 patients (23%) having this result (Figure 6).

**Figure 6**

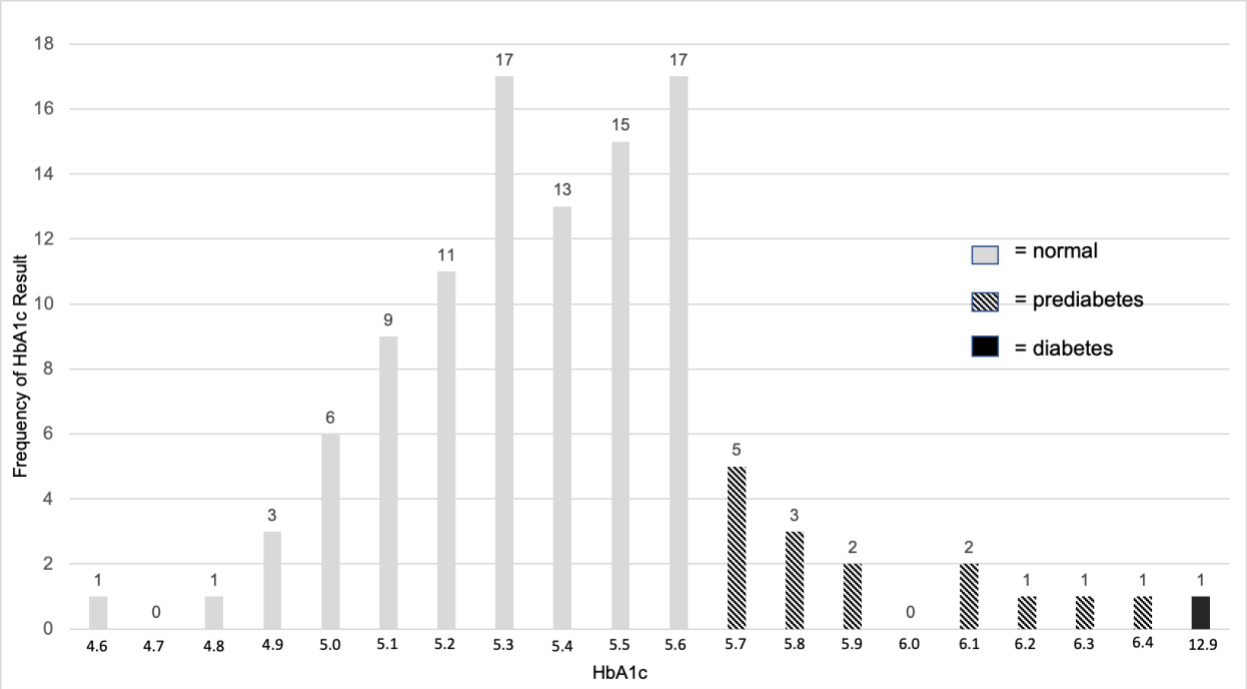
*Risk Test Scores*




One hundred nine of the patients identified as high risk (97%) completed POC HbA1c testing. The other three patients refused testing. HbA1c results ranged from 4.6% to 12.9%. The mean HbA1c was 5.5% (SD +/- 0.78) and the median was 5.4%. A graphic representation of HbA1c results appear in Figure 7.

**Figure 7**

*HemoglobinA1c Results*



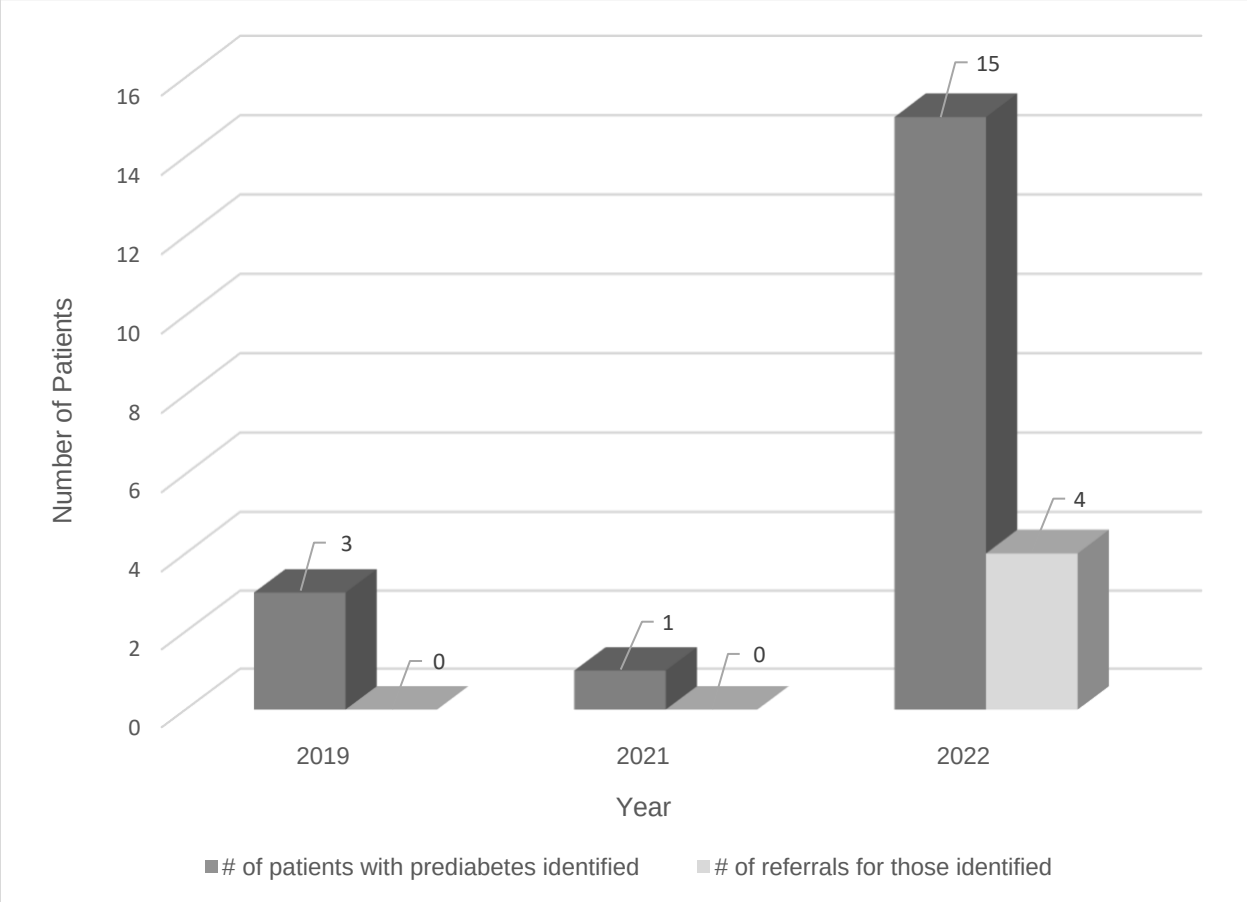

Of those identified as high risk who completed POC HbA1c testing, 15 were identified as having prediabetes with a HbA1c between 5.7-6.4%. This equated to 13% of those identified as high risk and 4.7% of the total number of patients screened. One patient was identified as having type 2 diabetes with a HbA1c of 12.9%. Four of the 15 patients identified agreed to an intervention (27%). Three patients were referred to lifestyle medicine and one was started on metformin. The remaining 11 patients (73%) declined intervention. These results are illustrated in Figure 8.

The data from the implementation period were compared to data collected retrospectively from the corresponding 12-week time frames in 2019 and 2021. The year 2020 was not included for comparison due to the ongoing Covid-19 pandemic and lack of routine visits during that time. In 2019, 285 patients presented for routine physical exam (four providers) and three patients were identified as having prediabetes. In 2021, 585 patients presented for

routine physical exam (five providers) and one patient with prediabetes was identified. No referrals were made for the patients who were identified as having prediabetes in 2019 and 2021. Utilizing the screening algorithm showed a marked increase in both the identification of prediabetes and referrals placed compared to the years analyzed prior to utilization of the algorithm (Figure 8).

**Figure 8**

*Prediabetes Identification and Referrals*



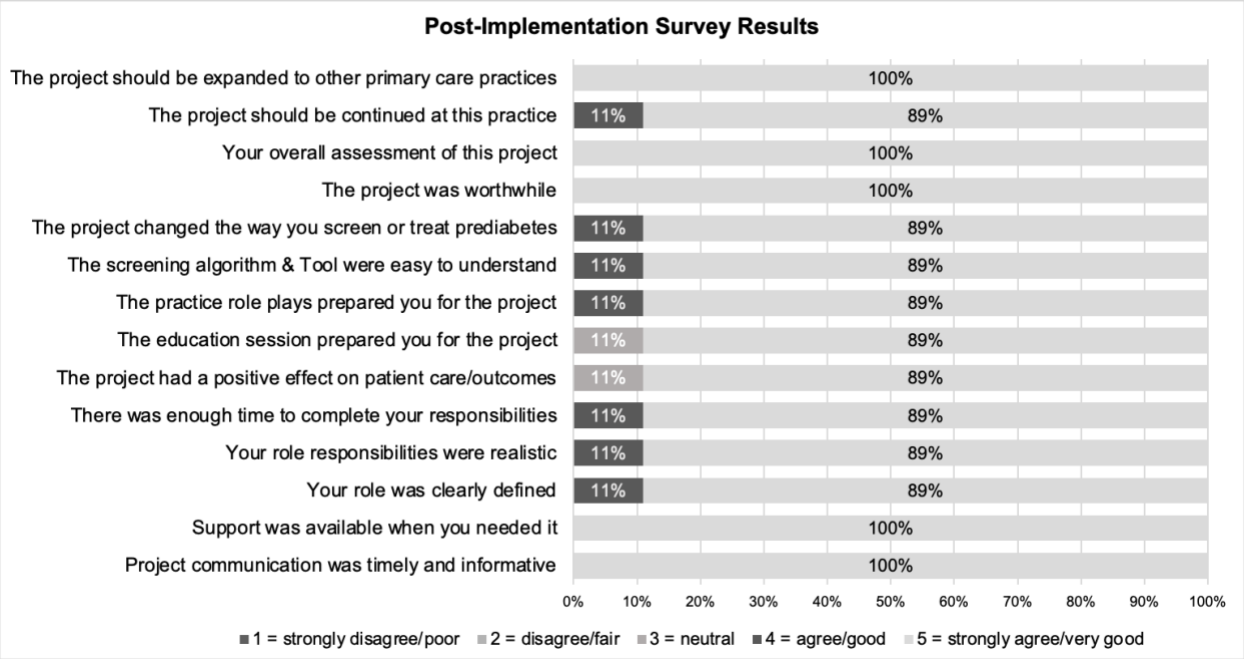

**Post-Implementation Analysis**

Following implementation all staff and providers completed a 14-item survey for evaluation of the project. Using a five-point Likert scale, 100% of providers and staff strongly agreed that project communication was timely and informative, support was available when needed, the project was worthwhile, the overall assessment of the project was very good, and

the project should be expanded to other primary care practices. Survey results are illustrated in Figure 9.

**Figure 9**

*Post-Implementation Survey Results*




The post-implementation survey also contained two open-ended questions to solicit recommendations for improvement and any additional comments or feedback. Eight of nine respondents provided answers to at least one question. Two respondents recommended incorporating the paper Prediabetes Screening Tool into the electronic health record for patients to complete prior to their visit while another recommended continuing the project as is. Several respondents wrote that the project was informative and beneficial to patients, and one specifically noted that the education sheet for patients was beneficial. Additional comments included that the screening algorithm was a fast and effective tool to identify prediabetes and improving insurance coverage for screening Medicare patients would be beneficial.

# Chapter 5

# Discussion and Conclusion

## Discussion

Identification of prediabetes is imperative to implement lifestyle modifications to prevent or delay the onset of type 2 diabetes. Lack of standardized reference ranges and screening guidelines remain limiting factors. Data show 38-80% of those eligible for screening are not screened, only 5-25% are given a diagnosis when prediabetes is identified, and 0-23% are referred for behavior intervention when prediabetes is identified (Brunisholz et al., 2021; Echouffo-Tcheugui & Selvin, 2021; Evron et al., 2019; Mainous et al., 2016; Mainous et al. 2022; Nhim et al, 2018; Obinwa et al., 2020; Thomas et al., 2021). Utilizing the screening algorithm designed for this project showed improved prediabetes identification and subsequent referral compared to the equivalent time frame from two prior years in the recent past. Staff and providers both had statistically significant improved knowledge immediately after the education and role-playing sessions and retention of knowledge after 12 weeks. The improved knowledge likely assisted with the identification of patients with prediabetes. Additionally, staff and providers had positive feedback about the project. The driver of the algorithm was the Prediabetes Risk Test which identified individuals who needed additional screening. The positive predictive value (PPV) of the tool in the literature is 8-13% depending on the population (Heikes et al., 2008; Herman et al., 1995). It performed on the higher end of that range in this project with a PPV of 13%.

There was an incongruence between the number of routine physical exam appointments (413) and number of Prediabetes Screening Tools completed (316). One contributing factor was the exclusion criteria of preexisting prediabetes or type 2 diabetes. The number of patients with these preexisting diagnoses was not readily available. An additional consideration was the potential for a change in appointment type: for example, if a routine physical exam was changed to a follow-up visit and was not updated in the electronic health record. Additionally, there were

staff changes over the 12-week project implementation period that could have resulted in a missed screening. It is not clear that every eligible patient who presented for routine physical exam was screened.

Patients over the age of 65 were not adequately represented in this project. Most patients over the age of 65 have Medicare insurance and in the absence of a supplemental insurance or an advantage plan, routine physical exam appointments are not a covered entity. Individuals between the ages of 50 and 59 were also not adequately represented in the project. It is not clear why this group had a statistically significant underrepresentation. Additionally, one provider's patients were not included in the project as this provider joined the practice where the project was being implemented after it had already begun. This provider took over the patients of a provider in the practice who retired and anecdotally noted that many of the patients she took over had elevated fasting glucose levels, often on several occasions, that were not further evaluated. It is possible that including all patients and providers in the project may have identified additional patients with prediabetes.

Only 27% of those patients identified as having prediabetes were willing to accept a referral. There are several factors related to this low percentage to consider. Patients could have been overwhelmed with information as this was the first time for many patients that prediabetes was mentioned or discussed. Lifestyle-change programs are the most effective intervention and have shown success at delaying the progression to type 2 diabetes by 36-58% (NIDDK, 2021; Duan et al., 2021; Glechner et al., 2018). However, many patients felt confident they could implement lifestyle modifications on their own. Additionally, some patients were concerned with the financial aspects of a referral. Co-pays are often necessary for additional visits with a higher cost associated with specialty visits (Machlin & Mitchell, 2018). To improve referral uptake, lifestyle medicine offered at the primary care site, or virtually through an application on the mobile phone or computer, might be more successful (Ali et al., 2012). Future studies can look at re-screening patients in six months to one year to see if they would be more

willing to accept a referral, if they still met criteria for prediabetes despite the lifestyle modifications they implemented or failed to implement despite their best intentions.

In this project, 83% of patients screened noted that they were physically active. The CDC reports that only 46.9% of adults meet the physical activity guidelines of 150 minutes of moderate intensity physical activity and two days of muscle strengthening activity weekly (CDC, 2022e). People with prediabetes may have been missed because of an inaccurate response to the physical activity question because the amount of physical activity is not quantified or otherwise specified on the Prediabetes Screening Tool. This incongruence is notable as many patients (23%) scored a 4 on the risk test. The question, “are you physically active,” is very subjective and is likely to result in less accurate scores. To improve the accuracy and utilization of the Prediabetes Risk Test, future studies can look at adjusting the physical activity question to “Do you get 150 minutes of moderate intensity physical activity and two days of muscle strengthening a week?” The direct nature of the question, with only a yes or no answer, will allow the tool to remain easy to administer and result in more precise assessment and identification of those at high risk.

**Limitations**

This project had multiple limitations. Routine physical exam appointments were the target appointment type for this project as their focus is on screening for, and prevention of, chronic disease. As mentioned above, routine physical exams are not a covered entity for patients who have Medicare and no additional or secondary insurance, thus a significant number of patients over the age of 65 were not included in this project. Increasing age is correlated with higher risk of having prediabetes or type 2 diabetes (CDC, 2022c). Additional studies should be conducted implementing the screening algorithm for follow up-type visits to include patients who have Medicare and no other supplementary insurance.

The sample population must also be considered. This project was conducted in a single center with relatively financially advantaged surrounding towns. This could cause the sample to

be less representative of the U.S. population. Additionally, there was a lack of diversity in the sample population. White, non-Hispanic Americans make up 7.4% of all adults diagnosed with diabetes in the U.S. while American Indian or Alaskan Natives make up 14.5%, Asians make up 9.5%, Black, non-Hispanics 12.1% and Hispanic, overall 11.8% respectively (CDC, 2022d). The specific demographics such as race and ethnicity were not collected on project participants. Specific demographics of the practice revealed the majority of patients identify as Caucasian (84%) while nationally Caucasians make up 59% of the population (U.S. Census Bureau, n.d.). To better evaluate prediabetes screening and identification, conducting this project in different locations that serve a wider variety of socioeconomic and demographic groups would be beneficial.

Other limitations include staffing shortages resulting in missed opportunities for screening. Two MAs, who attended the education session and began the project, left the practice midway through. Only one MA was present from start to finish of the project. Float staff from other offices rotated in for coverage until permanent staff could be hired. While every attempt was made to educate new or floating MAs, lack of time and prior notice of their arrival to the practice limited the amount of education they received about the project. An additional staffing limitation was having a provider retire and one new provider start in the middle of the project. While neither provider was included in the project, there were disruptions to the normal office workflow covering for the retirement and onboarding a new provider.

While the main goals of the project were to increase identification of prediabetes and increase referrals to lifestyle intervention, due to the short time frame of this project, tracking the referral to see if patients attended was not feasible. Additionally, tracking a patient's readiness for change was not part of this project. While patients were anecdotally noted to be interested in change, they often wanted to try to make lifestyle modifications on their own prior to considering a referral. Conducting a similar project with long term follow up, aimed at tracking attendance to referrals with follow up HbA1c testing and readiness for change assessments, would be

beneficial. Understanding patients' readiness for change and success with referral attendance and independent implementation of lifestyle modifications would help focus future interventions.

An additional consideration is the use of POC HbA1c testing. Currently only one POC machine, Abbott's Afinion AS100 Analyzer, is FDA approved to use for diagnosis of both prediabetes and diabetes (Sobokesky et al., 2018). The majority of POC HbA1c machines are only approved for use for the monitoring and management of already diagnosed prediabetes and diabetes. While the Siemens DCA Vantage machine that was used in this project is NGSP certified, it does not have FDA approval for diagnosis of prediabetes and type 2 diabetes (Siemens Healthineers, 2022). This limits the use of POC testing for diagnosis of prediabetes until additional POC systems are approved. With current technological advances it is likely that other machines will also be approved for the diagnosis of prediabetes in the near future in addition to monitoring and management.

**Strengths**

This project had several strengths. The results indicate improved prediabetes identification and increased referrals using a system that was low cost and feasible to implement in a primary care setting. The low cost would allow for easy implementation in other practices or institutions. Providers and staff found the Prediabetes Screening Tool easy to use and noted that it could be improved with integration into the EHR. Additionally, with EHR integration, the risk test questions could be completed prior to a visit to save on the amount of time spent in the office when the patient comes in for a visit. A variety of providers, including MDs, a DO, & APRNs, utilized the tool and found it both helpful and beneficial for patients. Knowledge of prediabetes screening and management improved in providers and staff who were part of this project following implementation of the screening algorithm.

Another strength of the project was the increased awareness of prediabetes among patients, staff, and providers. During meetings with staff and providers post-implementation, they noted more confidence with screening and counseling, and reported screening more

consistently. Many providers noted they started ordering labs prior to physical exams and included HbA1c testing as part of the panel. Additionally, some providers are continuing to screen their patients who are at high risk of having prediabetes with POC HbA1c testing during their visits.

**Sustain and Scale**

As noted by several respondents in the post-implementation survey, integrating the Prediabetes Screening Tool into the EHR would allow for patients to complete the risk test prior to their appointment and save time during the rooming process. Additionally, creating a screening tab in the EHR that has the Prediabetes Risk Test--like the depression screening--would allow easy access for providers to complete screening for any patient during any visit. An EHR “smartphase” currently exists that can pull the risk test information from the chart. However, there are several limitations related to this tool. For example, if family history is not up to date in the EHR, or gestational diabetes or hypertension are not on the problem list, this information will not be captured for inclusion when making the assessment, thus resulting in an inaccurate risk score. Additionally, it should be noted that some patients who may be eligible might get missed if their risk is calculated based on old, and potentially incorrect, information (such as a normal BMI from a prior visit with subsequent significant weight gain). Moreover, since physical activity can often change, what was entered initially will get pulled in and may not be accurate or up to date, contributing to an imprecise score.

Another way to sustain prediabetes screening is to order labs, including HbA1c, for eligible patients prior to appointments. This would allow for results to be available at the time of visit and discussion to take place face-to-face. Creating a health maintenance reminder in the EHR--like vaccinations due, breast cancer screening, and colon cancer screening--would trigger health care providers to screen patients for prediabetes and diabetes at regular intervals. Consistent standardized guidelines from organizations like the ADA, AACE, USPSTF, and WHO

would also help to facilitate this by reducing varied definitions and diagnosis criteria that results in confusion among providers.

Disseminating project findings will occur with presentations to stakeholders in the organization. Project findings suggest that implementing the Prediabetes Screening Tool in a primary care setting improved identification of prediabetes and increased referrals to lifestyle intervention. This has several beneficial practice implications. As type 2 diabetes is the most expensive chronic condition in the nation, reducing the number of patients who develop type 2 diabetes is a priority (CDC, 2022b; Dall et al., 2019). Similarly, as new payment models begin to emerge with outcome-based reimbursement, reducing the number of patients who develop type 2 diabetes and ultimately the complications related to this, is imperative to ensure reimbursement. Further dissemination at local and national conferences will take place to garner support for consistent definitions and guidelines for prediabetes across organizations and improved screening practices among providers.

**Practice Implications**

There are several implications for practice that emerged from this project. A major implication is the need for consistent criteria and definition of prediabetes among organizations such as the ADA, AACE, USPSTF, and WHO. Standardized screening guidelines would reduce confusion and varied practices among providers. Adding prediabetes and diabetes screening to the health maintenance list would provide a recurrent reminder for providers to screen their patients and continue the conversation about prediabetes and its implications. Improved understanding of patient attitudes about prediabetes identification and readiness for change would be helpful to address referral uptake. Additional resources are needed such as more diabetes prevention programs or lifestyle change programs that are readily accessible. Many organizations are launching applications or technology-based diabetes prevention programs (DPP) and lifestyle change programs, such as the HALT Diabetes application and Project Power (ADA) to increase access for more patients (HALT Diabetes Health & Lifestyle Training,

2023; Project Power: American Diabetes Association, 2023). A recent systematic review found that virtual or remotely administered lifestyle interventions were effective at reducing glycemic biomarkers and weight and had higher participation rates than in-person programs (Villegas et al., 2022). Additionally, a randomized control trial (n=599) where participants were placed in a digital diabetes prevention program or an in-person education class showed significantly greater reductions in weight and HbA1c in the digital diabetes prevention program (Katula et al., 2022). Ensuring patients have access to these efficacious programs is imperative.

**Conclusion**

The screening algorithm utilized in this project, which included the Prediabetes Risk Test and POC HbA1c testing was a feasible, low cost, and effective way to improve prediabetes screening and identification in the primary care setting. Educating staff and providers about prediabetes and the project itself immediately prior to project implementation was effective and showed improved knowledge based on pre- and post-test results as well as retention of knowledge following implementation. While the project lacked a representative sample, future studies can be designed to incorporate more diverse populations. Additionally, there remains a gap in uptake of referrals that must be addressed. The results of this project support the utilization of combination screening, with a validated risk test and POC HbA1c testing, at outpatient preventative care visits as a way to improve prediabetes identification and increase referrals to lifestyle intervention.

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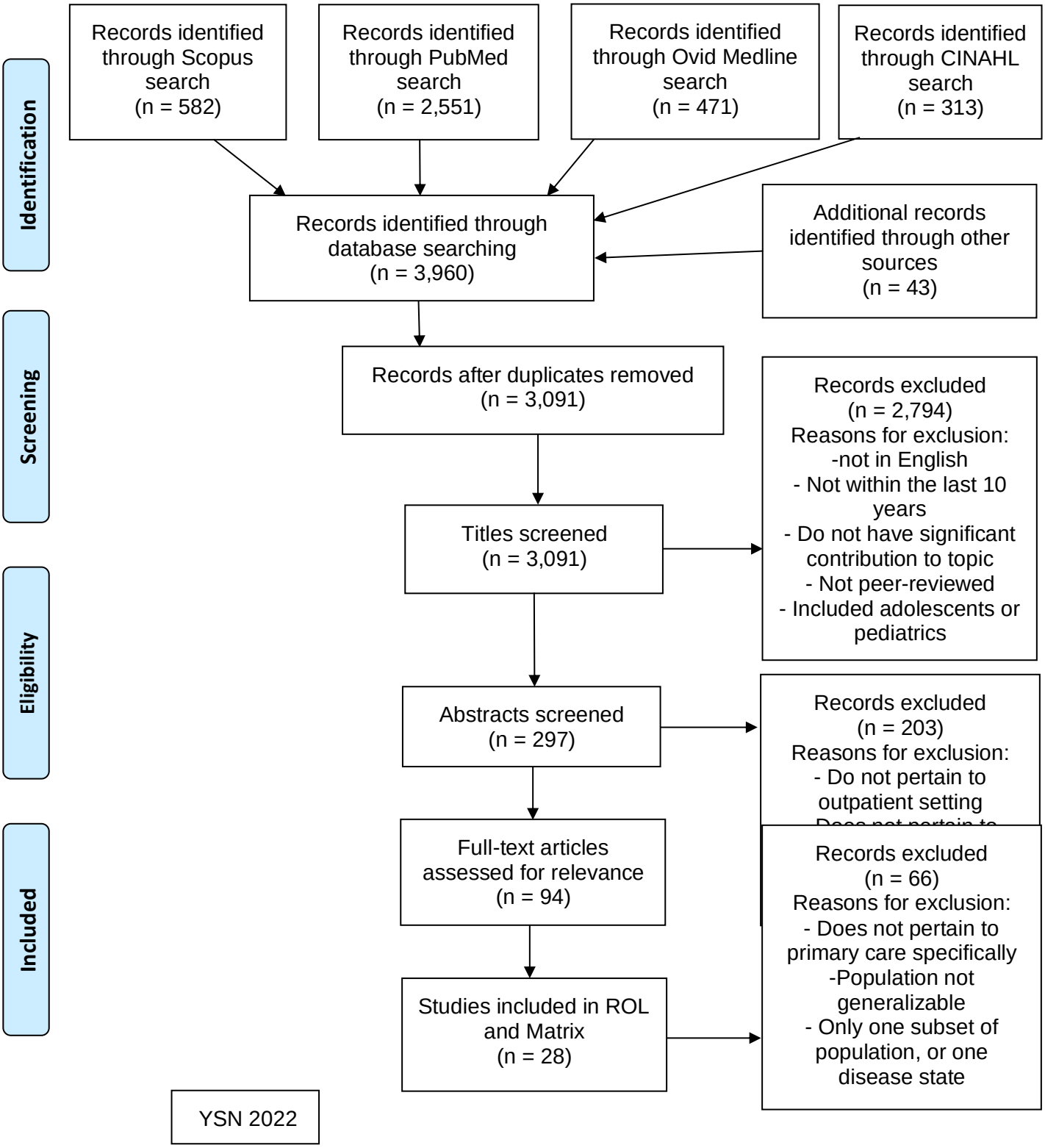
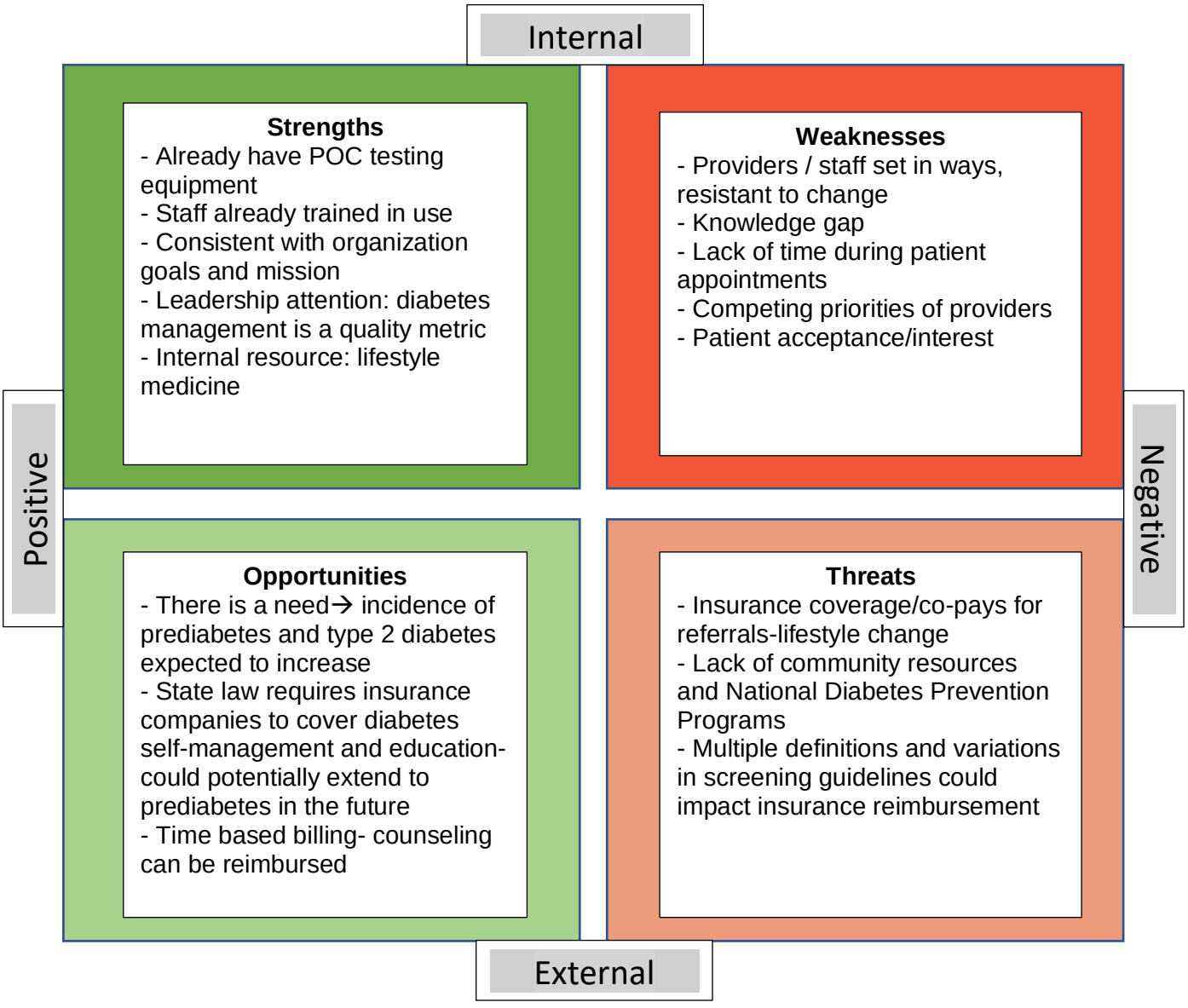
**Appendix A**

Adapted PRISMA Flow Diagram for DNP Project ROL



## Appendix B

**Figure 1** *SWOT Analysis as applied to project implementation*



## Appendix B

**Figure 2a** *Prediabetes Screening Tool: Front Side*

# Prediabetes Risk Test

NATIONAL DIABETES PREVENTION PROGRAM

**1. How old are you?**

Write your score in the boxes below

Younger than 40 years (0 points)
40–49 years (1 point)
50–59 years (2 points)
60 years or older (3 points)

**2. Are you a man or a woman?**

Man (1 point) Woman (0 points)

**3. If you are a woman, have you ever been diagnosed with gestational diabetes?**

Yes (1 point) No (0 points)

**4. Do you have a mother, father, sister, or brother with diabetes?**

Yes (1 point) No (0 points)

**5. Have you ever been diagnosed with high blood pressure?**

Yes (1 point) No (0 points)

**6. Are you physically active?**

Yes (0 points) No (1 point)

**7. What is your weight category?**

(See chart at right)

Total score:

| Height | Weight (lbs.) | | |
|---|---|---|---|
| 4'10" | 119-142 | 143-190 | 191+ |
| 4'11" | 124-147 | 148-197 | 198+ |
| 5'0" | 128-152 | 153-203 | 204+ |
| 5'1" | 132-157 | 158-210 | 211+ |
| 5'2" | 136-163 | 164-217 | 218+ |
| 5'3" | 141-168 | 169-224 | 225+ |
| 5'4" | 145-173 | 174-231 | 232+ |
| 5'5" | 150-179 | 180-239 | 240+ |
| 5'6" | 155-185 | 186-246 | 247+ |
| 5'7" | 159-190 | 191-254 | 255+ |
| 5'8" | 164-196 | 197-261 | 262+ |
| 5'9" | 169-202 | 203-269 | 270+ |
| 5'10" | 174-208 | 209-277 | 278+ |
| 5'11" | 179-214 | 215-285 | 286+ |
| 6'0" | 184-220 | 221-293 | 294+ |
| 6'1" | 189-226 | 227-301 | 302+ |
| 6'2" | 194-232 | 233-310 | 311+ |
| 6'3" | 200-239 | 240-318 | 319+ |
| 6'4" | 205-245 | 246-327 | 328+ |
| | 1 Point | 2 Points | 3 Points |
| | *You weigh less than the 1 Point column (0 points)* | | |

Adapted from Bang et al., Ann Intern Med 151:775-783, 2009. Original algorithm was validated without gestational diabetes as part of the model.

### If you scored 5 or higher

You are at increased risk for having prediabetes and are at high risk for type 2 diabetes. However, only your doctor can tell for sure if you have type 2 diabetes or prediabetes, a condition in which blood sugar levels are higher than normal but not high enough yet to be diagnosed as type 2 diabetes. Talk to your doctor to see if additional testing is needed.

*If you are African American, Hispanic/Latino American, American Indian/Alaska Native, Asian American, or Pacific Islander, you are at higher risk for prediabetes and type 2 diabetes. Also, if you are Asian American, you are at increased risk for type 2 diabetes at a lower weight (about 15 pounds lower than weights in the 1 Point column). Talk to your doctor to see if you should have your blood sugar tested.*

### You can reduce your risk for type 2 diabetes

Find out how you can reverse prediabetes and prevent or delay type 2 diabetes through a CDC-recognized lifestyle change program at https://www.cdc.gov/diabetes/prevention/lifestyle-program.

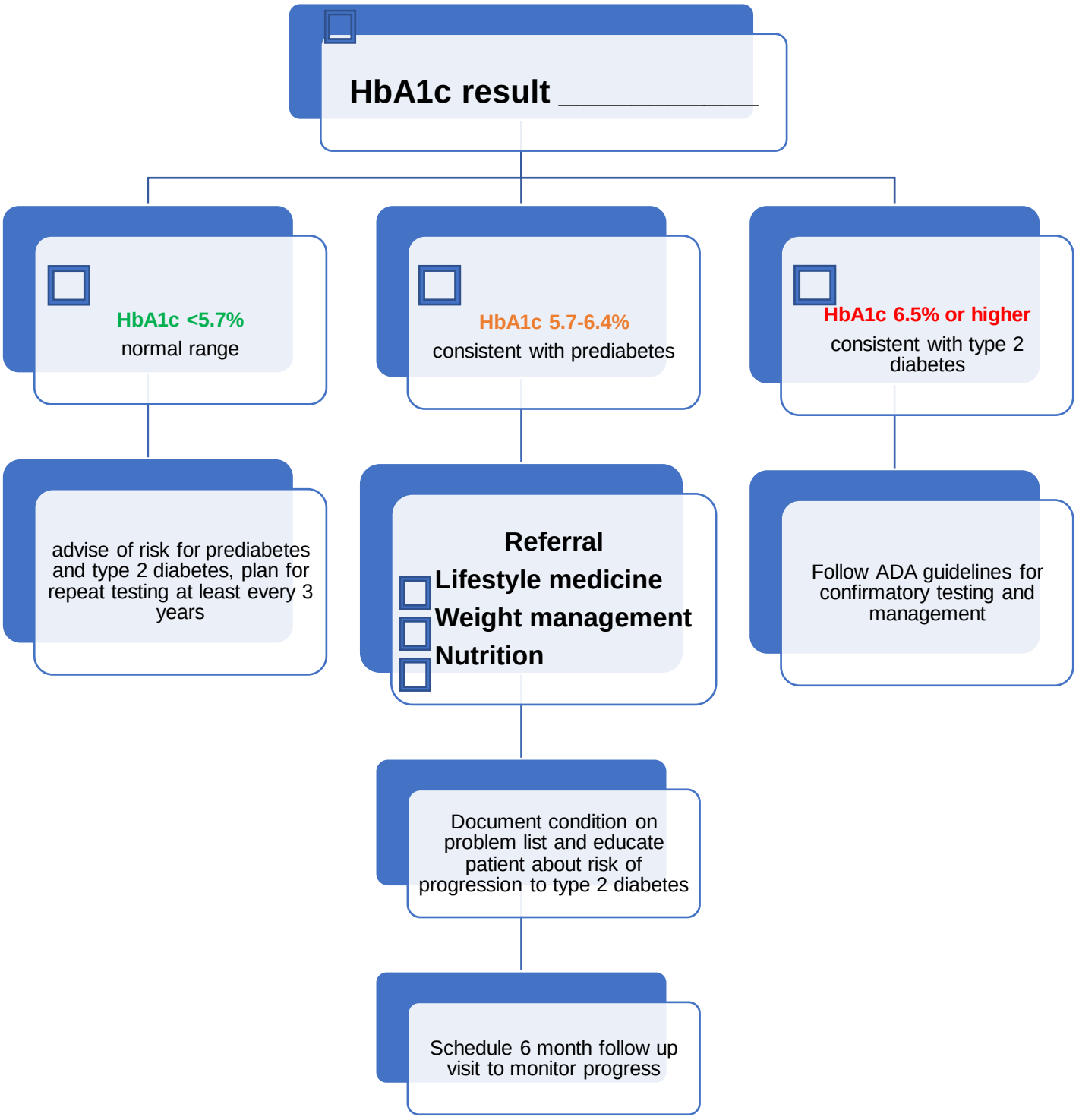
Risk Test provided by the American Diabetes Association and the Centers for Disease Control and Prevention.

American Diabetes Association. CDC Centers for Disease Control and Prevention

CS300699-A

**Appendix B**

**Figure 2b** *Prediabetes Screening Tool: Back Side*

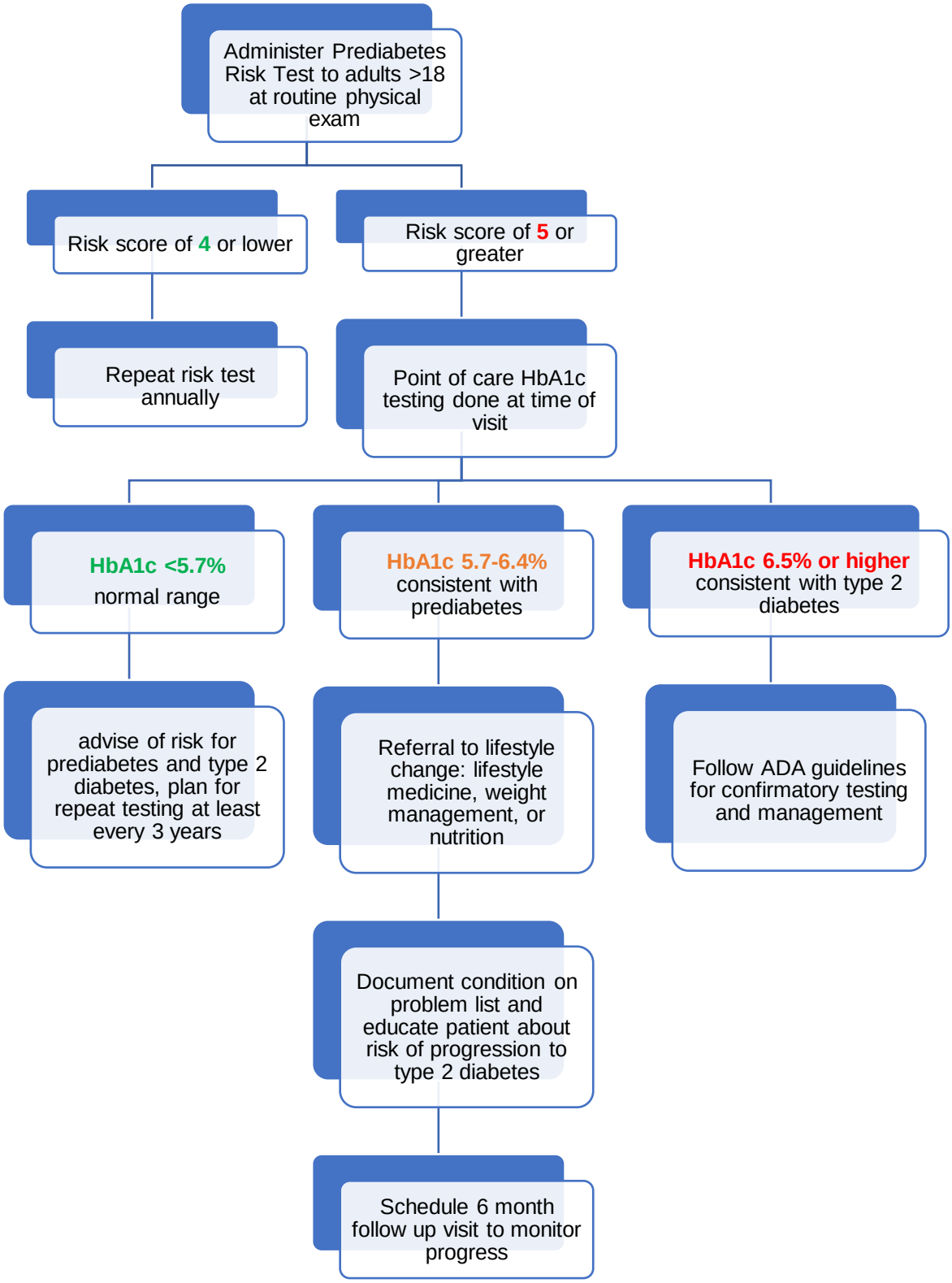



**Declined referral** **Metformin Prescription**

**Place completed form in designated folder in medication room**

## Appendix B

**Figure 3** *Prediabetes Screening Algorithm*



## Appendix C

*Role review*

- **The Medical Assistant** (MA) will identify the patients scheduled for routine physical exam without a diagnosis of diabetes or prediabetes. They will complete the paper risk test on the front Prediabetes Screening Tool with the patient during the rooming process. The MA will add up the score of the risk test and if the score is 5 or greater, they will run a POC HbA1c test on the patient which is part of their normal role responsibility and within their scope of practice. They will document the HbA1c result in the EHR and on the back of Prediabetes Screening Tool in the designated area and give to the provider.
- **The LPN** is occasionally required to help with the rooming process. In these instances, they will complete all the MA tasks as outlined above for rooming.
- **The Provider (MD, DO, or APRN)** will be responsible for interpreting the POC HbA1c test. If the HbA1c test is normal (5.6% or less), the Provider will educate the patient about their risk for prediabetes and type 2 diabetes and plan to repeat HbA1c testing at least every 3 years per ADA guidelines. If prediabetes is identified (HbA1c 5.7-6.4%) the Provider will make a referral for lifestyle intervention and check the corresponding box on the back of the Prediabetes Screening Tool. The determination of which option is best will be based on shared decision making to include clinical judgement and patient preference. The Provider will document prediabetes on the problem list, educate the patient about prediabetes, give written education materials from the ADA (Appendix E), and schedule a follow up visit in 6 months to reassess. If the HbA1c is 6.5% or greater, the Provider will follow ADA guidelines for ordering confirmatory testing and initiate treatment of type 2 diabetes. If the patient declines a referral to lifestyle intervention or is given a prescription for metformin, the designated box will be checked on the back of the Prediabetes Screening Tool. The completed Prediabetes Screening Tool will then be placed in a lockbox in the medication room. The medication room is secured by badge-

controlled access and is only accessible to Providers, the Office Manager, MAs and LPNs.

- **The Project Lead** in addition to serving as a Provider (as outlined above), will retrieve the completed Prediabetes Screening Tools twice a week and enter the following data into REDCap: risk test answers, HbA1c result, and intervention or referral. The Prediabetes Screening Tools will then be shredded. The Project Lead will also extract data from REDCap on a biweekly basis during the implementation period that will be posted on the staff huddle board to provide ongoing motivation. The Project Lead will be available to all staff and Providers to answer questions and assist with any part of the project throughout implementation. Ongoing meetings with the project working group will occur monthly and as needed during implementation to hear feedback about barriers that may arise with the algorithm.
- **The Office Manager** will support staff and providers by being familiar with all roles and responsibilities such that they will be able to answer questions or direct them to the appropriate person.
- **The Patient Service Coordinators** will understand the steps of the screening algorithm, referral options, the definition of prediabetes, and will direct patient questions to the appropriate person.

*Role Play*

MA will go through the rooming process with the Project Lead acting as the patient and record the answers to the risk test on the front of the Prediabetes Screening Tool. The MA will then go through the motions of doing a POC HbA1c test, recording the result and giving the Prediabetes Screening Tool with HbA1c result to the Provider. The Provider will then interpret the HbA1c and go through the motions of determining what referral will be placed and check the designated box on the Prediabetes Screening Tool. They will then place the completed

Prediabetes Screening Tool in the lockbox in the medication room. LPNs who are occasionally required to help with rooming patients will complete the role play process in the same fashion. The Office Manager who is responsible for understanding all roles will watch role plays or act as a patient. Each staff member and Provider will participate in two role plays prior to implementation. If any staff member or Provider does not feel confident in completing their role, additional practice role plays will take place with the Project Lead.

## Appendix D

*Education Session Pre- & Post-Test*

Role- Please check one: Provider_____ LPN _____ MA _____

1. Which test is NOT recommended for screening for prediabetes?
   A. Random blood glucose (RBG)
   B. Fasting blood glucose (FBG)
   C. HemoglobinA1c (HbA1c)
   D. Oral glucose tolerance test (OGTT)

2. Prediabetes is defined using which of the following reference ranges?
   A. HbA1c 5.7%-6.4% or FBG 100-125mg/dl
   B. HbA1c 6.5% or greater
   C. OGTT >200
   D. RBG >200

3. What percentage of the population has prediabetes?
   A. 7%
   B. 22%
   C. 38%
   D. 54%

4. What complications of type 2 diabetes can also be present in someone with prediabetes? Select all that apply:
   A. Neuropathy
   B. Nephropathy
   C. Retinopathy
   D. Increased risk of cardiovascular disease

5. Who should be screened for prediabetes? Select all that apply.
   A. A healthy 35-year-old female
   B. An overweight 19-year-old
   C. A 57-year-old smoker
   D. A 45-year-old with hypertension
   E. A 27-year-old with a history of gestational diabetes and BMI of 19

6. Which is NOT a risk factor for prediabetes?
   A. Smoking
   B. Gestational diabetes
   C. Having a child with diabetes
   D. Being overweight or obese
   E. High cholesterol

7. Which is NOT a treatment option for prediabetes?
   A. Lifestyle change programs
   B. Lose 7% of body weight
   C. Metformin
   D. GLP- Ozempic, Victoza, Trulicity

## Appendix E

*Patient Education Materials*

# Prediabetes: What Is It and What Can I Do?

American Diabetes Association.

**What is prediabetes?**

Prediabetes is a condition that comes before diabetes. It means your blood glucose levels are higher than normal but aren't high enough to be called diabetes.

There are no clear symptoms of prediabetes. You can have it and not know it.

### If I have prediabetes, what does it mean?

It means you might get type 2 diabetes soon or down the road. You are also more likely to get heart disease or have a stroke.

The good news is that you can take steps to delay or prevent type 2 diabetes.

### How can I delay or prevent type 2 diabetes?

You may be able to delay or prevent type 2 diabetes with:

- Daily physical activity, such as walking.
- Weight loss, if needed. Losing even a few pounds will help.
- Medication, if your doctor prescribes it.

If you have prediabetes, these steps may bring your blood glucose to a normal range. But you are still at a higher risk for type 2 diabetes.

**Regular physical activity can delay or prevent diabetes.**

Being active is one of the best ways to delay or prevent type 2 diabetes. It can also lower your weight and blood pressure, and improve cholesterol levels. Ask your health care team about activities that are safe for you.

One way to be more active is to try to walk for half an hour, five days a week. If you don't have 30 minutes all at once, take shorter walks during the day.

**Weight loss can delay or prevent diabetes.**

Reaching a healthy weight can help you a lot. If you're overweight, any weight loss, even 7 percent of your weight (for example, losing about 15 pounds if you weigh 200), may lower your risk for diabetes.

# Prediabetes: What Is It and What Can I Do?

American Diabetes Association.

### Make Healthy Choices

Here are small steps that can go a long way toward building healthy habits. Small steps add up to big rewards.

- Avoid or cut back on regular soft drinks and juice. Have water or try calorie-free drinks.
- Choose lower-calorie snacks, such as popcorn instead of potato chips.
- Include at least one vegetable every day for dinner.
- Be careful with salad toppings—the calories can add up fast.
- Choose fruit instead of cake, pie or cookies.
- Cut calories by:
  - Eating smaller servings of your usual foods.
  - When eating out, share your main course with a friend or family member. Or take half of the meal home for lunch the next day.
- Roast, broil, grill, steam or bake instead of deep-frying or pan-frying.
- Be mindful of how much fat you use in cooking.
- Avoid foods high in saturated fat, such as butter, lard and shortening.
- Use healthy oils, such as canola, olive and vegetable.
- Start with one meat-free meal each week by trying plant-based proteins such as beans or lentils in place of meat.
- Choose fish at least twice a week.
- Eat lean meats, such as the round or loin cuts, or chicken without the skin.
- Cut back on processed meats that are high in fat and sodium. These include hot dogs, sausage and bacon.
- Eat fewer and smaller portion sizes of desserts and treats, such as ice cream, cake and cookies. Try saving these for special occasions.

### Track Your Progress

Write down what and how much you eat and drink for a week. Writing things down makes you more aware of what you're eating and helps with weight loss. Take note of the easier changes you can make to reduce your calories and start there.

### Summing It Up

Diabetes is a common, but serious, disease. You can prevent or delay type 2 diabetes by increasing your activity and losing a small amount of weight.

#### Get Started

- Be physically active.
- Make a plan to lose weight.
- Track your progress.

#### Get Checked

If you are at increased risk for diabetes, ask your doctor about getting tested at your next visit. You can take our risk test at diabetes.org/risktest to find out if you are at risk for type 2 diabetes.

The American Diabetes Association® is here to help. For more information, visit us at **diabetes.org** or call **1-800-DIABETES** (800-342-2383).

## Appendix F

*Post-Implementation Staff & Provider Feedback Survey*

Please answer the following questions by circling a number based on the following scale:

**1** = Strongly disagree / poor
**2** = Disagree / fair
**3** = Neutral
**4** = Agree / good
**5** = Strongly agree / very good

| | | | | | |
|---|---|---|---|---|---|
| Project communication was timely and informative | 1 | 2 | 3 | 4 | 5 |
| Support was available when you needed it | 1 | 2 | 3 | 4 | 5 |
| Your role was clearly defined | 1 | 2 | 3 | 4 | 5 |
| Your role responsibilities were realistic | 1 | 2 | 3 | 4 | 5 |
| There was enough time to complete your responsibilities | 1 | 2 | 3 | 4 | 5 |
| The project had a positive effect on patient care/outcomes | 1 | 2 | 3 | 4 | 5 |
| The education session prepared you for the project | 1 | 2 | 3 | 4 | 5 |
| The practice role plays prepared you for the project | 1 | 2 | 3 | 4 | 5 |
| The algorithm and Prediabetes Screening Tool were easy to understand | 1 | 2 | 3 | 4 | 5 |
| Your knowledge of screening for prediabetes improved after completing the project | 1 | 2 | 3 | 4 | 5 |
| Your knowledge of managing prediabetes improved after completing the project. | 1 | 2 | 3 | 4 | 5 |
| This project changed the way you screen or treat prediabetes | 1 | 2 | 3 | 4 | 5 |
| The project was worthwhile | 1 | 2 | 3 | 4 | 5 |
| Your overall assessment of this project | 1 | 2 | 3 | 4 | 5 |
| The project should be continued at this practice | 1 | 2 | 3 | 4 | 5 |
| The project should be expanded to other primary care practices | 1 | 2 | 3 | 4 | 5 |

Continued on back →

What recommendations do you have to improve the screening algorithm, the Prediabetes Tool or workflow? _____

_____

_____

_____

_____

Any additional comments or feedback? _____

_____

_____

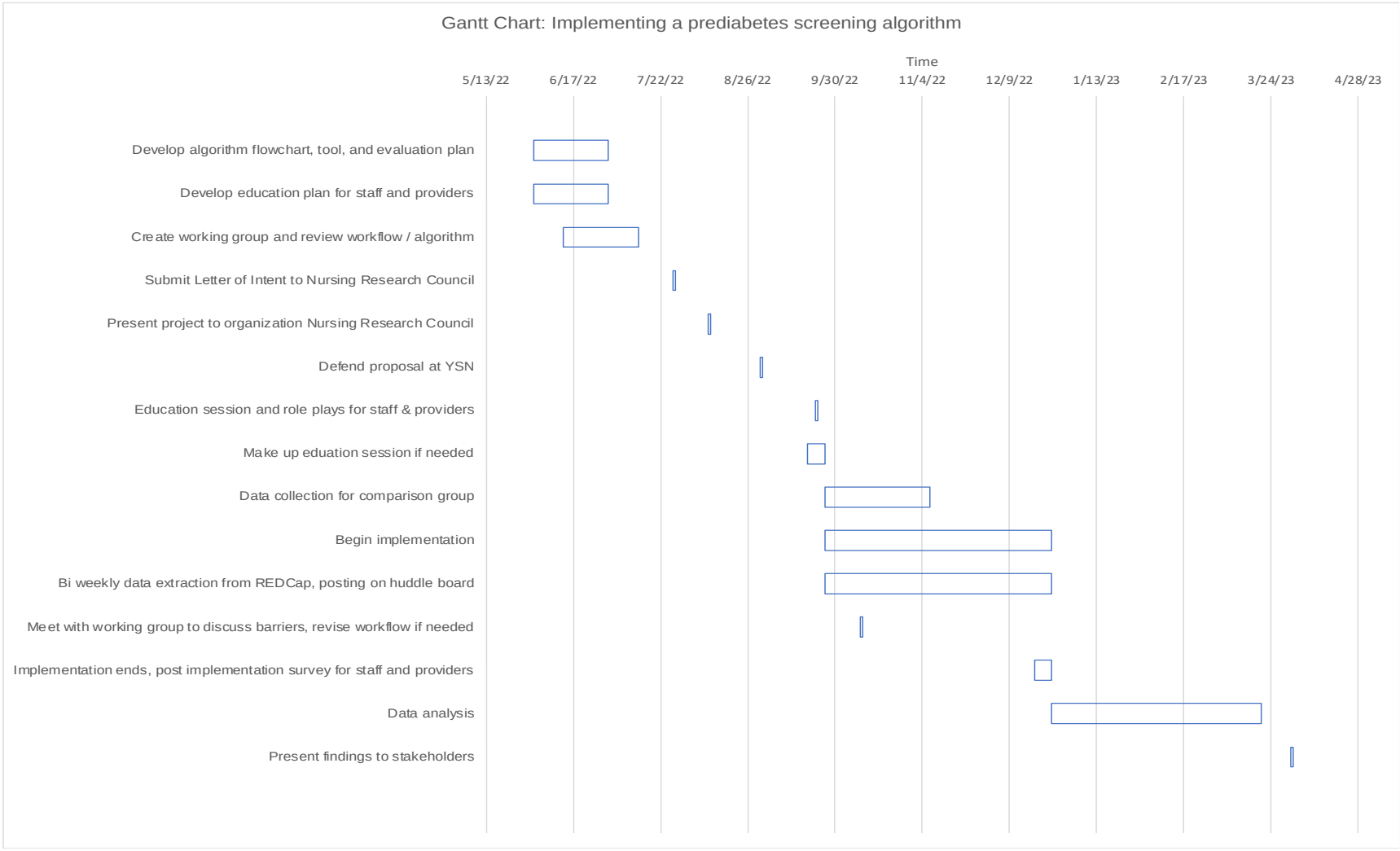
_____

_____

_____

# Appendix G

*Gantt Chart*



## Appendix H

*Stakeholder Engagement*

| Name of Stakeholder(s) | Impact | Influence | What is important to the stakeholder | What are the stakeholder's issues or concerns | Level of Support | What actions need to be taken to increase support? |
|---|---|---|---|---|---|---|
| Office Manager | H | H | Workflow as usual, no increased overtime for staff | Time needed for staff and providers to use algorithm, delays in care | Supportive | - review roles of those involved<br>-practice run throughs |
| Regional Director | M | M | Improved patient outcomes, no increase in resources needed | Staff overtime, costs, patient satisfaction | Supportive | - present evidence that supports algorithm<br>-present other potential positives of improved screening & identification |
| Regional Medical Director | M | M | Improved patient outcomes, no increase in resources needed | Patient outcomes, staff resources | Supportive | - present evidence that supports algorithm<br>-present other potential positives of improved screening & identification |
| President of Medical Group | L | H | Improved patient outcomes, no increase in resources needed | Patient outcomes, staff resources | Neutral | - present evidence that supports algorithm<br>-present other potential positives of improved screening & identification |

| | | | | | | |
|---|---|---|---|---|---|---|
| Organization Nursing Research Council | L | H | Quality improvement patient safety and confidentiality | Quality improvement vs research, patient confidentiality | Supportive | - present project with emphasis on evidence guided activities/changes that will improve quality of care of patients |
| Providers in office | H | M | Maintain flow in day, limited delays | Time | Supportive | - review positives for patients<br>- review positives for providers- identify problem and refer/counsel<br>-emphasize billing for time and reimbursement for addressing prediabetes |
| Office staff | H | L | Maintain flow in day, limited delays | Time | Neutral | -Review importance for patient outcomes/quality metric<br>-practice run throughs to show there is not a significant increase in time needed to implement |
| School of Nursing Faculty | L | M | Understand quality improvement process from start to finish | Time constraints | Supportive | -participate in all aspects of courses online and in person |

## Appendix I

*Project Costs*

| Project Expense | Projected Cost | Actual Cost |
|---|---|---|
| ▪ Material Costs: Paper for copies of Prediabetes Screening Tools, patient education sheets & patient information sheets | ▪ 300-400 Prediabetes Screening Tools<br>▪ 300-400 Patient information sheets<br>▪ 200-300 Patient education sheets<br>▪ 800-1100 total sheets of paper<br>▪ $28.75 = 1 Case of paper, 10 reams per case, 500 sheets per ream = 5000 sheets per case) $5-10 | ▪ 316 Prediabetes Screening Tools<br>▪ 316 Patient information sheets<br>▪ 316 Patient education sheets<br>▪ 948 total sheets of paper<br>▪ 2 reams = $5.75 |
| ▪ Salaries/Wages to attend Education Session | ▪ 3 providers x 60 minutes additional administrative time each $75-125 x3 = $225-375<br>▪ 5 employees 60 minutes each = $80-110 | ▪ $225-375 providers<br>▪ $82-131 employees (Specific salary/wage information not able to be disclosed to this author) $307-506 total |
| ▪ Lunch for education session | ▪ $169 Christo's Pizza- Pizza, wings, and salad | ▪ $169 |
| ▪ Cost of POC HbA1c tests not covered by insurance | ▪ 1 box/10 tests = $74.40<br>▪ Estimated 0-5 tests uncovered despite coding = $37.20 | ▪ $0 |
| ▪ Bound copy of DNP project manuscript | ▪ $100-200 | ▪ $100-200 |
| Totals: | $516.20 - $891.20 | $581.75- $880.75 |