Examining Individual Factors to Explain Overdue A1Cs in Patients with Type 2 Diabetes:

A Multnomah County Diabetes Project

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Abstract

Background: Type 2 diabetes is a condition of particular concern, especially among groups with healthcare disparities. Multnomah County Health Centers treat a diverse population of patients with type 2 diabetes, many of whom are not receiving regular diabetes care.

Purpose: The Health Resource Services Administration requested a thorough examination of patients with type 2 diabetes treated in Multnomah County Health Centers who had gaps between hemoglobin A1C rechecks greater than 1 year in duration. It was theorized that socioeconomic and disease-related factors were among the causes for these overdue A1C checks.

Methods: A sample of 164 type two diabetes patients from 7 Multnomah County Health Centers were surveyed with an A1C and diabetes questionnaire—97 with greater than 1 year between A1C checks and 67 without. Multiple independent variables were collected from the Epic electronic medical record system of these 164 patients and analyzed long with the survey data. findings which could be intervened upon to improve overdue testing.

Findings: Statistically significant differences in the results revealed the A1C overdue group had lower starting A1C (8.7% vs. 9.7%), less diabetes complications (0.51 vs 0.78), less total medications (6.6 vs 8.7), less diabetes medications (1.51 vs 1.96), and were less likely to be on insulin (26.8% vs 46.3%). COVID was reported as a barrier in 23.7% of A1C overdue patients and only 9.0% of on-time and a reminder was requested for improvement clinic improvement in 17.5% of overdue group and only 6.0% of on-time, although these were not statistically significant differences between the two groups.

Conclusions: Due to the findings, a short-term intervention was developed to send automated reminders to patients 10 months from last A1C check. Changes to patient education surrounding A1C was noted as a long-term intervention developed from the project data analysis.

Introduction

Problem Description

Type 2 diabetes is a serious and preventable chronic health problem affecting almost 30 million people in the United States and nearly 400 million globally (Walker, Smalls, & Egede, 2015; Salimi, Momtazi, & Zenuzian, 2016). In the United States, diabetes is the leading cause of kidney failure, non-traumatic lower limb amputations, new diagnosis of blindness in adults, and a major contributor to cardiovascular diseases like heart disease and stroke (Walker et al., 2014). The benchmarks for type 2 diabetes care are being met at a suboptimal level, putting millions of patients at risk for long-term complications. Between 2013 and 2016, 64% of adults with diabetes met blood glucose goals, 70% achieved blood pressure goals, 57% met cholesterol goals, 85% of diabetics abstained from smoking, but only 23% achieved all 4 metrics at once (American Diabetes Association, 2020b). Understanding the human context behind these unmet benchmarks is an invaluable part of improving diabetes care.

Diabetes outcomes are highly influenced by an individual's resources. The social determinants of health (SDOH) are socioeconomic conditions that people are born into, live, work, and age in, which influence health status and disease outcomes (Walker et al., 2014). People living in neighborhoods which lack basic social and environmental resources have significantly worse diabetes outcomes and research is consistently showing that minorities make up significant portions of the population in these areas (Durfey et al., 2019; Smalls et al., 2015). The American Diabetes Association (ADA) (2020b) currently emphasizes individualized treatment approaches that acknowledge the SDOH and integrate multidisciplinary care teams as a cornerstone of ongoing diabetes care. Multnomah County Health Centers (MCHCs) are using this framework to provide the most current diabetes care to vulnerable groups. An emphasis is

being put upon maintaining patient engagement in diabetes care in order to receive up-to-date therapy on the status of a patient's diabetes. Patient who are not receiving regular diabetes care present the risk of an uncontrolled condition causing long-term organ damage and decreased quality of life.

Available Knowledge

A literature review was conducted in March 2020 to generate research articles examining the SDOH, health disparities, and diabetes. Electronic searches were conducted using CINAHL, PubMed, and Google Scholar databases through OHSU student access. Search terms included, "diabetes," "social determinants of health," "health disparities," "chronic disease," "Medicaid," "management," "assessing," "treatment," "nutrition," "exercise," "mental health," "social support," "self-efficacy," "interventions," and "primary care." The terms were joined using "AND" in various combinations using the search function. Filters included English language, full text, and publications from 2012 to 2020. Twenty-five articles were used to develop the DNP benchmark scholarly inquiry paper, *Addressing the Social Determinants of Health to Improve Diabetes Outcomes*. From this research document, 18 of the 25 articles were used in this DNP project proposal.

Additionally, from June 2020 to September 2020, OHSU student access to PubMed, CINAHL, and Google Scholar databases, and standard Google Search were used to find full text articles in English with a date range from 2012 to 2020 with key words: "type 2 diabetes," "Oregon," "Multnomah County," "Health Resource Services Administration (HRSA)," "health," "assessment," "education," "language," "access," "treatment," "management," "HbA1C," "A1C," "outcomes," "barriers," "comorbidities," "culture," "transportation," and "frequency." From this search, 11 more documents were added to the research in this proposal as well as two

documents from the ADA's *Standards of Medical Care in Diabetes*. In the final project analysis 10 more articles were added from a follow-up search in April 2021 with the same search criteria as the previous inquiries.

In the current literature, there is evidence that social and environmental circumstances in a diabetic person's life can cause a lack of the basic resources needed for appropriate type 2 diabetes care, resulting in a failure to meet disease-related benchmarks. The barriers to diabetes care tend to arise in specific populations, among the most vulnerable members of society. Underserved neighborhoods that struggle with more violence, less favorable outdoor environments, less available activities, more food insecurity, and less social support have higher rates of diabetes and worse diabetes control when compared to neighborhoods without socioeconomic depravation (Smalls et al., 2015). In the Pacific Northwest, data gathered through an electronic medical record (EMR) of three community health centers serving primarily Medicaid beneficiaries revealed greater than 97% of the patients reported difficulty in at least 1 or more SDOH, which included financial strain, housing insecurity, food insecurity, intimate partner violence, inadequate physical activity, social isolation, and stress (Gold et al., 2018).

Socioeconomic, racial, cultural, educational, and other factors may present as barriers in these patients, contributing to differences in their care and outcomes. Underserved groups face some of the most significant struggles related to diabetes. In the United States, 15.9% of Native American people are diabetic, followed by 13.2% of non-Hispanic black people, 12.8% of Hispanic people, and 9.0% of Asian people, compared with 7.6% of non-Hispanic white people; while at the same time these minority groups experience more disease burden, complications, and resulting mortality (Walker, Williams, & Egede, 2016). In Oregon, MCHCs serve a diverse patient population, which provides a stark contrast to the county's collective population. More

than 62,000 patients receive healthcare from MCHCs and 64.2% of those patients are from racial or ethnic minority groups, with 36.2% Hispanic/Latino, 15.8% Black/African Americans, 11.6% Asian, 1.5% Native Hawaiian/Pacific Islander, 1.2% Native American, and 4.2% reporting more than one race, with the remaining non-Hispanic white at 41.8% of the clinic population (HRSA, 2019). These numbers are important to contrast with the overall population of Multnomah County. The racial demographics of Multnomah County are 78.2% non-Hispanic white, 11.1% Hispanic/Latino, 6.9% Asian, 5.4% Black/African American, 0.8% Native American, 0.6% Native Hawaiian/Pacific Islander, and 5.2% identify as two or more races (Healthy Columbia Willamette Collaborative, 2019). In Multnomah County, 38% of African Americans and 38% of Native American/Alaska Natives are below the federal poverty line, followed by 32% of Hispanic/Latinos, 32% of Hawaiian Natives/Pacific Islanders, 21% of those with two or more races, and 17% of Asian people, all significantly above the regional average in poverty level, with whites near the regional average at 15% (Healthy Columbia Willamette Collaborative, 2019).

Diabetes health outcomes are highly correlated with race and ethnicity, with minorities receiving less diabetic care, poorer glycemic control, and more resulting complications (Agarwal, Hilliard, & Butler, 2018; Canedo et al., 2018; Durfey et al., 2019). According to the 2019 Community Needs Assessment, diabetes trends in Multnomah County share similar characteristics with poverty trends as minority groups, specifically African American, Asian, Pacific Islander, and Native Americans as the most affected groups (Healthy Columbia Willamette Collaborative, 2019). These disparities are consistent across the country, in which higher rates of diabetes and worse glycemic control are found among those with low socioeconomic status on Medicaid, Medicare, or uninsured (Durfey et al, 2019; Smalls et al.,

2015). In Oregon, 19% of those individuals on the state Medicaid program have diabetes, in contrast to 7% of people who receive health insurance from employer-provided health plans (Oregon Health Authority, 2014). Throughout the seven MCHCs, 72.1% of patients use Medicaid insurance, 6.5% use Medicare, and 17.1% are uninsured; 75.5% of patients are at or below 100% of the federal poverty line and 95% are at or below 200% of poverty line (Health Resource Services Administration, 2019). The county clinics treat a substantial number of people with diabetes, but more information is needed to understanding why some patients are able to manage their diabetes effectively by receiving regular care and some are not.

In urban settings, transportation is often reported as a barrier to appointments for various reasons. In the literature between 10% and 51% report problems with transportation to appointments, largely composed of minority groups and those on public funded insurance such as Medicaid (Locatelli et al., 2017). Best practice by the ADA recommends rigorous diabetes care including A1C checks every 3 to 6 months, periodic evaluation and treatment of elevated blood pressure, serum lipids, periodic testing for kidney and liver function, continued assessment of thyroid function, annual visual examination, frequent foot and neuropathy assessments, and for patients to stay current on vaccinations and cancer screenings (ADA, 2020c). Having unreliable transportation can disrupt these frequent healthcare activities which are extremely vital to stable diabetes management. A1C is currently the best measure to assess type 2 diabetes status and guide treatment, therefore overdue A1C checks can leave proper management of the condition unfulfilled.

Diabetes outcomes also correlate with diabetes care knowledge and self-efficacy of care (Durfey et al., 2019; Smalls et al., 2015; Vivian & Ejebe, 2014; Walker, et al., 2015; Young et al., 2018). This is especially critical in patients with limited English proficiency (LEP). Diabetic

patients with LEP are less likely to have regularly scheduled appointments, less likely to be meeting diabetes benchmarks, and exhibit poorer overall health literacy when compared to those without LEP, especially when the provider doesn't speak the patient's language (Marquez, Calman, & Crump, 2018). In MCHCs, 43.2% of patients have a primary language other than English, which can alter understanding and retention of diabetic education if not done correctly (HRSA, 2019). There is also evidence to suggest that cultural influences are independent from language and health literacy. A variety of factors directly and indirectly related to culture may limit the adherence and intensification of diabetic medications (Marquez et al., 2018).

Considering the complexity of diabetes care, patient health literacy, independent from language or culture, must also be considered in treatment plans. Understanding the rationale for care has shown to increase self-efficacy and self-care behaviors including medication adherence among patients (Bailey et al., 2014; Marquez et al., 2018). Both diabetes education and self-management programs have shown to improve glycemic control in those with poor health literacy (Bailey et al., 2014). Diabetes treatment burden is a problem that affects many diabetics given the intensive management required from the disease, but the burden is especially difficult on those who have limited resources and lack social support (Walker et al., 2015).

Left unaddressed, the SDOH in the lives of diabetic patients can be detrimental to psychological health, which can negatively affect glycemic outcomes and promote disease progression (Silverman et al., 2015; Smalls et al., 2015; Walker et al., 2014; Walker et al., 2015). Living in poverty promotes chronic stress and depression, resulting in decreased self-efficacy in diabetes management (Walker et al., 2015). This is a vicious cycle as chronic situational stress and diabetes distress act as two components of a positive feedback loop, constantly worsening a patient's clinical condition. However, when a patient can learn coping strategies, improve self-

efficacy, and find outlets of social support, these tools can act as buffers to the situational stress and depression from living in poverty (Houle et al., 2016). It is of great importance to identify the barriers patients are experiencing in order to target appropriate treatment plans. These are all important factors to take in mind as diabetes is a resource intensive diagnosis and suboptimal care can result in serious complications.

Rationale

MCHCs play a vital role in the treatment of patients in Portland, Gresham, and other surrounding communities. The clinics provide a significant portion of their services to the Medicaid, Medicare, and uninsured populations, which are individuals with extreme vulnerability to poor diabetes outcomes. In this project, the Multnomah County Health Department (MCHD) Integrated Clinical Services (ICS) was interested in learning about the similarities and differences in the diabetic patients utilizing the county's services, with their most significant interest focused on individuals not meeting adequate A1C follow-up goals. A conceptual framework guiding the research in this project was the Health Promotion Model. Conceptual frameworks are important in nursing research because they provide clarity to a problem and allow for a smooth convergence between reality and theoretical concepts (Messecar, 2020). The Health Promotion Model uses a schematic representation to show the relationship between individual factors, thoughts, influences, and behavioral outcomes (Polit & Beck, 2017). The emphasis however, is on the individual's cognition, including perceived benefits of action, perceived barriers to action, perceived self-efficacy, activity-related affect, interpersonal influences, and situation influences, which can all be modified by outside forces (Goudarzi et al., 2020). A1C frequency as a dependent variable is not well studied in the literature, however it is sometimes considered as an element of diabetes self-care. The purpose

was to examine the individual patient factors that consciously and subconsciously contribute to the ability to complete A1C rechecks.

Project Aims

This project has 3 aims:

1) Analyze the survey responses from the A1C survey separately implemented by ICS.

2) Conduct a retrospective/prospective chart review on all adult patients with type 2 diabetes who completed the A1C survey.

3) Develop interventions to improve A1C follow-up supported by the project data.

Proposed Methods & Measures

Context

MCHD ICS constructed an interdisciplinary diabetes team to discover ways to meet the needs of the type 2 diabetes population. The MCHCs receive HRSA funding from the federal government to improve the diabetes care in the patients they serve. A diabetes care pathway was developed by ICS in accordance with the ADA's *Standards of Medical Care in Diabetes*. This document helps to provide clinicians and healthcare entities with an outcome-driven guide in the effective diagnosis, evaluation, and management of patients with type 2 diabetes (ADA, 2020b). MCHD's diabetes care pathway is an interdisciplinary care algorithm which coordinates diabetes-specific care upon diagnosis and throughout the course of the patient's disease. Integral components of the pathway include the patient, the primary care provider, the registered nurse, the pharmacist, and support staff, who work together to coordinate treatment, education, and other health services.

The diabetes care pathway team was created to join interdisciplinary leaders who work directly and indirectly with type 2 diabetes patients. The team consisted of a project leader, nurse

practitioner, pharmacist, clinical social worker, nurse, community health worker, and several other staff involved in patient care logistics. In response to federal funding, HRSA requested a diabetes action plan to contain 3 SMART goals: 1) a standard pre-diabetes and diabetes order panel and updates to the care pathway, 2) to reduce the number of people with overdue for A1C checks by over 1 year, and 3) connect those with A1C above 9% to behavioral health providers (BHPs). This project was designed to address SMART goal 2 in the diabetes action plan for federal reporting to HRSA. ICS meetings were held monthly to develop strategies and report individual progress on the work each member was doing within the collective action plan. The team was motivated to make changes, but movement towards change was slow due to the checks and balances required in a large governmental organization, as well as COVID-19.

Intervention/Study of Intervention

HRSA requested a deep dive into the lives of the patients with type 2 diabetes who had an A1C gap greater than 1 year. The ICS team developed an A1C and diabetes knowledge survey which was administered to patients who met the overdue criteria and another sample who was not overdue. This is significant as A1C is the most reliable metric used for titration of type 2 diabetes therapy (ADA, 2021b). An unknown A1C value prevents needed alterations in therapy. The survey developed by ICS contained questions relating to knowledge of diabetes, A1C importance, barriers to care, and clinic improvements which could be made. This DNP project helped to develop some of the survey questions, but did not take part in the administration of the survey (majority contacted by phone) to the patients or the recording of patient responses. Answers to A1C survey questions included open-ended responses, multiple choice, and Likert scale rating (0 to 10). The results of this survey were recorded and, in some cases, re-coded to find common themes among the patients. As the core of this DNP project, a

retrospective/prospective chart review was then conducted on the patients who completed the A1C survey in order to find associations between overdue A1C and independent variables related to specific demographic, logistic, physical health, and mental health data from the EMR.

Measures

All of the variables collected from the survey and chart review were found in the literature to be associated with the presence of diabetes, diabetes control, diabetes knowledge and self-care, or are ADA measures that predict diabetes morbidity and mortality. Many of these factors are directly or indirectly related to the SDOH, which are known to predict diabetes outcomes (ADA, 2020b). A total of 172 patients were surveyed, with 164 used in the final analysis. Inclusion criteria required a patient to have type 2 diabetes and be receiving active care at one of the seven MCHCs. Patients who were eliminated from the final analysis had either pre-diabetes or type 1 diabetes. The survey date for each person was assumed to be the starting point for any of the retrospective or prospective data.

Demographic/logistical variables were collected such as: age, body mass index (BMI), sex/gender, race/ethnicity, primary language, insurance status, primary MCHC, primary care provider (PCP) on record, language discordance between patient and PCP, distance the patient lives from the clinic, MyChart registration status, zip code of residence, and historic no-show rate. Disease specific variables were collected such as: presence of an interdisciplinary visit (RN, pharmacist, or BHP), appointments before and after the outreach survey, A1C before the survey, presence of greater than 1-year A1C gap, A1C percent change after the gap, missed opportunity for A1C recheck, number and presence of ongoing health conditions (including mental health diagnosis), total number of prescriptions number of diabetes medications prescribed including

presence of insulin use, diabetic complications, lipid and blood pressure measurements, and presence of medication specific for lipids and blood pressure control.

Analysis

Both descriptive and inferential statistics were calculated in the data analysis to identify trends in the data. The measures taken from the survey and the chart were assumed to be independent variables, with the dependent variable being the presence of an A1C gaps greater than 1 year or not (time period extending to December 1st 2017). Additional evaluation was taken using a dependent variable of presence of A1C level 9% and above or below 9%. When the data was collected, measures of central tendency were calculated when appropriate with a variety of variables such as age, BMI, recent A1C value, and numerous other continuous variables. Categorical variables such as race/ethnicity, insurance status, and others were re-coded into appropriate groups and frequency of responses analyzed.

The differences between the frequency of variables among the two groups were examined using Chi-Square testing. In a 2x2 evaluation, the standard Pearson Chi-Square testing was used to determine statistically significant differences in results. Other parameters were used to assess for statistically significant differences in the Chi-Square test under unique data conditions. If larger than a 2x2 table Cramer's V was used, but if the assumptions of the Chi-Square were violated, either Fisher's Exact test or the Likelihood Ratio were used to determine statistically significant differences between expected and observed results. To further identify the location of statistical significance, adjusted residuals were obtained and post hoc testing using Bonferroni Correction was done to prevent type 1 error. The p-value determining a 95% confidence level ($p<0.05$) was adjusted to a more robust value using the aforementioned methods in Chi-Square testing. When comparing differences in means, independent-sample t-test were used to assess for

statistical significance between an independent variable in the two groups. Paired t-tests were also used to assess pre-test/post-test changes with the outreach survey as the intervention. The software used to store data was Google Sheets, but the analysis done with de-identified data using SPSS and Excel software.

Ethical Considerations

The project was exempted by OHSU institutional review board and Multnomah County project review team as not meeting the criteria for additional oversight. Data collection began once these two exemptions were achieved. Due to the lack of actual patient contact or experimental manipulation, the most important factor in this project was the protection of patient information. Patient data from the EMR was accessed through secure remote online access and stored in a MCHD secure server that required MCHD privileges to access. No protected health information was taken off of the server and medical record number and social security number were not recorded. Additionally, the information technology department at MCHD was contacted to confirm procedures regarding safe remote access and data storage. Interventions designed as a result of the project were intended to be equitable for all patients with respect to socioeconomic circumstances.

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Results

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After the A1C surveys were completed, the 164 patients represented two distinct groups: one sample of 97 patients with type 2 diabetes who had greater than 1 year between A1C checks and 67 patients with type 2 diabetes who did not have a gap during the same timeframe, which dated back to December 1st 2017. When the project was initially created, multiple clinic staff were assigned to conduct the A1C survey. A miscommunication occurred, and upon review of the EMR, numerous patients did not meet the intended HRSA criteria of having an A1C >1 year

overdue. Once the problem was clarified, a new group of patients meeting the intended criteria were able to be surveyed. The original mishap of the survey population became beneficial in the final statistical evaluation of the project, as a group for comparison was available.

It is important to note that although the groups were labeled as A1C "overdue" and A1C "on-time" in the context of this project, these labels reflected the interest of HRSA and not the recommendations by the ADA. For the means of this project an "overdue" patient was any individual with more than 1 year between A1Cs in the specified timeframe regardless of A1C value. The "on-time" group consisted of patients who had no gap between A1C checks greater than 1 year regardless of A1C value within the same timeframe. The ADA recommends that individuals not meeting their A1C goals should have A1C measured every 3 months and those who are meeting their goal every 6 months. Although the ADA intervals were not recorded, many of the patients in this sample were not meeting the ADA recommended schedule, regardless of the group they belonged in this project.

To better understand the data, multiple variables were grouped in the analysis under one of five themes. These topics were: demographic characteristics, understanding of illness, patient care logistics, physical health, and mental health. Prior to the study, similar themes were hypothesized to impact the ability of a patient to get their A1C rechecked, as these themes were known in the literature to impact A1C levels and other diabetes care behaviors. Analysis also examined the A1C survey as an outreach intervention and compared the patients by A1C value (instead of frequency) in order to better compared the data with the known literature.

Demographic Characteristics

Among the clinics surveyed in the study, there were significantly more patients in the A1C overdue group from East County Health Center in comparison to the A1C on-time group

[32.0% (31/97) vs 6.0% (4/67)]. There was also a significant difference between the patients in each sample from Southeast Health Center [6.2% (6/97) vs 26.9% (18/67)]. The difference in age of the two groups was found to have statistical significance, with the A1C overdue group having a younger average age (49.9 years old) versus the A1C on-time group (55.6 years old). Body mass index (BMI) also showed a significant difference, as the A1C overdue measured an average BMI of 35.6 and A1C on-time measured an average BMI of 31.9.

After inferential analysis, demographic variables such as race, ethnicity, legal sex/gender, language, and insurance status did not show any statistically significant difference between groups, but painted an important picture of the unique characteristics of the type 2 diabetes patients sampled. The two groups (overdue vs on-time) consisted of females [73.2% (71/97) vs 64.2% (43/67)], males [24.7% (24/97) vs 35.8% (24/67)], and those who declined to answer the gender question [2% (2/97) vs 0% (0/67)]. Both groups had large samples of people who identified as White for their race [82.5% (80/97) vs 65.7% (44/67)] and ethnicity as Hispanic [66.0% (64/97) vs 50.7% (34/67)]. Spanish speakers and English speakers were prevalent in both groups, but the majority of the patients in each group were Spanish speakers. The A1C overdue group had 62.9% (61/97) Spanish speakers, 32.0% (31/97) English speakers, and 5.2% (5/97) speakers of other languages, whereas the A1C on-time group had 42.3% (31/67) Spanish speakers, 28.4% (19/67) English speakers, and 17.9% (12/67) speakers of other languages. Insurance status of the participants consisted of Medicaid [38.1 % (37/97) vs 50.7% (34/67)], CAWEM [28.9% (28/97) vs 28.4% (19/67)], none [18.6% (18/97) vs 7.5% (5/67)], Medicare [5.2% (5/97) vs 9.0% (6/67)], Medicaid and Medicare [7.2% (7/97) vs 4.5% (3/67)], and private [2.1% (2/97) vs 0% (0/67)] insurances in overdue and on-time groups respectively. Although the differences were not significant, the total amount of patients who did not have insurance to cover

numerous primary care services was notable in the CAWEM and no insurance groups. The variables of language, race, ethnicity, and insurance status were recoded to further analyze the results for statistical significance, but was still not found after comparing the correctional p-value to the cross tabulation residual score at the adjusted level of significance.

Understanding of Illness

People in the A1C overdue group had significantly more detailed answers to the knowledge about diabetes survey question, 38.1% (37/97) versus 10.4% (7/67) in the on-time group. The A1C on-time group was more likely to seek diabetes-related support through diabetes specific RN visits [65.7% (44/67) vs 47.4% (46/97)] and diabetes related pharmacist visits [31.3% (21/67) vs 15.5% (15/97)] dating back to December 1st 2017. These two variables were the only in this theme which had statistically significant differences between overdue and on-time groups.In the other data, only 13.4% (13/97) people in the A1C overdue group and 19.4% (13/67) people in the A1C on-time group could accurately report their last A1C value within 0.5%, but the majority of patients in each group did not know what to guess for their last A1C level [76.3% (74/97) vs 65.7% (44/67)]. Both groups rated the importance of getting their A1C checked as high on a 0 to 10 Likert scale, 8.5/10 in the A1C overdue group and 8.1/10 in the A1C on-time group. There was also no significant difference in whether patients said their provider had explained the importance of A1C to them and no difference in patient-provider language discordance when looking at the primary care provider and the patient's desired healthcare language.

Patient Care Logistics

There were no statistically significant differences between average distance a patient's residence was from the clinic (4.5mi overdue vs 3.8mi on-time) or in average no-show rate

(16.0% in overdue vs 14.6% in on-time). The large majority of patients in both the overdue and on-time groups wanted to be connected by phone for appointments or reminders. MyChart activity between the two groups did not show statistically significant differences, but it was noted in each group there were individuals with active MyChart accounts that had not logged in for several years. Of the 27 active MyChart accounts in the overdue group, 15 had been used within the last year of the A1C survey date. In post hoc analysis of the Chi-Square distribution, COVID-19 being reported as a barrier slightly missed the level of statistical significance between the two groups with 23.7% (23/97) reporting this as a barrier in the overdue group and 9.0% (6/67) in the on-time group. Other barriers such as socioeconomic, scheduling, or none reported were comparable between the groups. When recommending clinic improvements, 17.5% (17/97) of patients in the A1C overdue group stated they wanted reminders versus 6.0% (4/67) in the on-time group. This difference also narrowly missed the cut-off for statistical significance in the adjusted analysis. Largely the groups were unsure or had no suggestion for improvement, with 64.9% (63/97) in the overdue and 79.1% (53/67) in the on-time group.

Physical Health

The physical health variables had the most noticeable differences between the two groups. The A1C overdue group tended to have better controlled diabetes with the diagnosis for a shorter period of time and less diabetes burden (as assessed by medications and complications). The A1C overdue group had an average A1C of 8.7% prior to the survey, in comparison to 9.7% in the A1C on-time group. The A1C overdue group not only had a lower average A1C, but they were also less likely to have patients with an A1C > 9%, as they had only 41.2% (40/97) with an A1C above this level compared to 65.7% (44/67). In the A1C survey, the overdue group had 19.6% (19/97) of patients who reported a diabetes diagnosis for 1-3 years, compared to 3.0%

(2/67) of the A1C on-time group. Less diabetes burden was noted in the A1C overdue group as they on average had less diabetes complications (0.51 vs 0.78), less total medications (6.6 vs 8.7), less diabetes medications (1.51 vs 1.96), and were less likely to be on insulin [26.8% (26/97) vs 46.3% (31/67)]. These were all statistically significant differences between the two groups. Interestingly, there were no significant differences in the average number of chronic diagnosis (5.2 in overdue vs 5.9 in on-time). Other variables compared such as blood pressure measurements, lipid measurements, and tobacco use history did not show any significant difference between the two groups.

Mental Health

Although there were no statistically significant differences in patient-reported stress or depression, surveyed self-efficacy, mental health diagnosis, diagnosis of depression, or diagnosis of anxiety, the number of patients in each group was notable. Stress impacting diabetes management was experienced at least sometimes by 38.1% (37/97) in the A1C overdue group versus 46.2% (31/67) in the A1C on-time group. Depression interfering with diabetes management was experienced at least sometimes by 20.6% (20/97) vs 20.9% (14/67) in the overdue and on-time groups respectively. Despite these figures, the perceived control of diabetes in both groups was high, with 70.1% (68/97) of overdue and 65.8% (44/67) of the on-time group saying they felt in control of their disease at least sometimes. An answer of "yes" for patient's feeling they had control over their illness was answered by 52.6% (51/97) in the overdue vs 55.2% (37/67) in the on-time group. Data collected form the chart review showed no significant difference between the average number of mental health diagnosis (.72 vs .84), the presence of a depression diagnosis [29.9% (29/97) vs 29.9% (20/67)], or the presence of an anxiety diagnosis [15.5% (15/97) vs 19.4% (13/67)] in overdue versus on-time. Although there was no significant

difference in appointments with a behavioral health provider (BHP) during the retrospective timeframe (Dec 1st 2017), the majority of each group had not used this resource [82.5% (80/97) with no BHP appointment in overdue versus 73.1% (49/67) without a visit in the on-time group].

Survey as an Outreach Intervention

When looking at the A1C survey as a diabetes related outreach attempt, it was successful in getting patients to have a higher utilization of clinic services. Using a paired samples t-test, there was a statistically significant increase in appointments in the 3 months after the survey compared to appointments in the 3 months before the survey. This finding was present in the entire group (n=164) when analyzed together, but also remained statistically significant when each group was looked at separately (overdue vs on-time). There was no statistically significant difference showing the overdue or on-time group benefitted more with a greater number of appointments in the 3 months following the survey.

When looking deeper at the descriptive statistics in the A1C overdue group, 63 out of 97 patients had a A1C test done after the 1-year gap, with 34 of the patients still not having a new value because their A1C gap continued after the data collection period had been completed. Out of the 63 patients who had a value after the greater than 1-year gap, 48 (73.8%) patients had an increase in their A1C by any value, and 32/48 (66.7%) had an A1C increase by at least 1%. In the A1C overdue group, 32/97 (33.0%) patients had an appointment which the A1C could have been rechecked during the >1year overdue timeframe (excluding a dental visit or COVID-19 testing appointments). For data collection purposed, this was considered a missed opportunity for an A1C. Numerous other patients came to a MCHC for a dental appointment or COVID-19 lab test during their overdue A1C timeframe. Of the 32 patients who had missed opportunities for A1C recheck, 20 patients did not have the standard pre-visit chart scrubbing completed to review

for overdue metrics. The other 12 patients had their charts scrubbed correctly for A1C and the lab order was missed by the provider. It was also noted in the A1C overdue group that 27.5% (14/51) of patients who reported "yes" to the survey question relating to control over diabetes had an A1C greater than 9%, which by HRSA definition is uncontrolled diabetes.

Using A1C Value as the Dependent Variable

Comparative analysis was also done with A1C level before the survey as the dependent variable. Two groups: 1) A1C greater than or equal to 9% (n=84), and 2) A1C less than 9% (n=80), were used to separate the patients and complete the same statistical Chi-Square and T-test measures for A1C frequency. Patients with an A1C greater than or equal to 9% had significantly more patients report they did not have control over their diabetes [44.0% (37/84) vs. 16.3% (13/80)] which matches with trends in the literature. All 24 patients from Northeast Health Center had an A1C 9% or higher, which was a statistically significant difference found by no other clinic. Patients with an A1C 9% or higher had significantly more diabetes medications (2.0 vs 1.3) and people prescribed insulin [50% (42/84) vs 18.8% (15/80)]. The A1C 9% and above group also had statistically significant higher average lipid measures in total cholesterol, LDL, and triglycerides when compared to the group below 9%. However, both groups had high numbers of patients who had an LDL level above 70 [overdue 80.4% (78/97) vs on-time 83.6% (56/67)], which is a goal metric for patients with type 2 diabetes. Some unusual findings were that the A1C less than 9% group had statistically significant higher average number of chronic conditions (6.0 vs 5.0) and more patients with a diagnosis of depression [37.5% (30/80) vs 22.6% (19/84)]. All other measures compared had no statistically significant difference between the two A1C levels.

Discussion

Summary

The most statistically significant differences between the A1C overdue and A1C on-time groups were found among the physical health characteristics, particularly diabetes status. Patients with overdue A1Cs were more likely to have had diabetes for a shorter period of time, less diabetes-related complications, and better A1C control. They perceived the needed for less diabetes assistance, utilizing RN and pharmacist appointment support significantly less. An impactful finding in the overdue group was the substantial A1C increase in numerous patients after their 1-year overdue gap was done. This shows the importance of timely A1C rechecks to properly manage type 2 diabetes in MCHC patients, regardless of A1C level. Even in the absence of statistically significant differences between overdue and on-time groups, data showing the high number of non-English speakers in this sample [69.5% (114/164)] is much higher than the 43.2% of non-English speakers served by MCHD in totality (HRSA, 2019). Another important factor relating to the entire group is the larger number of uninsured people in this diabetes sample [42.7% (70/164)] when compared against MCHD as a whole (17.1%). This is a telling comparison to the type of patients who have type 2 diabetes at MCHCs. The need for increased education surrounding A1C and ongoing diabetes care was found to be an important observation from the data. This was reserved to be a long-term focus rather than an immediate focus for intervention.

Strengths of this project included the large sample size and wealth of available subjective and objective data from the A1C survey and EMR to use for analysis. The project had no experimental intervention and was not limited to assessing a particular outcome. Although the final analysis of this A1C project was not completed when interventions began to be formulated,

there was a vast amount of descriptive data to shape the discussion surrounding various interventions. The barriers and improvements listed on the survey pointed towards patients having increased scheduling conflicts with appointments including work, childcare, transportation, and generally forgetting appointments. An increased interest in A1C reminders was stated in both survey in groups and was more numerous in the overdue group. This information allowed the diabetes care pathway team to begin planning for an intervention focused around reminders for A1C rechecks.

It was agreed upon to start an intervention with an automated reminder system for those approaching the 1-year A1C overdue timeframe, starting at 10 months from previous A1C. The automated system would limit excessive staff utilization and allow patients to be informed about their A1C recheck. An automated reminder system already existed for previously scheduled appointments, so it was proposed to utilize this system to develop phone reminders for patients to have their A1Cs checked. This intervention was supported by the high number in both groups who wanted to be reached by phone and the overdue group who wanted reminders. It was determined that a report be generated using Epic Workbench containing patients who were overdue on A1C by greater than 10 months. The 10-month mark was chosen as a threshold to allow patients enough time to schedule appointments and be seen prior to the 1-year mark. This list of patients would be giving to the automated telephone vendor and from there they would contact the patients with a standard recording which would meet privacy requirements.

Interpretation

The main findings in this study were the differences in diabetes control and associated burden between the two groups. In the literature similar findings have shown that worse diabetes control was present in individuals who were older and had more medication burden and

complications (Badedi et al., 2016). It was also noted in the literature that patients with more complicated medication regimens tend to have worse diabetes control (Yeh et al., 2017). This helps to understand the project findings related to A1C, diabetes complications, and diabetes medications. It is helpful to think of this as a correlation rather than a causation of the medication regimen. One would expect that someone who requires multiple medications would have worse diabetes, rather than the medications contributing to the poor control. Since A1C is the most accurate target of diabetes control, this study also helps us learn about the needs of the A1C on-time group, as they were shown to have higher A1Cs and need more overall support.

The A1C on-time group was found to utilize support from RN and pharmacist appointments more frequently than the A1C overdue group. Patients who seek additional support have been shown to have better diabetes care behaviors like attending regular appointments (Powers et al., 2017). In this group however, the increased engagement did not contribute to better glucose control in comparison to the overdue group. Diabetes distress was not directly measured in this project, but some elements of disease burden and psychosocial functioning were assessed. The ADA notes that individuals with an excessive diabetes burden benefit from integrated approaches with more visits from interdisciplinary care team members such as nurses, pharmacists, and BHPs (ADA, 2021b). The difference in RN visits and BHP visits, as well as more regular A1C checks could suggest that the on-time group needed more regular support because of their illness burden. The A1C overdue group showed more knowledge on the survey questions when compared to the A1C on-time group. This is contrary to some findings which suggest that individuals with more knowledge and self-efficacy have better self-care behaviors related to their illness (Yang et al., 2016; D'Souza et al., 2017). However, the survey response interpretation was a limited picture of diabetes knowledge in this study. When the entire group

was separated by A1C level rather than A1C frequency, the people with lower A1C had better self-efficacy, which is consistent with the literature.

The literature review done prior to project implementation showed that transportation was a barrier experienced by patients seeking primary care services who were underinsured (Locatelli et al., 2017). A difference in transportation needs was not found to be statistically significant in our analysis, as people in both groups reported this problem at similar rates. Patients with limited English proficiency were found to be less likely to attend regularly scheduled visits as compared to those who spoke English proficiently (Marquez et al., 2018). Both groups had large samples of non-English speakers without significant differences [68.0% (66/97) overdue vs 62.7% (42/67) on-time], so this did not explain differences in A1C duration between the groups as they were equal. The most reliable indicator relating to SES which was analyzed in the project was insurance status. Although the data cannot be relied on for statistical significance, the total percentage of insurance coverage of patients who had no coverage for primary diabetes care (CAWEM and no insurance) was 47.4% (46/97) in the overdue group and 35.8% (24/67) in the on-time group.

Although it was not expected for the overdue group to have better control before the survey, it presents a theory that they may have been easier to forget an A1C recheck if not as worried about their glucose control. Another explanation which further explains the diabetes control between the two groups is that these two groups may be at a difference point in time regarding their illness as Badedi et al. (2016) described. Since the A1C overdue group was on average younger and more controlled in their diabetes, they could be nearly identical to the A1C on-time group in patient characteristics, but at a different time course in their illness. This hypothesis is supported by the increase among A1Cs in the overdue group when they returned

for an A1C check after the gap in testing. A reassessment of average A1C for comparison was not done in the overdue group because 35.1% (34/97) of patients did not have a new value to reassess. With the average increase of A1C greater than 1% after the gap, this would make the A1C level of the overdue group nearly identical to the on-time group if the average A1C increase remained constant.

Although there is a comparator group to help limit the impact of COVID-19 on the data, COVID was mentioned by numerous patients in the barrier question and was greater in the A1C overdue group, though not statistically significant. A1C testing volume monitored in a large national laboratory decreased by 66% in March and April of 2020 (Fragala et al., 2021). COVID-19 spanned a portion of the data collection as the A1C surveys were done by clinic staff from August 2020 to January 2021. Patients who may have been less than one year overdue during the onset of COVID-19 may have been significantly affected. This project clarifies the impact of deferred self-care during a pandemic, especially on those who were better controlled from the beginning. COVID-19 may have an impact on society for several years both directly and indirectly. It is important to continue adapt for change the caused by COVID-19 so fragmented care to vulnerable populations like one in this study can be corrected.

The only cost that can be attributed to this project will be the future cost taken to implement the automated reminder. Many different interventions were suggested and supported by the data gathered from this project. Both cost and feasibility were considered when planning the specific intervention to implement. The ICS team was interested in the implementation of an intervention with little direct utilization of MCHD staff. When the automated reminders go live, a staff member will be assigned to generate a report from the Epic system on a quarterly basis showing which patients are 10 months or more overdue for an A1C. Using the Workbench

system in Epic, this report creates an almost instantaneous list of those with a specified criterion as determined by the user, saving time and effort. Once this list is generated, it will be securely provided to the MCHD vendor who generates automated reminders. A script was approved for use on one of two possible automated reminder systems. The automated reminder will inform patients to call MCHD to schedule a visit for a lab appointment. Each message generated to a patient was estimated to be around 10 cents depending on which vendor was used, making the intervention extremely feasible based on cost and effort.

A question arose related to resource utilization if numerous patients were going to try to call and schedule appointments. Choosing to send these messages to those 10-month overdue on A1C will generate a report with a smaller number of people and give the clinics the capacity to support a potentially increase in patient volume. When a mock report was generated, the number of people with A1Cs greater than 10 months overdue was found to be 3,000 patients. The project implementation was temporarily paused to look into the capacity at each facility to support the additional influx of patients. Discussion arose on whether additional criteria needed to be added to the report to decrease the amount of patient influx. Adding a filter to the report such as A1C >9% could allow for a more focused approach to a smaller group of patients in need of more intensive therapy. At the same time an additional barrier arose as the county automated vendor Televox is in the process of being switched to another vendor called Wells. It was agreed to wait to roll-out the automated reminder system until Wells is fully adopted so that the implementation will not have to occur twice. This will delay the intervention for 2-4 months. Until that time, each clinic's capacity to handle more appointments will be more deeply reviewed and the appropriate patient criteria determined for the contact list.

Limitations

Elements surrounding socioeconomic status (SES) were not gathered in depth in this project. Only a subset of SES variables were able to be examined, which may or may not have resulted in a difference between the overdue and on-time groups. Patient zip code was collected in the chart review, but given the numerous zip codes reported, the data was difficult to compare using the implemented statistical measures. Literature suggests that neighborhood and community impact diabetes care behaviors, as those living in communities with more social challenges have less care behaviors (Smalls et al., 2015).

While some variables were eliminated from the study all together, others had their inclusion criteria and definitions molded overtime. This was a challenge as the definition of certain variables were left open to interpretation or had broad inclusion criteria. For example, the variable *number of chronic conditions* was interpreted as any diagnosis in which a patient is prescribed a medication with recent use or refills, has multiple visits in the study time period, has lab results done for in the study time period, is a condition known or suspected to cause a care burden or decreased quality of life, or something that should require frequent follow-up. The reason why this definition and a few others were so broad was to capture the burden of a diagnosis in a lower socioeconomic population, with insurance barriers, language barriers, transportation, and/or financial barriers who was already experiencing the burden of diabetes treatment. The greater inclusivity of *number of chronic conditions* and *total medications prescribed* (as it included frequently filled PRNs), allowed a more comprehensive capture of treatment burden which may not have been detected if the definition was too narrow.

Another limitation of the project was the many different surveyors administering the A1C questionnaire and the standardization of recording survey responses. Each surveyor may have

had a different strategy at recording or summarizing the responses. The surveyors were also never officially briefed about the project and its purpose. It's unclear if this would have changed the way any of the answers were collected. Given the limitations of time and oversight, the project was conducted in this manner to achieve meaningful results in the intending timeframe requested by HRSA.

This project focused on the outcome of A1C duration, which is an inconsistent predictor of glycemic control and not well discussed in the literature. Recommended A1C testing every 3 to 6 months is needed to intensify diabetes management, but an assessment of daily home blood glucose checks is another factor contributing the overall A1C reduction and other diabetes self-care behaviors (Chow et al., 2016). Frequency of daily blood glucose testing was not assessed in these patients, which is another good predictor of overall adherence to treatment. The ADA continues to recommend A1C evaluation with individualized A1C goals to prevent microvascular complications and prevent hypoglycemia every 3 months if not meeting goals and every 6 months when meeting goals (ADA, 2021a). A much greater timeframe was assessed in these patients potentially limiting interpretation of the data.

Statistically significant differences were not found in as many of the test variables as originally anticipated at the project onset. This could be due to the lack of random sampling and a sample size of 164 patients with unequal assignment. The adjustments to the Chi-Square analysis helped the confidence of the results, but could have at the same time increased the likelihood of a type 2 error (saying there is not a significant finding when there actually is one present). It would be interesting to see this project done with random sampling from overdue and on-time groups with both larger and equal sample sizes to help with internal validity. More differences were observed in this project than those that met the criteria for statistical

significance. This could be improved upon in future research by limiting the responses of the participants to select from standardized answers instead of open-ended responses. A great deal of the survey responses needed to be recoded under a challenging framework, as the patient was not available to clarify their response. Interpretation of the responses was made to organize the data to better support the chi square analysis. A more focused approach with less components to the study design could have also increased the validity of the results. The project involved many hours looking at the EMR. Follow-ups were attempted as late as possible to identify patients who had returned for an A1C check after a 1-year gap. Unfortunately, the data collection was not able to continue until the time in which all 97 patients had repeat A1Cs.

Conclusions

The partnership between OHSU and MCHD filled a mutual need on this project. Not only did the DNP project generate a great deal of data, but there is a vast amount of diabetes-related work to be continued by other DNP students. This project was an intervention requested by MCHD and HRSA to address SMART goal #2 in the diabetes action plan. The work done on this project saved a great deal of time, effort, and cost for MCHD who would have assigned a clinical staff member to complete this task. Especially in the context of COVID-19, there was no other person with the capacity to complete this task.

During the COVID-19 pandemic, Multnomah County outreach staff have had an extremely limited capacity to conduct in-person telephone outreach. However, the A1C survey showed that individuals who were contacted by the clinic were likely to have an increase in appointments by a PCP or other care provider like an RN, BHP, or pharmacist in the following 3 months. These individuals had the opportunity during a routine visit with any of these providers to have the chart scrubbed for an overdue A1C and ordered if needed. Understanding that

COVID-19 had spread the MCHD staff thin, an intervention with less human input and training was needed, so the in-person outreach attempts were not feasible for each overdue patient.

This project provided insight into the differences between two distinct samples of patients with type 2 diabetes who receive care at Multnomah County clinics. The A1C overdue group had diabetes for shorter duration and had better control with less disease burden. A working hypothesis is that this group may not be aware how easily their disease can decline if not managed properly. The majority of these patients had a substantial increase in A1C after their 1-year gap. The education needed for adequate type 2 diabetes management can be complex. A vital piece of communication given to patients should be the fragile nature of A1C and the risk of substantial increase when regular care is not taken. Some patients in the study had an A1C increase over 6% when they finally had their A1C check completed. This clearly illustrates how quickly the diagnosis can shift from stable to uncontrolled.

The intention of the project was to try to explain behaviors in this sample by looking at objective and subjective data of a specific sample. Any attempt to generalize this research to larger populations needs to be taken with caution. In the case of diabetes research, there is still a great deal of information to be learned about individual patient characteristics and the way they interact with one another. There were numerous logistic and statistical limitations in this project. Methodologic errors like sampling bias and the possibility of making type I or II errors were potential risks in this project given the convenience sampling. The greater number of overdue patients from East County Health Center or the entire sample of 24 patient from Northeast Health Center with an A1C greater than or equal to 9% show the need for random sampling, but also the need for investigation at each clinic site in a large metropolitan area.

The research gathered on this project helped provide additional context to patients with type 2 diabetes and overdue A1Cs at MCHD. The data will be helpful a helpful tool in alerting providers to look for patients with overdue A1Cs when they might be seen in clinic for another reason. Patients may not always be aware of when their last A1C was done and any opportunity to timely assess a patient's diabetes should be taken. This project shows the risk of uncontrolled diabetes if a gap of more than 1-year is taken, as an increase was seen in the majority of patients after a period of delayed follow-up. This project shows patients go for long periods of time without diabetes care for various reasons. There is usually not one clear answer. Each patient needs to be assessed independently and offered support unique to their specific barriers to care. Although the automated reminders were not fully implemented by the end of the project, the framework is in place to be sustainable into the future. Utilizing automation and technology make this intervention a low risk, high reward strategy.

A systematic review done by Nuti et al. (2015) discovered articles which found that phone reminders for appointments and for overdue lab work not only increased the number of A1C visits, but also significantly decreased A1C levels and systolic blood pressures in the patients. The impact of these phone reminders will need to be monitored in the future to determine if the same results are seen in type 2 diabetes patients at MCHD. There will need to be a framework applied to assess the intervention once it is live with the new messaging vendor. MCHD must assure that the lab capacity exists before full roll-out of the reminders. If scheduling barriers arise, the intervention is likely to fail. This can be mitigated by adjusting the inclusion criteria on the Epic Workbench report to limit the census produced by the report. The intervention should be started slow and evaluated along the way for both patient adherence and related A1C changes. Getting patients into the clinic is the first step in forming an ongoing

partnership with diabetes-related care. With the right approach this can be a successful

intervention to maintain patient engagement and improve diabetes outcomes.

References

American Diabetes Association. (2020a). Introduction: standards of medical care in diabetes—2020. *Diabetes Care*, *43*(Supplement 1), S1-S2. https://doi.org/10.2337/dc20-Sint

American Diabetes Association. (2020b). 1. Improving care and promoting health in populations: Standards of Medical Care in Diabetes—2020. *Diabetes Care*, *43*(Supplement 1), S7-S13. https://doi.org/10.2337/dc20-S001

American Diabetes Association. (2020c). 4. Comprehensive medical evaluation and assessment of comorbidities: standards of medical care in diabetes-2020. *Diabetes Care*, *43*(Supplement 1), S37-S47. https://doi.org/10.2337/dc20-S004

American Diabetes Association. (2021b). 6. Glycemic targets: Standards of medical care in diabetes—2021. *Diabetes Care*, *44*(Supplement 1), S73-S84. https://doi.org/10.2337/dc21-S006

American Diabetes Association. (2021a). 5. Facilitating behavior change and well-being to improve health outcomes: Standards of medical care in diabetes—2021. *Diabetes Care*, *44*(Supplement 1), S53-S72. https://doi.org/10.2337/dc21-S005

Agarwal, S., Hilliard, M., & Butler, A. (2018). Disparities in are delivery and outcomes in young adults with diabetes. *Current Diabetes Reports, 18*(9), 1. https://doi-org.liboff.ohsu.edu/10.1007/s11892-018-1037-x

Badedi, M., Solan, Y., Darraj, H., Sabai, A., Mahfouz, M., Alamodi, S., & Alsabaani, A. (2016). Factors associated with long-term control of type 2 diabetes mellitus. *Journal of Diabetes Research*, *2016*. https://doi.org/10.1155/2016/2109542

Bailey, S. C., Brega, A. G., Crutchfield, T. M., Elasy, T., Herr, H., Kaphingst, K., ... & Rothman, R. (2014). Update on health literacy and diabetes. *The Diabetes Educator*, *40*(5), 581-

604. DOI: 10.1177/0145721714540220

Beck, A. F., Cohen, A. J., Colvin, J. D., Fichtenberg, C. M., Fleegler, E. W., Garg, A., Gottlieb, L. M., Pantell, M. S., Sandel, M. T., Schickedanz, A., & Kahn, R. S. (2018). Perspectives from the society for pediatric research: interventions targeting social needs in pediatric clinical care. *Pediatric Research*, 84(1), 10-21. https://doi-org.liboff.ohsu.edu/10.1038/s41390-018-0012-1

Canedo, J. R., Miller, S. T., Schlundt, D., Fadden, M. K., & Sanderson, M. (2018). Racial/ethnic disparities in diabetes quality of care: the role of healthcare access and socioeconomic status. *Journal of Racial and Ethnic Health Disparities, 5*(1), 7–14. https://doi-org.liboff.ohsu.edu/10.1007/s40615-016-0335-8

Chow, N., Shearer, D., Plaa, J. A., Pottinger, B., Pawlowska, M., White, A., & Tildesley, H. D. (2016). Blood glucose self-monitoring and internet diabetes management on A1C outcomes in patients with type 2 diabetes. *BMJ Open Diabetes Research and Care*, *4*(1). http://dx.doi.org/10.1136/bmjdrc-2015-000134

D'Souza, M. S., Karkada, S. N., Parahoo, K., Venkatesaperumal, R., Achora, S., & Cayaban, A. R. R. (2017). Self-efficacy and self-care behaviours among adults with type 2 diabetes. *Applied Nursing Research*, *36*, 25-32. https://doi.org/10.1016/j.apnr.2017.05.004

Durfey, S. N. M., Kind, A. J. H., Buckingham, W. R., DuGoff, E. H., & Trivedi, A. N. (2019). Neighborhood disadvantage and chronic disease management. *Health Services Research, 54*, 206–216. https://doi-org.liboff.ohsu.edu/10.1111/1475-6773.13092

Fragala, M. S., Kaufman, H. W., Meigs, J. B., Niles, J. K., & McPhaul, M. J. (2021). Consequences of the COVID-19 pandemic: reduced hemoglobin A1c diabetes

monitoring. *Population Health Management*, *24*(1), 8-9.

https://doi.org/10.1089/pop.2020.0134

Gold, R., Bunce, A., Cowburn, S., Dambrun, K., Dearing, M., Middendorf, M., Mossman, N.,

Hollombe, C., Mahr, P., Melgar, G., Davis, J., Gottlieb, L., & Cottrell, E. (2018).

Adoption of social determinants of health EHR tools by community health centers.

Annals of Family Medicine, 16(5), 399–407. https://doi-org.liboff.ohsu.edu

/10.1370/afm.2275

Gottlieb, L. M., Wing, H., & Adler, N. E. (2017). A systematic review of interventions on

patients' social and economic needs. *American Journal of Preventive Medicine, 53*(5),

719–729. https://doi-org.liboff.ohsu.edu/10.1016/j.amepre.2017.05.011

Goudarzi, H., Barati, M., Bashirian, S., & Moeini, B. (2020). Determinants of medication

adherence among hypertensive patients using the Pender's health promotion

model. *Journal of education and health promotion*, *9*, 89. https://doi-

org.liboff.ohsu.edu/10.4103/jehp.jehp_687_19

Healthy Columbia Willamette Collaborative. (2019). *2019 Community Needs Assessment*.

Retrieved from https://comagine.org/sites/default/files/resources/HCWC-Community-

Health-Needs-Assessment-Report-July2019.pdf

Healthy Columbia Willamette Collaborative. (2019). *Community Health Needs Assessment

Overview*.

Health Resources & Services Administration. (2019). *Health Center Program Data*. Retrieved

on August 15, 2020 from https://data.hrsa.gov/tools/data-reporting/program-

data?type=AWARDEE#titleId

Houle, J., Lauzier-Jobin, F., Beaulieu, M. D., Meunier, S., Coulombe, S., Côté, J., Lespérance,

F., Chiasson, J. L., Bherer, L., & Lambert, J. (2016). Socioeconomic status and glycemic control in adult patients with type 2 diabetes: a mediation analysis. *BMJ Open Diabetes Research & Care, 4*(1), e000184. https://doi-org.liboff.ohsu.edu/10.1136/bmjdrc-2015-000184

Locatelli, S. M., Sharp, L. K., Syed, S. T., Bhansari, S., & Gerber, B. S. (2017). Measuring Health-related Transportation Barriers in Urban Settings. *Journal of applied measurement*, *18*(2), 178–193.

Marquez, I., Calman, N., & Crump, C. (2018). A framework for addressing diabetes-related disparities in US Latino populations. *Journal of Community Health, 44*, 412-422. https://doi.org/10.1007/s10900-018-0574-1

Messecar, D. (2020). *Frameworks for clinical inquiry: Part 1* [PowerPoint slides]. Echo360. https://echo360.org/section/9524ad5a-67a4-4c78-ba9b-ce104701b243/home

Montgomery, J., Lu, J., Ratliff, S., & Mezuk, B. (2017). Food insecurity and depression among adults with diabetes: results from the national health and nutrition examination survey (NHANES). *The Diabetes Educator, 43*(3), 260–271. https://doi-org.liboff.ohsu.edu/10.1177/0145721717699890

Multnomah County Health Department. (2015). *Community Health Assessment*. https://multco.us/file/47115/download

Multnomah County Health Department. (2017). *Multnomah County North Portland Health Center Remodel*. http://multnomah.granicus.com/MetaViewer.php?view_id=3&clip_id=1508&meta_id=102390

Nuti, L., Turkcan, A., Lawley, M. A., Zhang, L., Sands, L., & McComb, S. (2015). The impact of interventions on appointment and clinical outcomes for individuals with diabetes: a

systematic review. *BMC Health Services Research*, *15*(1), 1-54.

https://doi.org/10.1186/s12913-015-0938-5

Oregon Health Authority. (2014). *Oregon Diabetes Report—2019*. Retrieved from

https://www.oregon.gov/oha/PH/DISEASESCONDITIONS/CHRONICDISEASE/DIAB

ETES/Documents/OregonDiabetesReport.pdf

Powers, M. A., Bardsley, J., Cypress, M., Duker, P., Funnell, M. M., Fischl, A. H., ... & Vivian,

E. (2017). Diabetes self-management education and support in type 2 diabetes: a joint

position statement of the American Diabetes Association, the American Association of

Diabetes Educators, and the Academy of Nutrition and Dietetics. *The Diabetes*

Educator, *43*(1), 40-53. https://doi.org/10.1177/0145721716689694

Salimi, C., Momtazi, S., & Zenuzian, S. (2016). A review on effectiveness of motivational

interviewing in the management of diabetes mellitus. *Journal of Psychology and Clinical*

Psychiatry, *5*(4), 1-6. DOI: 10.15406/jpcpy.2016.05.00294

Shalowitz, M. U., Eng, J. S., McKinney, C. O., Krohn, J., Lapin, B., Wang, C. H., & Nodine, E.

(2017). Food security is related to adult type 2 diabetes control over time in a United

States safety net primary care clinic population. *Nutrition & Diabetes, 7*(5), e277.

https://doi-org.liboff.ohsu.edu/10.1038/nutd.2017.18

Silverman, J., Krieger, J., Kiefer, M., Hebert, P., Robinson, J., & Nelson, K. (2015). The

relationship between food insecurity and depression, diabetes distress and medication

adherence among low-income patients with poorly-controlled diabetes. *Journal of*

General Internal Medicine, 30(10), 1476–1480. https://doi-org.liboff.ohsu.edu/10.1007/

s11606-015-3351-1

Smalls, B. L., Gregory, C. M., Zoller, J. S., & Egede, L. E. (2015). Assessing the relationship

between neighborhood factors and diabetes related health outcomes and self-care behaviors. *BMC Health Services Research, 15*(1), 445. DOI 10.1186/s12913-015-1086-7

Vivian, E. M., & Ejebe, I. H. (2014). Identifying knowledge deficits of food insecure patients with diabetes. *Current Diabetes Reviews, 10*(6), 402–406. https://doi-org.liboff.ohsu.edu/10.2174/1573399810666141124111453

Walker, R. J., Gebregziabher, M., Martin-Harris, B., & Egede, L. E. (2014). Independent effects of socioeconomic and psychological social determinants of health on self-care and outcomes in type 2 diabetes. *General Hospital Psychiatry, 36*(6), 662–668. https://doi-org.liboff.ohsu.edu/10.1016/j.genhosppsych.2014.06.011

Walker, R. J., Smalls, B. L., & Egede, L. E. (2015). Social determinants of health in adults with type 2 diabetes--contribution of mutable and immutable factors. *Diabetes Research and Clinical Practice, 110*(2), 193–201. https://doi-org.liboff.ohsu.edu/10.1016/j.diabres.2015.09.007

Walker, R. J., Williams, J. S., & Egede, L. E. (2016). Influence of Race, Ethnicity and Social Determinants of Health on Diabetes Outcomes. *The American journal of the medical sciences*, *351*(4), 366–373. https://doi-org.liboff.ohsu.edu/10.1016/j.amjms.2016.01.008

Yang, S., Kong, W., Hsue, C., Fish, A. F., Chen, Y., Guo, X., ... & Anderson, R. (2016). Knowledge of A1c predicts diabetes self-management and A1c level among Chinese patients with type 2 diabetes. *PloS one*, *11*(3), e0150753. https://doi.org/10.1371/journal.pone.0150753

Yeh, A., Shah-Manek, B., & Lor, K. B. (2017). Medication regimen complexity and A1C goal attainment in underserved adults with type 2 diabetes: a cross-sectional study. *Annals of Pharmacotherapy*, *51*(2), 111-117. https://doi.org/10.1177/1060028016673652

Young, C. F., Yun, K., Kang, E., Shubrook, J. H., & Dugan, J. A. (2018). Correlations between

A1C and diabetes knowledge, diabetes numeracy, and food security in a vulnerable

type 2 diabetes population. *Diabetes Spectrum, 31*(2), 177–183. https://doi-

org.liboff.ohsu.edu/10.2337/ds17-0036