FINAL REPORT:

STATE UNIVERSITY PARTNERSHIP

A STUDY ON TYPE 2 DIABETES MELLITUS FOR PATIENTS AMONG MEDICAID BENEFICIARIES IN KENTUCKY

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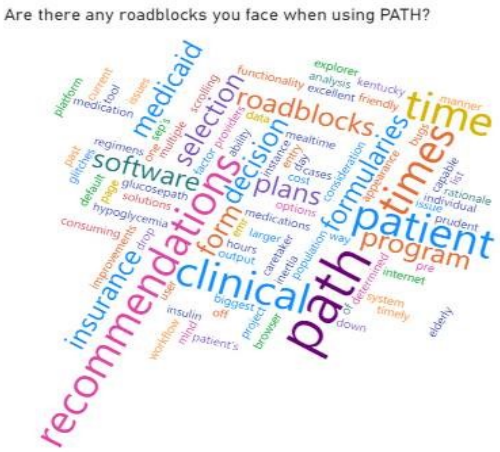

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Executive Summary

This project is a collaboration involving the Kentucky Cabinet for Health and Family Services (CHFS) Department of Medicaid Services (DMS) and Northern Kentucky University (NKU) under the State University Medicaid Partnership Program. The purpose of this contract is to provide analysis to DMS regarding the impact of an electronic decision support tool combined with team-based care workflow on provider decision-making and patient outcomes for the treatment of poorly controlled diabetes mellitus (diabetes) among patients receiving Kentucky Medicaid.

The goal is to assist with the development of successful interventions to improve the quality of care, patient engagement, and lower costs. NKU performed this project in collaboration with two subcontractors, St. Elizabeth Healthcare (SEH) and Path Decision Support Software LLC (GlucosePath). A Memorandum of Understanding became effective July 1, 2018 through June 30, 2020.

Project Goals and Outcomes

The goals of the project are:

1. Increase patient adherence through shared decision-making
2. Reduce complexity and improve treatment via point-of-care clinical decision support (CDS) tool
3. Analyze member and system medication cost and use of the CDS tool

Outcome measures are:

1. Member hemoglobin A1c (HbA1c)
2. System medication costs when made available
3. Member medication costs when made available
4. Claims for diabetes-related unplanned hospital treatments

Results

The project yielded very promising results relative to clinical outcomes and the potential to lower costs. Medication costs were not able to be reliably assessed due to the proprietary nature of formulary agreements and pricing, but patient encounters and claims were substantially lower for the study group compared to the control group. The improved outcomes and lower costs are interpreted as the results of increased patient adherence. The team-based strategy used in the study was well-accepted by providers. Of promise was the role played by the pharmacist.

- Patients treated by providers who changed the treatment regimen to one that either fully or partially followed the recommendation of the CDS tool had a statistically significant reduction in A1c of 2.15 or almost 20% over time.
- When compared to the control group, study patients who were treated either based upon either a full or partial recommendation have significant improvement in their A1c measures. In terms of the final A1c, the full group is statistically significantly lower that the control group, and the partial group is marginally close to being statistically significant with a p value of 0.06.

- The control group had a mean improvement in A1c of 1.7. During the project term, St. Elizabeth Physicians (SEP) had a parallel clinical quality improvement initiative focused on diabetes which likely contributed to this improvement. Consideration should also be given as to whether the control group represents the typical diabetic population as they were selected from patients adhering to quarterly follow-ups.
- Consistent with the research literature the inclusion of pharmacists plays a key role in team-based care for improvement in outcomes and patient engagement for diabetes.
- The study group had eight unplanned diabetes related hospitalizations compared to 28 for the control group.
- Based upon billing data, fewer encounters for unplanned diabetes hospitalizations resulted in a mean savings of $1,541 per patient in the study group compared to the control group over the course of the project.
- Medication costs or valid cost proxies were not available for this study. Issues are detailed in the report. Appendix C provides an analysis using proxy measures with noted limitations on their reliability and generalizability but are provided for directional guidance.
- Barriers to adoption of this approach appear to be workflow related and linked to time required to use the CDS tool, lack of integration of the CDS tool with the EHR, and adequate training.
- Of the 104 providers who signed a collaborative care agreement, indicating a willingness to consider being involved in this project, 43 participated. This may be an indication of concerns about workflow changes, time commitments, or availability of the pharmacists at specific locations and times. There appear to be barriers among some providers that may be attributable to clinical inertia.
- SEH has found the results very promising and will integrate the tool with its Epic EHR system in July 2020.

Lessons-Learned and Implications for the Kentucky Department of Medicaid

This project indicates that it may be possible to improve outcomes and lower some costs for Kentucky Medicaid patients with uncontrolled diabetes. The prevalence of clinical inertia, the failure of appropriate treatment intensification, in diabetes treatment is a well-documented worldwide phenomenon. Similarly, patient engagement of this population faces many challenges. Solutions to these challenges may be addressed through a combination of the application of decision support solutions at the point of care combined with team-based approaches to engagement. Having a pharmacist lead in this engagement team seems particularly promising.

Providers are faced with an increased complexity in determining treatment regimens while dealing with increased challenges in workflow and reporting requirements. A key lesson-learned concerns how decision-support tools must be efficient and integrated with workflow. That may encourage providers to increase adoption. Providers need also be encouraged to consider other treatment regimens in the context of their typical prescribing habits.

Providers and pharmacists identified the need for greater drug cost transparency and issues of prior approval by the Managed Care Organizations (MCOs) which cause delays in treatment and frustrations for the patient and provider. There is also a need for the MCOs to share up-to-date formularies with the providers.

While this is a health-systems level problem, policies encouraging best-practice sharing and educational programs concerning Medicaid patients are needed. Policies providing financial incentives either directly or through intermediaries such as the MCOs to adopt team-based care or using decision-support technologies can be considered.

A summary of the lessons learned relative to the decision-support tool:

- Integration into the providers' EHR system is key to maximizing productivity and accuracy, and to minimizing workflow disruption.
- Differences were noted in formulary coverage for the same medicines, and for patient co-pays, when comparing MCO's websites with pharmacy point-of-sale terminals. This caused confusion with some patients, who were expecting their medicines to be covered, and for a specific co-payment amount. One solution to this might be the MCOs providing the same access to the formulary and co-pay data available to pharmacies on a broader scale.
- Pharmacists and providers suggested more than 30 new medicines or new medicine doses that were incorporated into the tool during the project. Thus, future projects should be able to incorporate new medicines during the project.
- The tool's user interface was redesigned to move more frequently used fields to the top of the screen, based on pharmacist and provider suggestions. This saved data entry time. User interface and general human-factors design are critical to the adoption of new tools.
- While the tool displays ten regimen options, more diversity in medication class is needed within those ten options. For example, it might be more useful for the provider and patient if all ten options do not contain the same classes of medicines, because if a class of medicine is not acceptable to the patient or provider, then all 10 regimen options are unacceptable.

Lessons learned in the identification of eligible populations include:

- The project benefitted by having a team identify eligible patients in advance using EHR records, rather than relying on providers to review patients for eligibility during office visit.
- Provider buy-in to the project was improved by allowing providers to exclude inappropriate patients in advance.
- When inviting patients to participate in the project, positive language was used to explain the purpose of the project (e.g., "to help improve your diabetes control"), rather than negative language ("your diabetes is not under control").
- It was helpful to tell patients that their providers supported the study.

Key Team-Based Care lesson-learned:

Clinical inertia can be reduced by having pharmacists review current drug regimens for potential improvement by using a process that is congruent to the workflow of the provider and supports follow-ups during patient encounters with the health system.

Background

This project is funded under the State-University Partnership program (SUP). This is an ongoing collaboration between a state's government entities and state university research centers. This collaboration operates on a shared-cost basis. The partnerships focus on state-funded health programs working to provide the analysis and research, as well as program support, to create essential state-specific health information and conduct policy-related projects and programs.

Diabetes mellitus is a major health challenge to the population of Kentucky and state and local governments. The prevalence of diabetes among Kentucky adults has increased from 6.5% in 2000 (240,000) to 12.9% (442,480 adults) in 2017. Diabetes represents a particular challenge to the Kentucky Medicaid program. For 2017, 16.2% or 165,110 adult Medicaid members had a diagnosis of diabetes and at least one insurance claim. While the prevalence of diabetes in the Medicaid population remained constant between 2013 and 2017, Medicaid expansion of coverage resulted in a 2.2-fold increase in the number of adult members with diabetes during that time. For Medicaid, diabetes is the third highest overall cost of chronic diseases at $117 million. Table 1 provides a summary of diabetes prevalence in Kentucky Medicaid based upon data from the Kentucky Cabinet for Health & Family Services. [i]

In support of the Kentucky Medicaid program and under the SUP, Northern Kentucky University, St. Elizabeth Healthcare and St. Elizabeth Physicians undertook a quality improvement initiative with the goals of improving patient outcomes and lowering system costs. The project consisted of providing a team-based approach led by a pharmacist that uses a clinical decision support (CDS) to recommend an appropriate medication regimen. The project focused on Medicaid patients with a diagnosis of uncontrolled diabetes (A1c>=8). The twin goals were to increase patient adherence through shared decision-making and to reduce complexity in treatment decision-making via point-of-care CDS. The CDS also has the capability of providing member and system medication costs to the extent that they are available in order to provide financial decision support.

The complexity of treatment alternatives in diabetes is one of the causes of clinical inertia, or the failure for patients to receive acceleration of treatment. There are more than 160 drugs that have been identified for treatment for diabetes.[ii] This results in substantial complexity in determining treatments and considering costs.

The CDS tool used in this project uses algorithms based upon treatment standards approved by professional organizations to recommend treatment alternatives. This is based upon the patient's clinical data, select social determinants provided by the patient during the encounter, and costs when they are available and appropriate.

Table 1: Diabetes in the Kentucky Adult Medicaid Population

Prevalence of Diabetes in the Medicaid Adult Population		
Characteristic	Diabetes Prevalence	Number with Diabetes
Adults Age 19 and Older		
All Adults	16.2%	165,110
Gender		
Men	15.0%	66,153
Women	17.2%	98,957
Age		
18-44	8.2%	37,290
45-64	23.0%	39,625
55-64	31.9%	47,336
65+ not eligible for Medicare	38.9%	40,859
Race/Ethnicity		
White	15.5%	109,957
African-American	14.5%	14,253
Hispanic	11.1%	1,825
All Other or Unknown	20.3%	38,805
Geography		
Appalachia	18.6%	71,756
Non-Appalachia	14.8%	93,347
Unknown or Out of State	.01%	7
Metro	14.2%	55,927
Non-Metro	17.5%	109,176
Unknown or Out of State	.01%	7

The team-based approach is well-supported by the literature, particularly the use of a pharmacist as a key team member. The process consists of the patient encounter where the pharmacist asks the patient questions about personal medication preferences and adherence as prompted by the CDS. The patient and pharmacist discuss the customized treatment options recommended by the CDS. Patient and pharmacist agree on a treatment regimen. The prioritized treatment options are presented to the physician who decides whether to follow the full recommendation, partially follow the recommendation, try an alternative approach not included in the recommendation or make no change from the patient's current treatment. A goal is that the patient is more engaged and likely to adhere to the treatment plan including the lifestyle counseling.

Literature Review

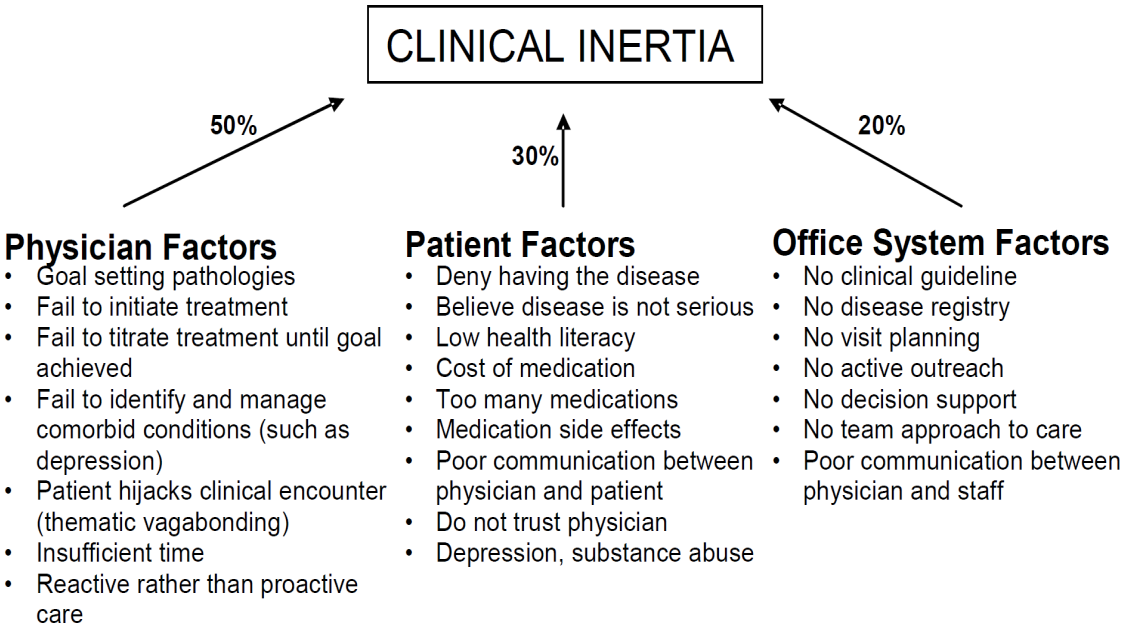
This project is at the intersection of the research domains of clinical inertia, clinical decision support, team-based care, and patient engagement in diabetes management. Clearly these domains overlap and the last three may be conceptualized as process solutions that can be used to address the first, the issue of clinical inertia in diabetes management. There is a substantial research literature. Many of these studies combine 2 or all three of the process solutions.

Consideration must be given to the time frame research studies were undertaken. The use of health information technology and data have changed the characteristics of patient encounters significantly during the last decade. The EHR Incentive Program, commonly known as Meaningful Use, promoted the adoption and use of Certified Health Information Technology beginning in 2010. Office-based provider use of EHRs grew from less than 25% in 2004 to about 50% in 2010 to almost 90% in 2018. [iii] Thus, changes in workflow, data availability, use of alerts, and other factors may make it difficult to compare studies in more recent years to those from earlier years. The movement to value-based care (VBC) as a reimbursement model since 2016 also can confound the comparison of studies across time periods.

Clinical Inertia in Diabetes Management

The seminal study of clinical inertia in chronic disease management was published in 2005. Clinical inertia is defined as (1) the failure of the patient of achieve major evidence-based clinical goals and (b) the patient fails to receive appropriate intensification of pharmacotherapy in a defined period of time. [iv] In this study the authors identified causal categories of clinical inertia and arbitrarily attributed percentages to each category with no consideration of interactions between them. This is represented in Figure 1 and has become the standard framework for approaching questions of clinical inertia.

Figure 1: Depiction of Factors in Clinical Inertia



Source: O'Connor, et al. "Clinical Inertia and Outpatient Medical Errors" (2005)

There are a myriad of studies confirming the prevalence of clinical inertia in diabetes management since this early study. Typical is a retrospective study undertaken by researchers at the Cleveland Clinic reviewing records of more than 7,000 patients where clinical measures indicated the appropriateness of an intensification of treatment. The study found that at this single institution almost two-thirds of patients did not have a treatment intensification within 6 months, including 44% in the highest risk category (A1c>9).[v] A second study, a systematic review of 54 research articles found that in these studies the mean time to intensification of treatment was greater than 1 year.[vi]

Medicaid populations may be subject to significant levels of clinical inertia in diabetes management. A study examining data from 2013 - 2015 found that 30% of the patients with a diabetes diagnosis and an A1c > 8 covered under a managed care plan experienced clinical inertia.[vii]

The principal research focusing on solutions to clinical inertia have been patient-engagement, team-based care, and the use of clinical decision support, typically in some form of combination.

Team-Based Care

Team-based care and patient engagement in diabetes management are very much intertwined processes. In effect, the patient is the key member of the team relative to adherence. Approaches to team-based care have been well-documented. A key problem in analyzing and comparing the effect of team-based care is the variety of models in use. The CDC has established guidelines to team-based care in diabetes and international organizations have created best practices.[viii] Systematic review articles indicate that most randomized controlled trials (RCT) studies associate modest improvement in diabetic clinical measures with team-based care.[ix]

Of importance to this project is the centrality of the pharmacist in team-based care. This approach is not unique and there are many articles examining the effect of including pharmacists in the care of diabetic patients dating to 1996.[x] Systematic reviews of the literature show a consistent positive relationship between improvement in clinical measures for diabetics when pharmacists are involved in the care process.[xi]

There do not appear to be any studies that focus on the role of the pharmacist in collaborative care through the introduction of a CDS tool. The pharmacist is uniquely qualified to deal with the more than 160 drugs available to treat diabetes and the complexity of the data associated with CDS. This is a novel element of this project.

Patient Engagement

Research studies in patient engagement in diabetes are numerous and varied. In this project, patient engagement needs to be considered in the context of the encounter including interactions with the care team and the patient subsequent behaviors, including adherence and self-management. Review studies of self-management focus on the impact of educational programs. A systematic analysis of 131 articles focused on self-management interventions, 62% of those studies found a statistically significant improvement in glycemic control. Over reduction in A1c was .57 compared to .17 for the control group across all studies. These results are for studies using a traditional engagement approach of group meetings and individual counseling.

This project does not rely upon traditional engagement models, but instead engages the patient at the encounter. A pharmacist asks the patient about personal preferences regarding medication adherence and lifestyle as prompted by the CDS tool, then the pharmacist together with the patient discuss the medication options recommended by the CDS tool. Together they agree upon a treatment regimen that should result in the best outcomes. It is an alternative path to get patient ownership of treatment decisions and adherence. There is no comparable research that examines engagement through such a process. Note that the process does include key elements that have been identified as part of successful engagement: convenient, tailored, streamlined, and uses open communication.[xii]

Clinical Decision Support in Diabetes Management

Using CDS to address diabetes treatment has a substantial research literature. This literature first must be understood in the context of EHR adoption in healthcare. For most providers this has occurred under the EHR Incentive Program (Meaningful Use/Promoting Interoperability). EHRs have been much maligned and associated with provider "burnout." Relative to CDS, based upon the 2019 Stanford University/Harris Poll EHR study, while 88% of primary care physicians identified providing CDS as important, only 56% indicated that they were satisfied with their EHR's CDS capability. Note that this is for CDS that is native to the EHR not a third-party tool. In that study most physicians indicated that they view EHRs primarily as a storage device for data.[xiii] This suggests that provider attitude toward and use of CDS may be part of the larger perception of the EHR.

Studies directly examining CDS in the treatment of diabetic patients predate the widescale adoption of EHRs. Fifteen of these early studies which were summarized in a 2012 meta-analysis which found an improvement in A1c in a range of .5 to 1.0. However, in these pre-EHR incentive days, the authors concluded that "the cost of implementation may outweigh benefits in patient care."[xiv]

A more contemporary subsequent meta-analysis of eight RCT trials found "weak and inconsistent variable results" with improvement in care processes but "weak to modest positive results" for clinical measures.[xv] This is significant in that most studies examining CDS in diabetes are not designed as RCTs.

There were two recent RCTs exploring the use of CDS. The first was in Belgium were 3,815 patients associated with 51 primary care providers were randomized into two groups. The study concluded that use of the CDS system did not improve outcomes.[xvi] The authors suggested the absence of complete structured records likely lead to low usage of the system by the providers.

The second study published in 2020 examined the use of a web based CDS service targeted at General Practice providers in Ireland. At the 14 practices and for 114 patients in the analysis, there was no difference in glycemic improvement between the intervention and control group. Nor were improvements found in the measures of secondary outcomes of blood pressure and total cholesterol or increased utilization of services. The providers reported "finding decision support helpful navigating increasingly complex algorithms," but that the "target group had poor engagement with the GP and hospital system."[xvii]

This project takes a different approach in that it is focused on the unique value proposition of sorting through and solving the complexity of medication treatment alternatives. This is absent in traditional CDS solutions. In addition, this project used a pharmacist lead in a team-based encounter.

Project Outcome Requirements

Based upon the Statement of Work in the contract between CHFS and NKU the following outcomes and deliverables are required from this project:

Deliverable D: Define patient outcomes compared with the level of utilization of the electronic decision support tool within the pilot project.

Deliverable E: Measure any differences in patient outcomes

Deliverable F: Measure the change in the knowledge by primary physicians/providers within the context of the literature of clinical inertia.

Deliverable G: Develop a lessons-learned analysis of the electronic decision support tool utilization, identification of the eligible population, and patient engagement to guide the process of full implementation in a wider rollout of the project.

Deliverable H: Summarize for DMS in the differences in individual medications and medication classes between the patient's current medication regime and the regime proposed by the electronic decision support tool, including costs.

Deliverable I: Analyze patient outcomes based on regimens partially followed, fully followed, followed an alternative recommendation, or "no action."

The project design, implementation, research methods and analyses were created to meet these outcomes/deliverables.

Project Design

The project directly addresses the problem of diabetes mellitus (diabetes) in the Kentucky Medicaid population through a clinical intervention. This intervention is centered in the intersection of clinical decision support, team-based care, and patient engagement and targets individuals with poorly controlled diabetes mellitus covered by Kentucky Medicaid that are seen within St. Elizabeth Healthcare. Northern Kentucky University (NKU), St. Elizabeth Physicians (SEP), and St. Elizabeth Healthcare (SEH) acted in partnership to introduce a quality improvement initiative. In summary, this consists of:

- The use of an electronic decision support tool to review and recommend treatment regimens based upon clinical, social, and cost factors
- The use of a pharmacist in the patient encounter to discuss treatment regimen alternatives as recommended by the electronic decision support tool
- A decision by the provider to follow, partially follow, or not follow the recommended regimen.
- Measurement at the patient level to determine the effect on outcomes and costs
- Measurement of the provider experience using the electronic decision support tool a team-based encounter
- Lesson's learned and strategy development to effectively use the decision support tool and a team-based encounter

The project was established through SEP where primary care providers participated on a voluntary basis. Educational programs were presented to all providers on the initiative that included CME credit. Initially 3 locations were targeted for the program. Following initial success at these locations, this initiative was expanded to 16 offices where the providers had an opportunity to participate. Seven ambulatory care pharmacists worked with the provider teams at these locations. Participating providers entered into a St. Elizabeth Physicians Pharmacist Collaborative Care Agreement (CCA) allowing pharmacists to provide patient-education and counseling per the American Diabetes Association's most recent Standards of Medical Care in Diabetes. A total of 104 providers signed the CCA and 43 providers participated in the initiative.

Study and Control Groups

The project was a quality improvement initiative as defined by the Department of Health & Human Services (HHS) criteria.[xviii] Therefore, a patient's informed consent was not required. Patients were studied based upon their provider's participation in the program and whether the individual patient qualified subject to exclusion criteria. The project was run as a pilot without prospective randomization. For the participating providers, 156 of their patients were included in this quality improvement initiative and 126 had the necessary follow-ups appointments and lab measurements to qualify for the study group.

Patients in the study group received follow-up calls from the pharmacists or other members of the care team to encourage relevant tests and follow-up appointments. Such follow-up engagements are standard procedure for all patients with this diagnosis including those in the control groups. A $5 travel reimbursement was provided to the patients in the study group after the follow-up sessions with their providers. The control group was randomly drawn from other patients seen by SEP and SEH based upon the same criteria as the study group from patients who have had at least one follow-up visit in adherence to an established regimen during the two year study.

As discussed in the research methods sections there are concerns that the control group may not represent the general diabetes patient population served by SEP. The distribution of patients with an initial A1c reading in the 8 to 9 range is substantially higher in the control group than the study group. This confounded a comparison for the change in A1c between the two groups. Further, patients in the control group may be more engaged and may be more likely to adhere to treatment regimens as they were selected from the diabetes patient population based upon the availability of measures from follow-up encounters. They were not incentivized nor encouraged to adhere to the regimen to the same extent as the study group, thereby potentially being more self-motivated. Specific medical characteristics concerning the control group are described in Appendix B.

Patient inclusion and exclusion criteria are described in Table 2. Note that the exclusion criteria exclude patients seen by an endocrinologist from both the control and study groups. St. Elizabeth Physicians has a large diabetes center with 6 endocrinologists and 4 nurse practitioners. Providers concerned about difficult to treat patients are encouraged to provide access to specialist care. This availability may bias the study and control groups away from patients of complexity and towards patients responsive to traditional intervention.

Intervening factors

Several intervening factors confounded this project:

- A concurrent initiative by SEP that provided incentives to providers who showed decreases in A1c measures in their diabetes patient population was in process. This likely results in an underlying system-wide trend in A1c improvements and could contribute to the skew for patients in the control group. Note that patients in the study group had registered uncontrolled diabetes despite these incentives.
- The Covid-19 pandemic which constrained testing and follow-up appointments during the last 4 months of the project.
- Costs of medicine to DMS and CMOs were not available, therefore providers could not factor these system costs into the decision-making.
- Patient duration of diabetes is not considered. Patients newly diagnosed may show an atypically large A1c reductions when first treated.

Table 2: Patient Inclusion/Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• KY Medicaid • Age >=18 years, <= 65 years • Type 2 Diabetes Mellitus • A1c >=8% anytime since 7/1/18 • Have had at least two A1c results between 7/1/18 – present • Have completed an appointment with SEP PCP since 7/1/18 • Omit patients with active research flag (Test group)	• Type 1 Diabetes or Gestational Diabetes • Participant currently or intending to start hemodialysis or peritoneal dialysis during project term • Chronic or planned systemic glucocorticoid use (at discretion of PCP and/or Pharmacist) • Patients that are adherent to prandial insulin. Patients that are non-adherent to prandial insulin may be included at the discretion of the pharmacist. • Patient has been treated by an endocrinologist within the last 6 months • Patient is scheduled for bariatric surgery. If patient has not been scheduled for bariatric surgery yet but is doing diet trial and being considered for bariatric surgery, patient may be included at discretion of provider.

The providers at St. Elizabeth Physicians are further assisted by monthly reports on their patient panel with administrative support given for providers who request help in reaching their quality goals.

Implementation of this strategy has led to consistent year-to-year improvement on this endpoint with the group meeting Medicare "4 star" quality at the beginning of 2020. The implementation of this project took place in this enriched environment.

Clinical Decision-Support Software

The electronic decision support software is provided by a subcontracted company, through a product named GlucosePATH. The application is not integrated within the EHR system, thereby requiring a separate workflow for its use. The software is designed to optimize a team-based care workflow, including a patient consultation. Patients are asked about things that affect adherence including:

- Cost
  - Monthly budget for medication
  - Cost sensitivity
- Adherence
  - Intentional and unintentional non-adherence
  - Work-related hypoglycemia risk
- Review regimen pros and cons
- Prompt patient to express values and preferences such as a preference to avoid injections

The application addresses the complexity of regimen selection and reimbursement coverage and prices. More than 60 front-line treatments for diabetes are analyzed. The application may recommend treatment regimens that select 0 to 5 treatments from more than 70 front-line therapies including diet and exercise. Based upon the patient's clinical characteristics, and expressed values and preferences of the patient, algorithms are used to suggest appropriate treatments. The algorithm is based upon recommendations of the American Association of Clinical Endocrinologists (AACE) and American Diabetes Association, standard data and rules are used to provide a list of preferred regimens. These can further be prioritized by out-of-pocket and/or system cost. The weighting of priorities in the algorithm are:

- A1c control
- Cost
- Body Weight change
- Adherence
- Side effects

The application in this project was used primarily by the pharmacist in conjunction with patient. Discussions provided the results of the analysis to providers. The design addresses all components of clinical inertia: physician, patient, and office system factors.

Of the 104 providers who signed the collaborative care agreement, 43 participated. Of those participating there were 4 possible outcomes:

- Fully followed the recommended regimen
- Partially followed the recommended regimen
- Continued with the existing regimen
- Introduced a new regimen whose treatment did not overlap with treatments in the regimens recommended by the clinical decision support application

Team-Based Decision Support

A goal of the project is to learn how to best increase patient adherence through shared decision-making. The design applies the principles of team-based care through the assignment of an individual with a Doctorate in Pharmacy to the participating providers. There is substantial literature supporting the engagement of pharmacists with diabetic patients and an associated increase of adherence and improved outcomes. The pharmacist ensures care collaboration by direct patient interactions and the use of the decision-support software. Patient interactions included all factors of adherence including lifestyle and social determinants. Regimen changes and alternatives are likewise a team-based discussion between the pharmacist and the provider.

Research Methods

The research methods are directly explicated from research questions driven by the project goals and outcomes. They consist of three categories:

- Assessment of clinical data
- Assessment of cost estimates
- Assessment of team-based decision support

The result is a mixed methodology approach consisting of a longitudinal and control group comparison of outcomes based upon clinical measures, a review of patient billable encounters with SEP and SEH, and surveys of providers and pharmacists involved in this project. These are described in the following sections.

Assessment of Clinical Data

The research methodologies required to address the research questions associated with the patient outcome deliverables of this project consisted of:

- A longitudinal analysis of the changes to clinical measures over time of individual patients
- A comparison of outcomes of the study group compared to a control group

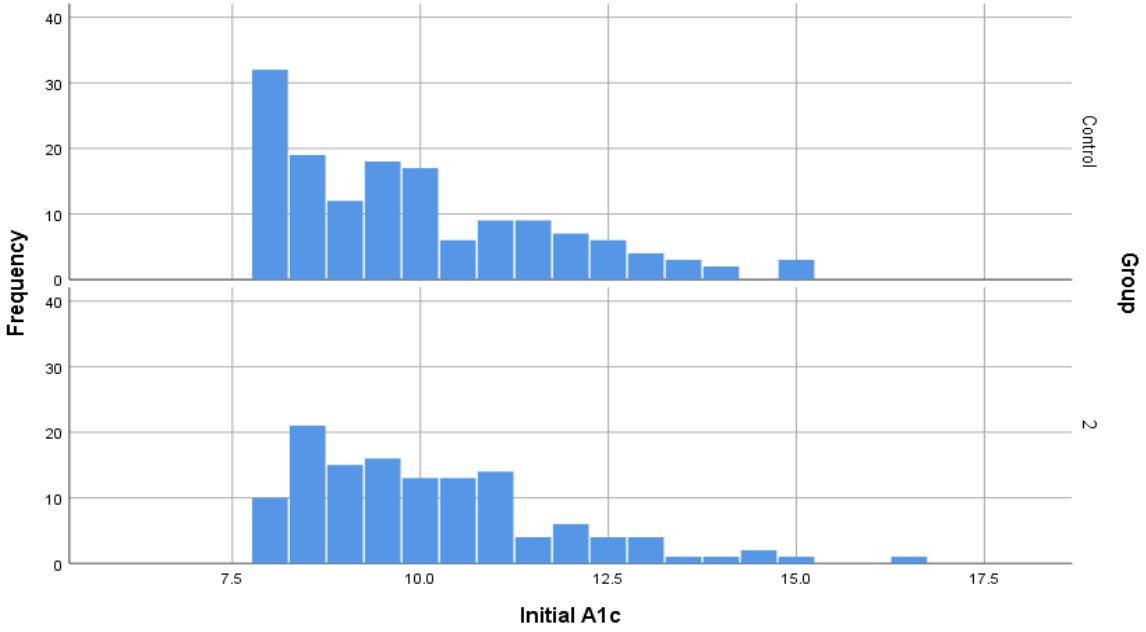
The statistical method used for both were T-tests of mean differences. Consideration was given to using an interrupted times series analysis for the longitudinal data but the small sample size, issues of variable collinearity, and variable interactions precluded that option.

A confounding factor in the analysis concerns differences between the control group and the study group. The control group consists of 147 patients (reduced from 150).[xix] The study group consisted of the 126 patients who had follow-up appointments during the period under study.

The control group was originally drawn on the assumption that all members of the study group could potentially have the required follow-up visits. There were also significant differences in the distribution of the A1c measures between the two groups. As depicted in Figure 2, there are significant differences between the initial A1c measures between the control and study groups. This skewed nature of the distribution for the control group violates the distribution assumptions when using T-test statistical analyses. Various transformations were applied, but a normal distribution could not be achieved. To

address the violations of statistical tests assumptions, bootstrapping method as well as nonparametric approach were used in data analysis.

Figure 2: Frequency Distributions for A1c Comparing Control and Study Groups



Assessments of Cost Data

A goal of this project was to assess the impact of team-based care and electronic clinical decision support on the costs of care for Medicaid patients with uncontrolled diabetes. The principal methodology used is the assessment of administrative data for patient encounters. A challenge in undertaking this analysis is that formulary data for the Medicaid Managed Care Organizations (MCOs) are proprietary. Also, costs are more than just those for drugs and include emergency department encounters, admissions, and those associated with comorbidities.

In the direct assessment of drug costs, analyses were undertaken by using the published formulary prices from the MCOs. These do not include steep negotiated discounts and are not indicative of actual costs. A second approach consisted of using data Centers for Medicare & Medicaid Services' (CMS) National Average Drug Acquisition Cost (NADAC) database. This source had missing data for key classes of drugs and there is also no evidence that these national data are appropriate of the region and hospital studies. The contracted deliverable states that drug costs will be estimated if available. The research team determined that no reliable measures of these costs are available, therefore the cost analysis is based upon system encounters. A discussion and summary assessment using these proxy costs in provided in Appendix B for the purpose of demonstrating the analysis and suggesting key issues and potential findings.

In undertaking the analyses, claims data for individual patients were not available from DMS. For most encounters, reimbursed costs to SEP and SEH were available. Analyses of these data were undertaken, but, owing to the complexity of the patients and costs associated with comorbidities an allocation of cost directly to the diabetes treatment appeared arbitrary and could not be systematically accomplished.

As such, costs are estimated using counts, that is the number of encounters by the patient for diabetes-related care. Chart reviews were undertaken to validate that an encounter is diabetes related. Comparisons are made between the control group and the study group. In terms of formulary costs, given the constraints of the proprietary nature of negotiated costs, federal data approximating costs for some drugs are available. These are used as surrogates for drug costs.

The methodologies used for comparing cost data are a comparison of raw counts and a comparison of mean differences.

Assessment of Team-Based Decision Support

The experiences and lessons-learned from team-based decision support were ascertained through qualitative research methods. Providers had a pre-test and post-test of knowledge of the project and clinical decision-support. Participating providers also were administered a survey concerning their experiences with this quality improvement initiative. The pharmacists involved in the project also were engaged in a survey consisting of an open-ended structure to allow for the capturing of common experiences, themes, and scope of experience.

Results

Deliverable D: Patient Outcomes and Level of CDS Utilization

A longitudinal analysis was undertaken to examine the change in outcomes as indicated by changes in the A1c measure following the use of the clinical decision support (CDS) system.

Table 3: Provider Use of the Clinical Decision Support System by Patient Count

Recommendation	Frequency	Percent
Full	72	57.10%
Alternate	22	17.50%
Partial	18	14.30%
No changes	12	9.50%
Alternate initially, Full @ 9-month f/u	1	0.80%
No changes initially, Full @ 6-month f/u	1	0.80%

As shown in Table 3, a total of 126 patients had encounters where the provider used the CDS tool. For these patients, 57.10% elected the full recommendation; 17.50% of providers recommend an alternative regimen; 14.30% recommend part of the recommended regimen; 9.50% recommend no changes. Initially one provider implemented no change in treatment but switched to the full recommendation after 6 months, and another patient was recommended alternate initially but switched to the full recommendation after 9 months. These two patients are included in the full recommendation category as necessary follow ups were executed.[xx]

Table 4 provide tests of significance for each of the provider utilization approach.

- Each of the recommendations involving a change to the regimen showed a statistically significant improvement in the A1c.
- Partially following the recommendation resulted in a mean decline of 2.13 in the A1c measure (20.96% reduction).
- Patients treated with the regimen following the full recommendation from the CDS application showed a decline of 2.03 in the A1c measure (17.80% reduction).
- Changing treatment to an alternative regimen, but one that was not the recommendation by the CDS application, resulted in a decline of 1.48 in the A1c measure (13.66% reduction).
- When no change was implemented there was no statistically significant change in the A1c measure.

The Final A1c by provider utilization category is provided in Table 4. Table 4 shows sample size, mean, standard deviation, minimum, maximum and 95% confidence interval of Final A1c for four recommendations. The lowest Final A1cis 7.83 (Partial), followed by 8.10 (Full), and 8.76 (Alternate). The No change group has the highest Final A1c – 10.13. The no change group has a widest confidence interval whereas the full group has the narrowest confidence interval.

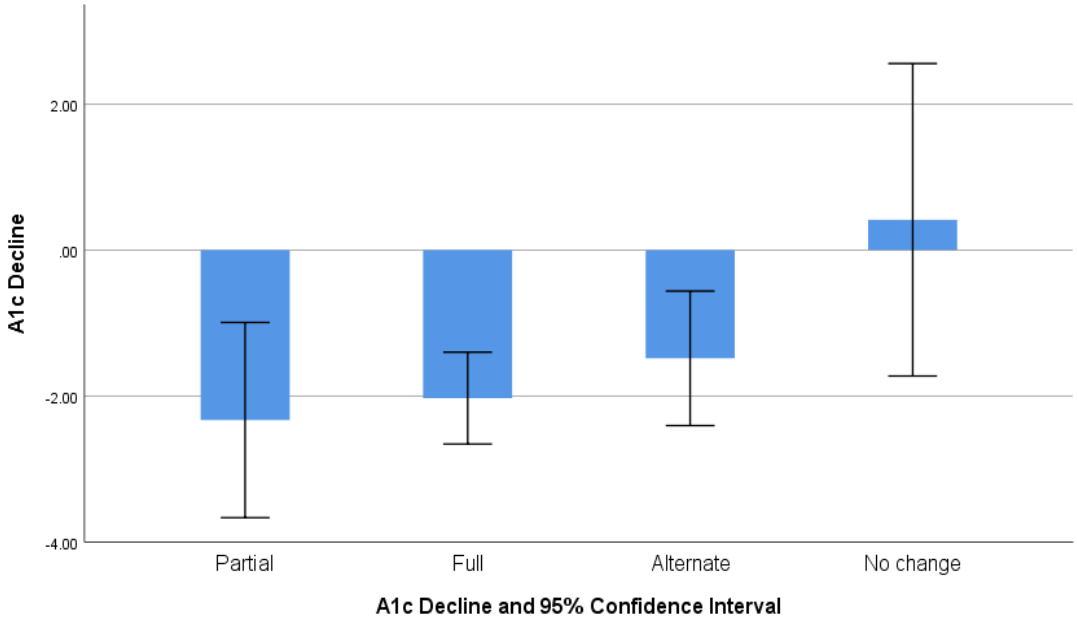
Table 4: Outcomes for Each Utilization Strategy

Recommendation	Sample Size	Final A1c	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Partial	18	7.83	2.07	6.80	8.86	5.3	14.7
Full	74	8.10	2.07	7.62	8.58	5.4	14.4
Alternate	22	8.76	1.97	7.89	9.64	6.0	11.9
No change	12	10.13	3.08	8.17	12.08	6.9	16.0

Recommendation	A1c Decline Mean	Std. Deviation	95% Confidence Interval for Mean Decline Lower Bound	95% Confidence Interval for Mean Decline Upper Bound	Min	Max	A1c Percentage Decline
Partial	-2.33	2.69	-3.67	-0.99	-7.30	6.30	-20.96%
Full	-2.03	2.72	-2.66	-1.40	-8.90	5.60	-17.80%
Alternate	-1.48	2.08	-2.40	-0.56	-5.70	1.90	-13.66%
No change	0.42	3.37	-1.72	2.56	-5.20	5.90	5.55%

Figure 3 shows the mean A1c decline and the 95% confidence interval of the associated A1c decline.

Figure 3: Confidence Interval for the Mean A1c Decline



Relative to testing the outcomes between the regimens selected, as depicted in Table 5, a statistically significant difference was found between Full and No change, and Alternate and No change. This analysis is constrained by the size of the sample population.

Table 5: Non-Parametric Tests between Provider Utilization Strategies For A1c

Comparison of Groups	p-Value
Full vs Partial	0.67
Full vs Alternate	0.10
Full vs No Change	**0.01**
Partial vs Alternate	0.09
Partial vs No Change	**0.02**
Alternate vs No Change	0.31

Deliverable E: Ascertainment of the Change in Patient Outcome Measures

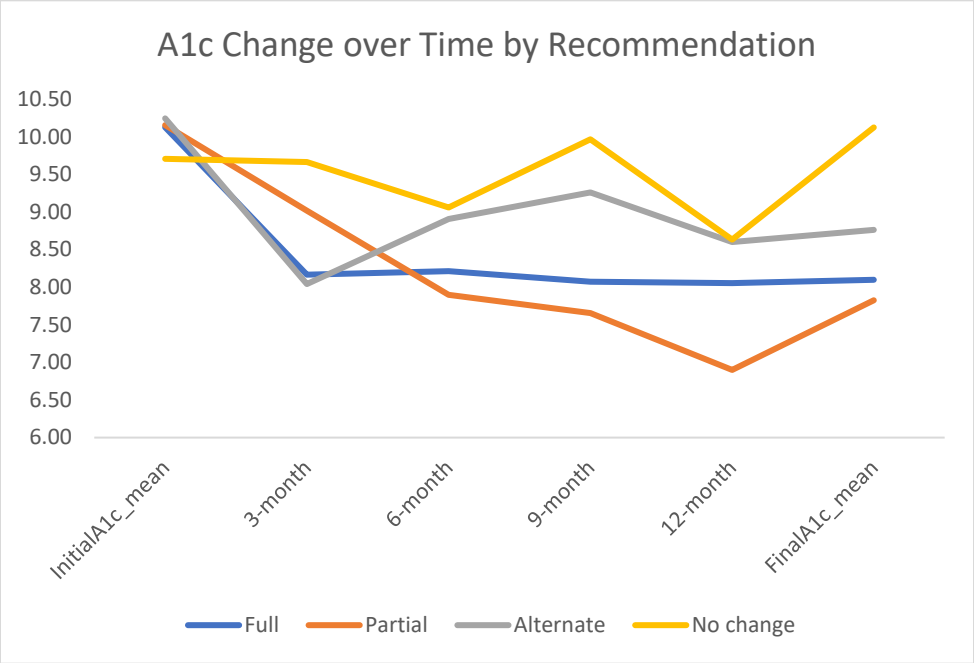
As discussed in the above section, patients being treated by providers using either the partial or full recommendations of the CDS application showed a statistically significant decrease in A1c measures at the beginning and end of the project. This section examines outcome measures in the study group relative to the control group.

Outcome Measurement Analysis by Quarterly Follow-Up Appointments

Data was analyzed for the 3-month follow-ups for the study group. No statistical or trend relationships can be established for these A1c measures. Figure 3 depicts these measures over time based upon the utilization strategy. The sample size within these categories limits any inferential power. Another limitation is that not all patients had the same start date for the tracking and many patients only partially adhered to quarterly follow-up appointments.

The results show an initial decline in A1c measures. Figure 4 shows that both full and partial have better A1c improvement. It appears that the full recommendation tends to stabilize patients' A1c after 3 months. The no change to the regimen appears to show a regression back to initial levels. Owing to the limited number of patients in this group, inferential capability is limited, but the pattern would seem to merit further investigation. Likewise, the alternate regimen approach appears to regress over time compared to the CDS-supported regimens. However, the sample size by recommendation varies at the different points in time which confounds the analysis and limits inference. This does suggest longitudinal studies with consistent periodic measurements merit further investigation

Figure 4: Outcome Measures for Quarterly Follow-Up Appointments



The adherence to quarterly follow-up appointments is another confounding variable that was unexpected. Table 6 provides a summary of quarterly follow-up appointments by study group category.

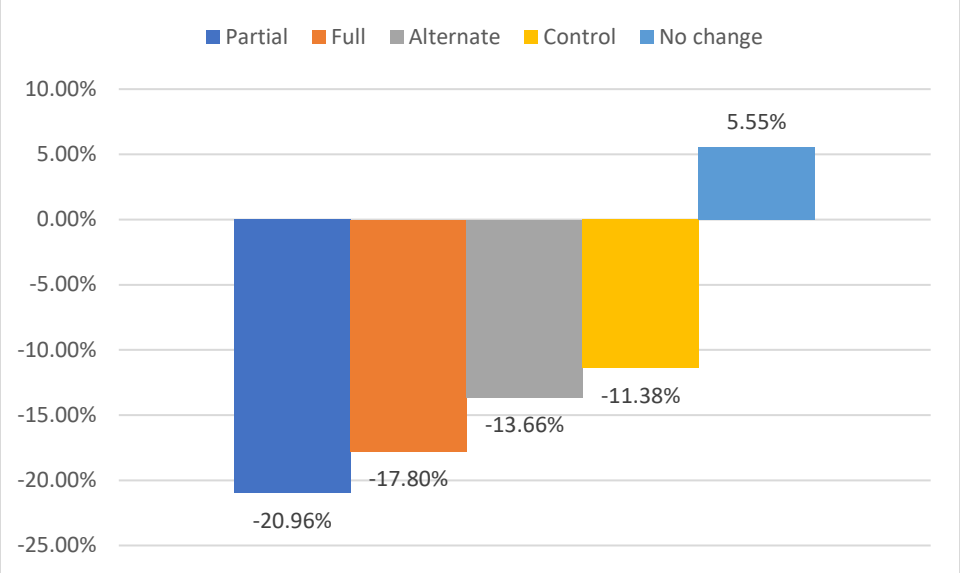
The partial treatment and alternate groups were the most adherent. This may be a random element but deserves consideration for further study.

Table 6: Adherence to Follow-Up Appointments by Study Group

Sub-groups	N	3-Month Appointments	6-Month Appointments	9-Month Appointments	12-Month Appointments
Full	74	60 (81.08%)	33 (44.59%)	21 (28.38%)	11 (14.86%)
Partial	18	12 (66.67%)	11 (61.11%)	11 (61.11%)	4 (22.22%)
Alternate	22	19 (86.36%)	14 (63.64%)	5 (22.73%)	5 (22.73%)
No Change	12	11 (91.67%)	5 (41.67%)	3 (25.00%)	3 (25.00%)

Figure 5 demonstrates the A1c decline percentage for each category of the study group and the control. As indicated the control groups only have superior outcomes when compared to the no change group.

Figure 5: Recommendation Groups Compared to Other Groups



Comparison of Study Group to Control Group

The sample size for the Study Group is 126. When breaking down the Study Group by recommendations (Full, Alternative, No Change and Partial), there are 74 patients in the full group, 18 in the partial group, 22 in the alternate and 12 in the no change group. The Control Group sample is 147 patients, with 150 initially drawn and then three excluded for receiving treatments outside of SEH or data issues.

As discussed in the Design Section, there are two issues with the control group. The first concerns the initial A1c measures. The distribution of these measures is skewed toward A1c readings between 8 and 9 when compared to the Study Group and when compared to an assumed normal distribution. This violates the distribution assumptions when using T-tests and also skews comparing the mean change between the Study and Control Groups. The second concerns the risk of overpowering the sample size of the Control Group (147) compared to the partial and full groups (74) increasing the likelihood of a Type 2 error. A bootstrap T-test with a biased correction was used to compare the Full and the Control group. For unbalanced sample comparisons, Mann-Whitney tests were used. Full descriptive statistics are found in Appendix A.

Comparison of the Full Recommendation and Control Group

Table 7 shows T-test on initial A1c, Final A1c and A1c improvement between groups. As shown in Table 7, there is no significant difference between the two groups on the initial A1c but there is significant difference between these two groups on the A1c improvement. In terms of final A1c, the two tailed test is not significant but one tailed test would be significant. We conclude that the final A1c of the Full Recommendation is significantly lower than that of the Control Group.

Table 7: T-Test of Change in Final Measures Full Recommendation vs Control Group

Measure	Mean Difference	Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval Lower	95% Confidence Interval Upper
Initial A1c	-0.21	0.00	0.25	0.40	-0.72	0.29
Final A1c	0.56	0.01	0.30	0.06	-0.07	1.17
A1c Decline	0.77	0.01	0.35	0.03	0.02	1.50

Comparison of the Partial Recommendation and the Control Group

The sample size for the partial group is 18. A nonparametric test was conducted to compare the median of the partial and the control. Table 8 depicts the Mann-Whitney test on the initial A1c, final A1c and A1c decline measures. Although the T-tests show no significant difference between Partial treatment and Control Group, the above analyses indicate better A1c outcomes in the Partial Treatment Group. Arguably this is more clinically important than the statistical significance given the sample size constraints of this analysis and argues for continuing this project with a larger sample size

Table 8: Mann-Whitney Test in Final Measures Partial vs Control

Method	Initial A1c	Final A1c	A1C Decline
Mann-Whitney U	1182	955.5	828
Wilcoxon W	12060	1126.5	999
Z	-0.74	-1.92	-2.59
Asymp. Sig. (2-tailed)	0.46	0.06	0.01

In summary, when compared to the control group, study patients who were treated either on a full or partial recommendation have significant in A1c. In terms of the final A1c, the full group is significantly lower that the control group, and the partial group is marginally close to being statistically significant with a p value of 0.06.

Comparison of the Combined Study Groups (Partial and Full) and the Control Group

Combining patients that received treatment from either the Full or Partial Recommendation resulted in a sample of 92. A bootstrap for T-test with bias correction was performed resulting a p value of 0.04 for final A1c and 0.02 for A1c decline. Descriptive statistics for the groups are available in Appendix A. As shown in Table 9, we conclude that the combined group (full + partial) has a significantly lower final A1c and better A1c improvement than the control group.

Table 9: T-Test of Change in Final Measures "Combined" Study Group vs Control Group

Measure	Mean Difference	Bias	Std. Error	Sig. (2-tailed)	BCa 95% Confidence Interval Lower	BCa 95% Confidence Interval Upper
Initial A1c	-0.22	0.00	0.24	0.34	-0.71	0.26
Final A1c	0.61	0.00	0.28	0.04	0.06	1.14
A1c Decline	0.83	-0.01	0.33	0.02	0.17	1.44

The combining of the groups whose treatment regimen changed due to either fully or partially following the recommendation showed statistically significant improvement in the decline of the A1c compared to the control group. The statistically significance is likely associated with the increase in sample size by combining the subsets of the study group.

Deliverable F: Change in Knowledge by Providers

Provider Surveys

Base line surveys of the provider understanding and attitude toward the project were undertaken at an SEP All Provider Meeting in Fall, 2018 and a follow-up survey was undertaken in Spring, 2020. Relative to the final survey, a total of 39 providers responded, a rate of 37%. The results of the Spring 2020 are most relevant to assessing the provider experience as the Fall, 2018 did not demonstrate substantial provider knowledge. The results of the 2020 survey and key conclusions are presented in Table 10.

Table 10: Provider Knowledge of CDS Tool

Question	Response	Frequency	Percent
Prior to participating in the Medicaid/PATH project, did you have knowledge and understanding of the concept of the path decision support tool?"	No	18	46.20%
	Yes	21	53.80%

Of the responding providers, slightly more than half indicated that they had a prior knowledge of the CDS tool. This knowledge was likely based upon the initial Fall, 2018 Meeting where the project was introduced. In analyzing responses, pre-knowledge of the tool had no association with answers to other question.

When asked "based upon your experience, use of the path decision support tool will support improved patient outcomes", Table 11 indicate more than 80% of the responding providers believe that use of the CDS tool will lead to improved outcomes.

Table 11: Provider Knowledge of CDS Tool and Patient Outcomes

Question	Response	Frequency	Percent
Based upon your experience, use of the path decision support tool will support improved patient outcomes	Strongly Disagree	1	2.56%
	Disagree	6	15.38%
	Agree	16	41.03%
	Strongly Agree	16	41.03%

As indicated in Tables 12 and 13, almost two out of three providers indicated that the CDS project expanded their knowledge of medication options and almost 85% indicated that they were comfortable with the recommended treatment option as presented by the pharmacist in the team-based interaction.

Table 12: Provider Perspective on CDS Tool Expanding Medication Knowledge

Question	Response	Frequency	Percent
Participation in the Medicaid/PATH project has expanded my knowledge of medication options to effectively treat type 2 diabetes	Strongly Disagree	2	5.13%
	Disagree	6	15.38%
	Unsure/Undecided	6	15.38%
	Agree	15	38.46%
	Strongly Agree	10	25.64%

Table 13: Provider Comfort Level with Recommendations

Question	Response	Frequency	Percent
In general, I felt comfortable with the treatment options recommended by the decision support tool as presented by the pharmacist	Disagree	1	2.56%
	Unsure/Undecided	4	10.26%
	Agree	18	46.15%
	Strongly Agree	15	38.46%

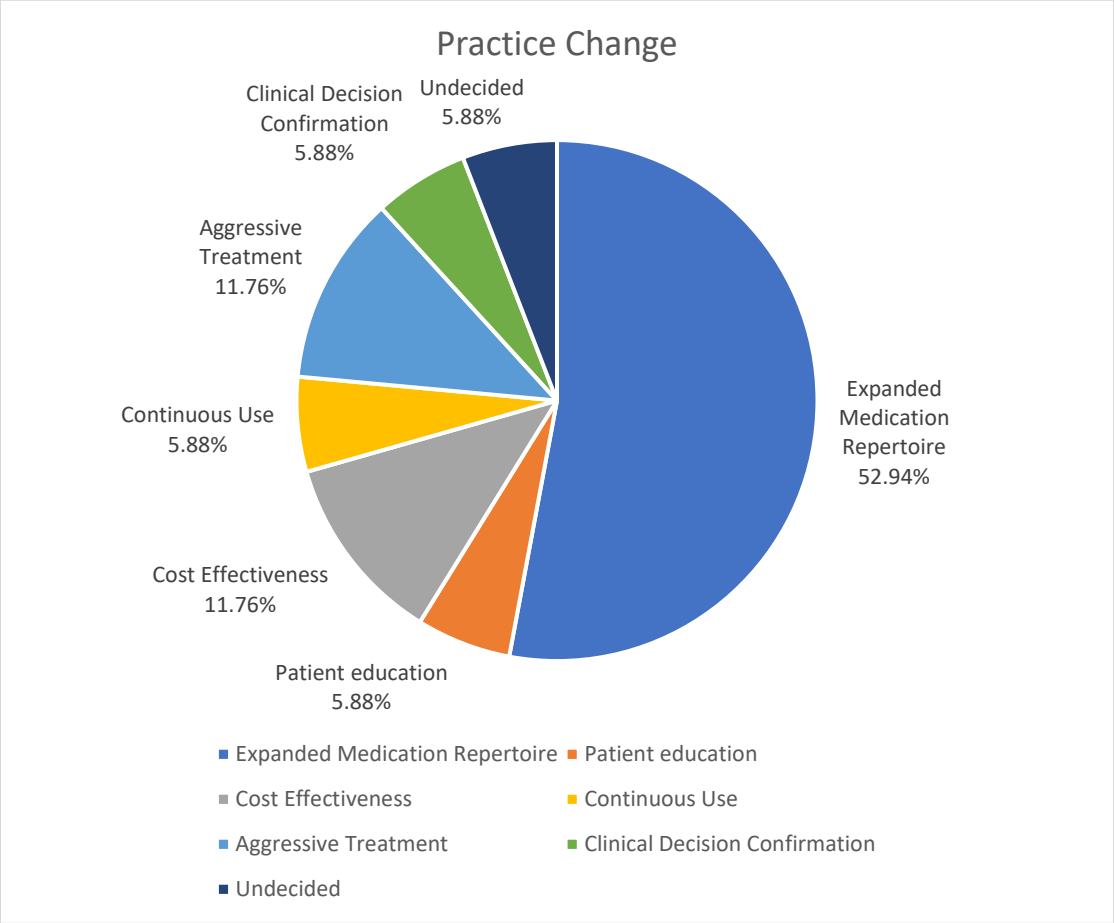
Table 14 shows that more than half of the respondents indicated that engagement in the project will lead to a permanent change in their practice.

Table 14: Provider Perspective on Change to Current Practice

Question	Response	Frequency	Percent
Participation in the Medicaid/PATH project will lead to changes in my current practice.	Disagree	4	10.26%
	Unsure/Undecided	14	35.90%
	Agree	10	25.64%
	Strongly Agree	11	28.21%

Figure 6 provides a response to the ways a practice would change, for those who indicated that experience from the project would create a permanent change. More than half indicated the change is an expansion of medication repertoire.

Figure 6: How Providers Indicated Their Practice Would Change



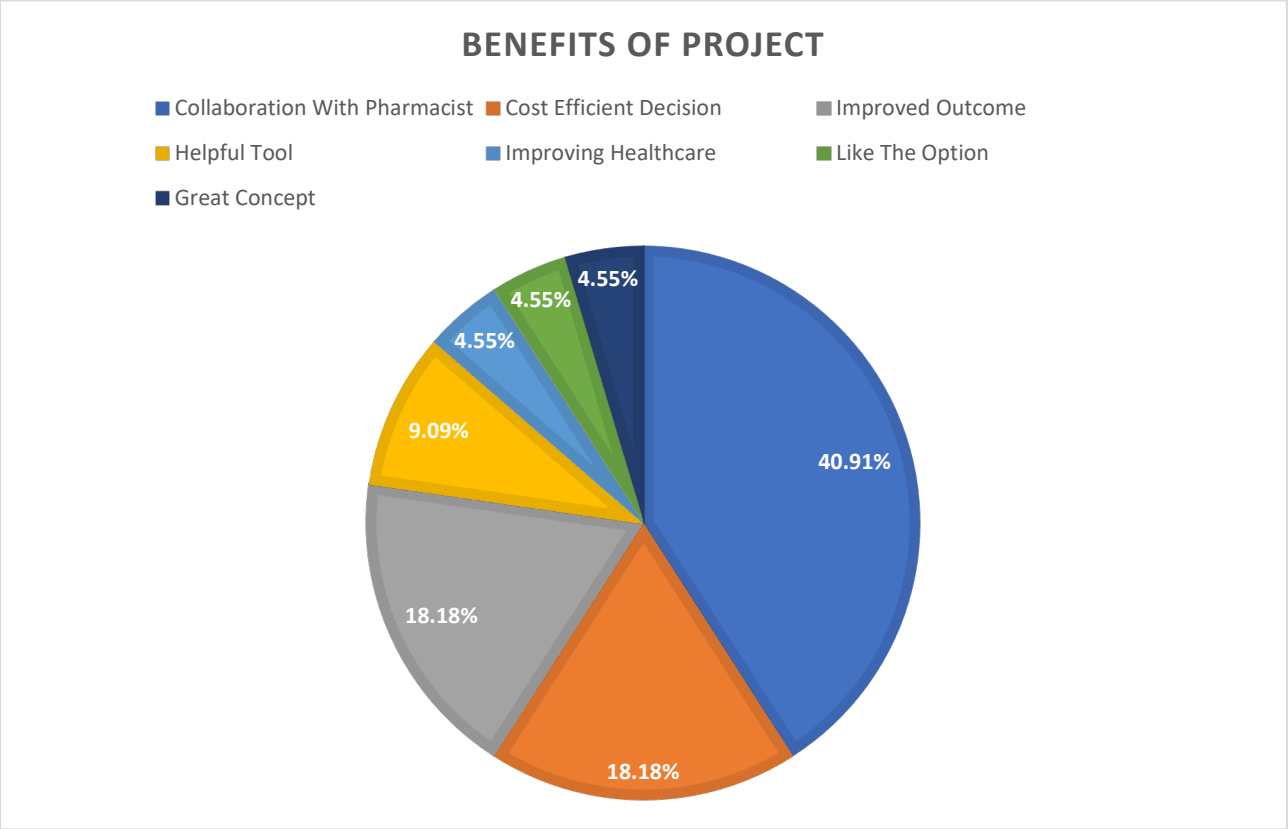
In responding to the survey, the principal barriers that providers identified in continuing to use the CDS tool after the project ends are workflow and training related as apparent in Table 15. Although about one quarter of the respondents indicated that there are no barriers.

Table 15: Provider Perspective on Barriers to Future Use

Question	Barrier Description	Count	Percent
What barriers do you foresee that might interfere with continuing to use the PATH decision support tool after the project ends?	Time required to use the decision support tool	15	38.46%
	Training on how to use the decision support tool	13	33.33%
	Lack of Epic integration	21	53.85%
	Software functionality	5	12.82%
	Disagree with treatment recommendations	3	7.69%
	Not Interested	2	5.13%
	None	10	25.64%

When asked what they liked best about the project, 40% indicated the collaboration with the pharmacist, second choices were improved outcomes and cost efficiency as presented in Figure 7.

Figure 7: What Did You Like Best About Participating in The Medicaid/Path Project?



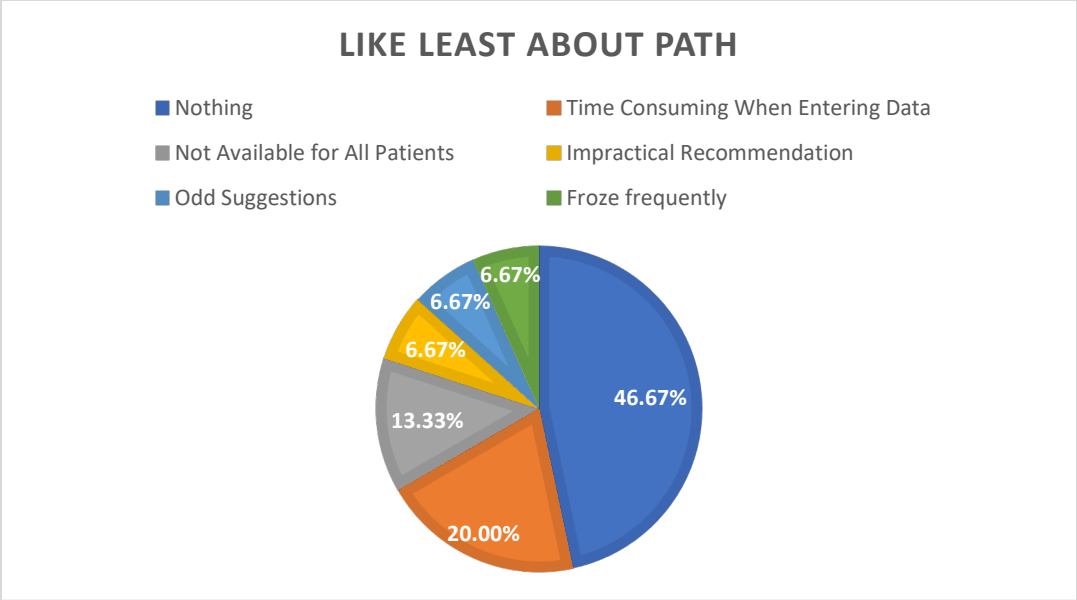
Providers were asked what they liked least about the CDS tool with 17 providing answers. They can be summarized in the following categories:

- Nothing (7)

- Impractical recommendation (1)
- Not available for all patients (2)
- Odd suggestions (1)
- Froze frequently (1)
- Time consuming when entering data (3)

Figure 8 shows the response distribution. Over 46.67% physicians answered "nothing," which is interpreted as indicating an approval of the current software design and use. In terms of criticisms, 20% state it is too time consuming to enter data. The data entry issue is an artifact of the software not yet being integrated with the Epic EHR system.

Figure 8: What Did You Like Least About Participating in The Medicaid/PATH Project?



In conclusion, for those providers that participated in this project with qualifying patients and responded to the survey the perceptions of the utility of the CDS is apparent. More apparent is the benefit of team-based care and engagement of the pharmacists in the patient encounters and treatment.

Key summary observations include:

- More than 80% of the responding providers viewed the CDS tool as leading to improved patient outcomes and almost 2/3rds indicated that the use of the application expanded their knowledge of medication options.
- About half the respondents indicated that the use of the CDS tool will lead to changes in their practice.
- Almost 90% of respondents indicated that they were "comfortable" with the recommended treatment options, but that could be associated with the pharmacist acting as an intermediary.
- Workflow was identified as the major barrier to use
    - Integration with the EHR

    - Training
    - Time required to use the CDS tool
- Team-based care in the form of collaboration with the pharmacist was the component that respondents found as the greatest benefit of the project.

Pharmacist Survey

In assessing provider responses to the project and CDS tool, pharmacists were queried through a series of open-ended prompts in an online survey about their experiences and opinions of the initiative. All seven pharmacists participated in process.

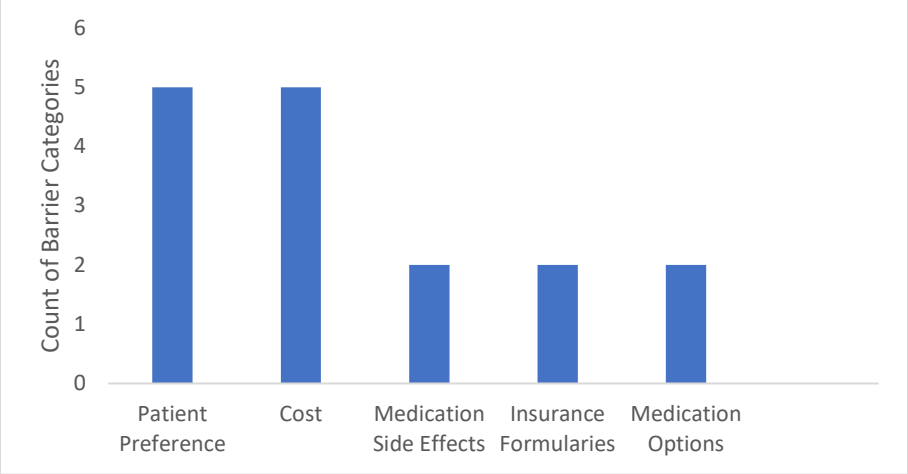
PROMPT 1: How does Path help patients & providers recognize barriers to medication adherence and find solutions to better treat Diabetes?

Seven pharmacists responded to this prompt. Theme analysis of the responses shows that the barriers are cost, insurance coverage, medication side effects, and patient preference. Thematic observations on solutions included:

- Engagement: By talking to the patients and asking the right questions patients are more honest about their medication adherence behavior
- PATH offers a variety of medications with cost information and pre-authorization information so that it can avoid frustration for patients.
- Providers can prescribe medications based on patients' preference and cost.

Figure 9 shows the frequency of themes expressed by the 7 pharmacists. Six out of seven pharmacists think medication adherences is a barrier; 5 of 7 view cost as a barrier; two view side effects as a barrier, and one as the formularies.

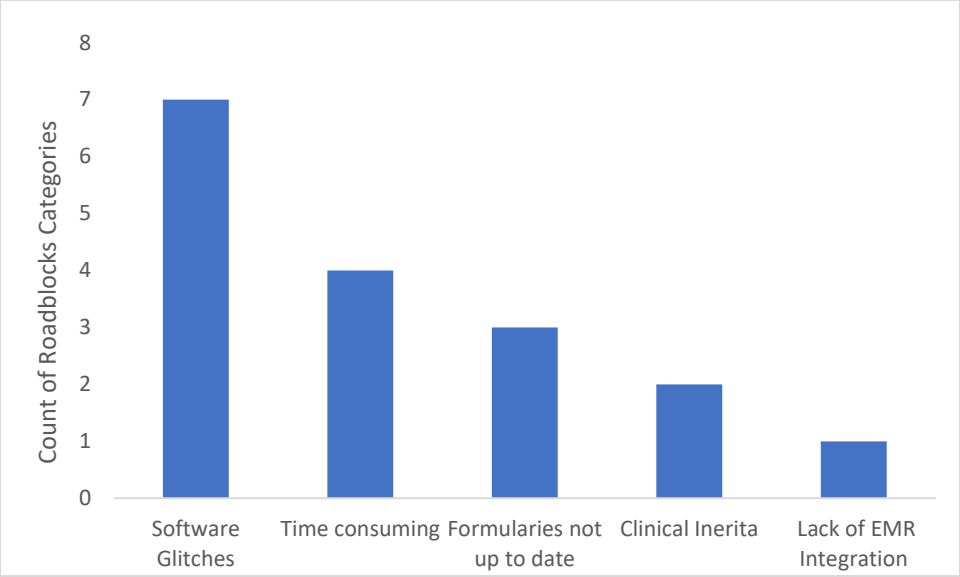
Figure 9: Pharmacist Identified Barriers to Medication Adherence



PROMPT 2: Are there any roadblocks you face when using PATH?

All seven pharmacists identified roadblocks. The roadblocks are time consuming to use, software glitches, formularies not being updated, lack of EHR integration, and clinical inertia. Figure 10 shows the frequency distribution of the themes.

Figure 10: Pharmacist Identified Roadblocks



PROMPT 3: How easy/hard is it to "pass the baton" from Clinical Research Coordinator (CRC) entering patient data into Path & you picking it up to use in office?

Among 7 pharmacists, 6 indicated that it is easy to enter patient data. Their comments are positive in general on this question as they say it is easy and helpful, but they still review the information. A general comment is that it is an excellent way to double check vital statistics. Figure 10 indicates the counts in each theme.

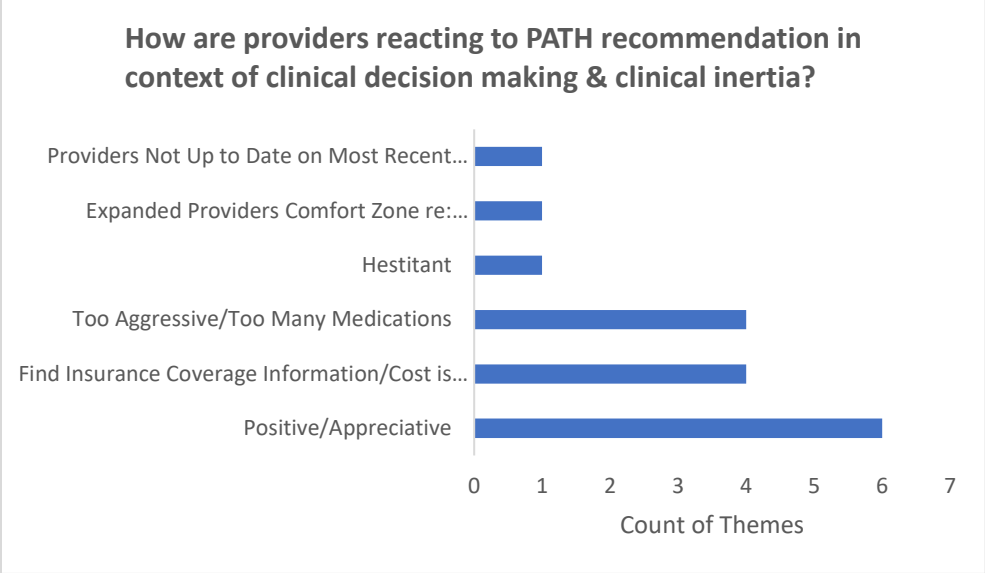
Figure 11: Pharmacist Response on the Ease of Data Use After Entry

PROMPT 4: How are providers reacting to PATH recommendation in context of clinical decision making & clinical inertia?

Figure 12 shows the frequency distribution of the themes identified from the pharmacists' responses. Specific comments include:

- "Most providers have expanded their comfort zone with regard to medications."
- "I have found that providers are usually more hesitant to accept a full recommendation when it involves adding multiple medications at once or insulin in addition to another medication."
- "Some feel the interventions are too aggressive, but most are on board, even asking us to use PATH to analyze patients who aren't eligible for the project."

Figure 12: Pharmacist Perceptions of Provider Reaction to the CDS Application



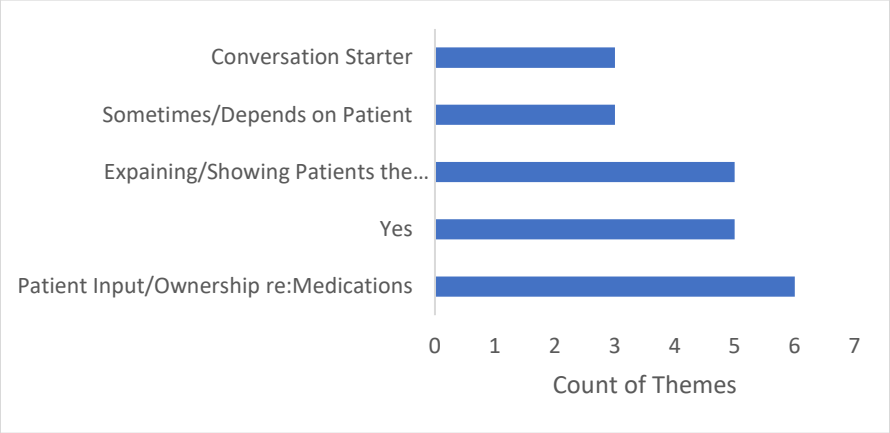
PROMPT 5: Are patients engaged in the decision-making process?

All seven pharmacists indicate that the PATH workflow engages the patients in the decision-making process. Specific themes are patient ownership, explaining to patients the program was helpful, patient feedback, pharmacist reaching out to patients. Figure 12 shows the frequency distribution of the themes. Specific comments were:

- PATH gives patients some of the ownership of choosing a new regimen and "allowed them to "buy-in" into their treatment plan and take hold of their diabetes".

- Time and effort are needed to get patients engaged: "I will add that the pharmacists and CRC spent a great deal of energy throughout this project reaching out to patients to get them engaged in their healthcare via scheduling or follow-up calls."

Figure 13: Pharmacists on Key Factors in Patient Engagement



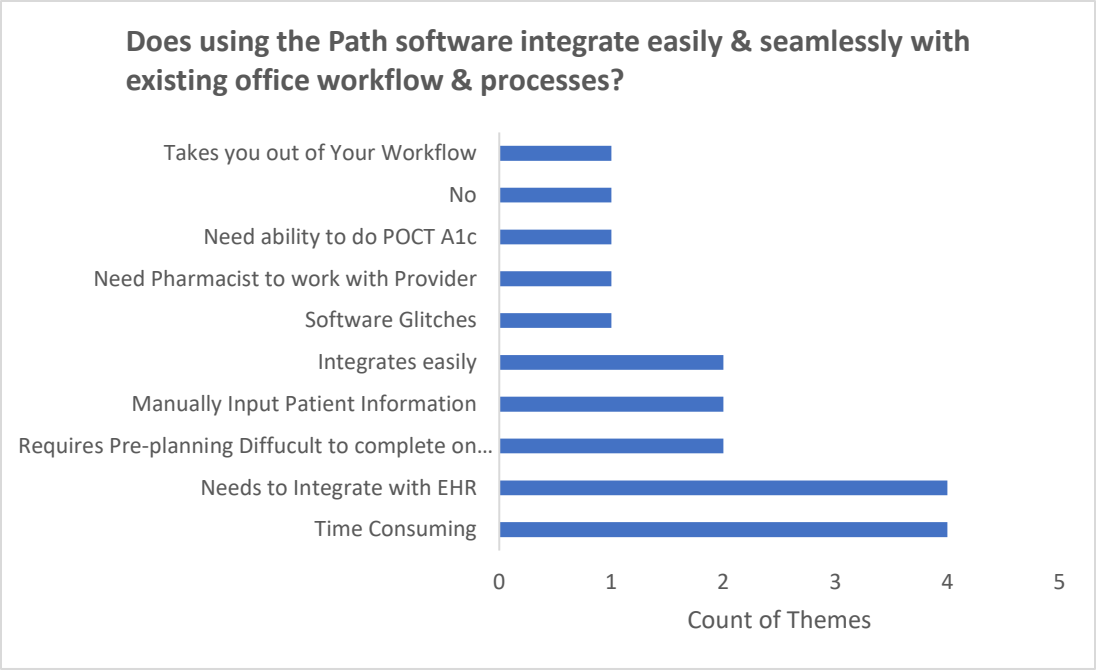
PROMPT 6: Does using the PATH software integrate easily & seamlessly with existing office workflow and processes?

Among the seven pharmacists, three said it integrates easily, and three indicated issues with seamless workflow integration. Comments indicated the following themes:

- Time consuming running PATH
- Lack of EHR Integration
- Requires pre-planning; difficult to complete on the spot
- Requires the manual input of patient information
- Software glitches
- Pharmacist needed to work with provider

Figure 14 provides the frequency distribution of comments for the workflow integration.

Figure 14: PATH Integration with Workflow



PROMPT 7: What do you like best about using PATH?

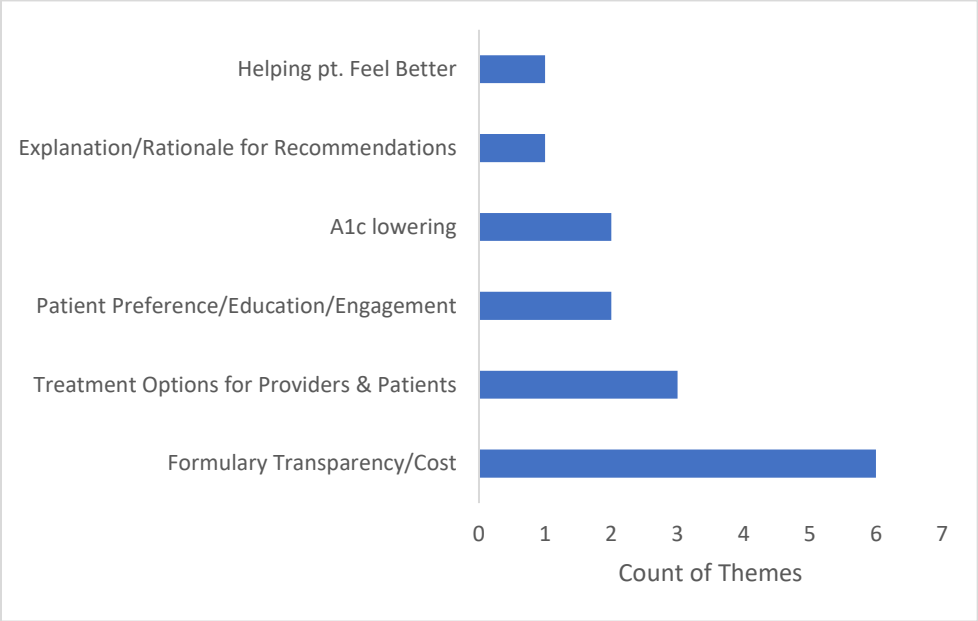
The characteristics that pharmacists liked about PATH are depicted in Figure 15. Summary comments included the following themes:

- Formulary transparency/cost
- Treatment options
- Patient engagement

Specific comments were:

- "It is excellent the way that GlucosePATH incorporates average A1c lowering of medications to determine the effectiveness of the patient's current regimen, and in arriving at its suggested regimens".
- "This really opens providers' eyes and makes them think about the drugs they are prescribing."

Figure 15: What Pharmacists Indicated They Like Most about PATH

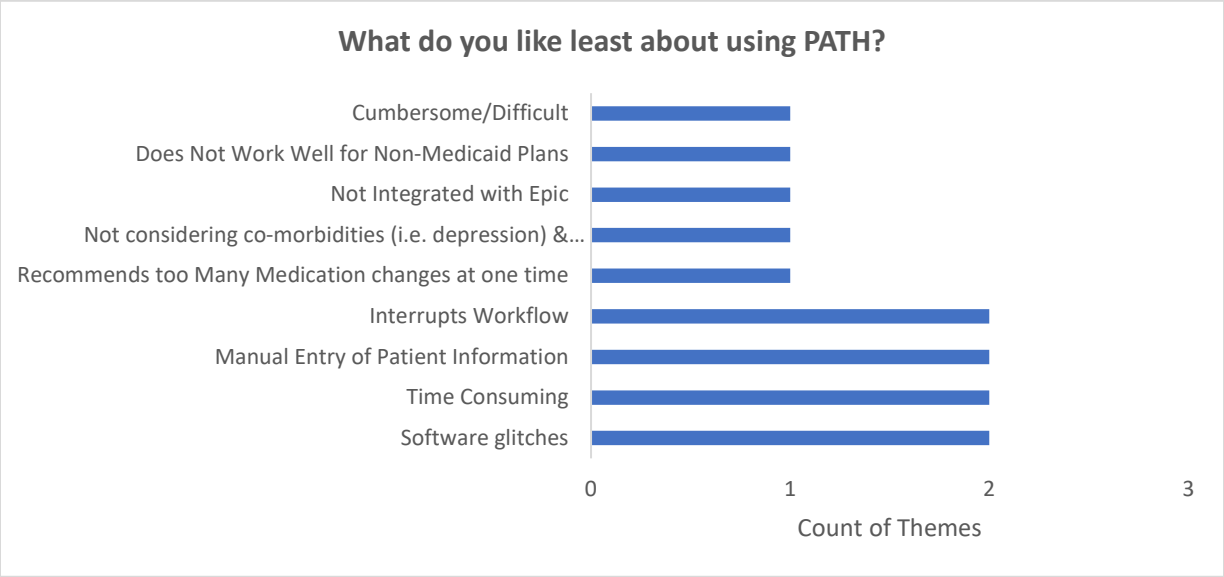


PROMPT 8: What do you like least about using PATH?

Pharmacists all express a variety of concerns related to PATH, its functionality, workflow disruption, and Medicaid plan choices. Specifically, the concerns are software glitches, time consuming, manual entry of patient information, interrupting workflow, recommending too many medication changes at one time, not considering some comorbidities (e.g., depression) & adherence, not Integrated with Epic. These are provided in Figure 16. Four of seven pharmacists state that too many medications are recommended; three of seven are concerned with workflow interruption. Specific comments included:

- "My least favorite thing about using PATH is the manual entry of clinical information outside of Epic. It not only forces me out of my workflow, but there's the risk of human error."
- "Streamlining PATH recommendations with the provider was often difficult due to busy daily schedule and workflow."
- "Using GlucosePATH for non-Medicaid plans is very cumbersome."

Figure 16: What Pharmacists Liked Least with PATH



The responses by the pharmacists parallel those of the primary care providers in important ways. Key observations include:

- Workflow is identified as a critical issue relative to ease of use and time involved for the CDS tool.
- The data entry effort is a key barrier emphasized by the pharmacists. This parallels the provider concern about the lack of integration with the EHR system.
- Given that pharmacists were the individuals using the application, they identified specific issues.
    - Software glitches
    - Formularies being current
    - Time required to use the software
    - Redundant or identical results across multiple runs
- Pharmacists found a generally positive reaction by the providers in terms of expanding treatment options and having cost information.
- Pharmacists indicated that using the tool assisted in patient engagement by encouraging patient ownership.

Deliverable G: Lessons-learned

The eligible population for the study was Medicaid patients with uncontrolled diabetes. The prevalence of clinical inertia, the failure of appropriate treatment intensification, in diabetes treatment is a well-documented worldwide phenomenon. Similarly, patient engagement of this population faces many challenges. Solutions to these challenges may be addressed through a combination of the application of decision support solutions at the point of care combined with team-based approaches to engagement. Having a pharmacist lead in this engagement team seems particularly promising.

Providers are faced with an increased complexity in determining treatment regimens while dealing with increased challenges in workflow and reporting requirements. A key lesson-learned concerns how decision-support tools must be efficient and integrated with workflow. That may encourage providers to increase adoption. Providers need also be encouraged to consider other treatment regimens in the context of their typical prescribing habits.

Providers and pharmacists identified the need for greater drug cost transparency and issues of prior approval by the Managed Care Organizations (MCOs) which cause delays in treatment and frustrations for the patient and provider. There is also a need for the MCOs to share up-to-date formularies with the providers.

While this is a health-systems level problem, policies encouraging best-practice sharing and educational programs concerning Medicaid patients are needed. Policies providing financial incentives either directly or through intermediaries such as the MCOs to adopt team-based care or using decision-support technologies can be considered.

A summary of the lessons learned relative to the decision-support tool:

- Integration into the providers' EHR system is key to maximizing productivity and accuracy, and to minimizing workflow disruption.
- Differences were noted in formulary coverage for the same medicines, and for patient co-pays, when comparing MCO's websites with pharmacy point-of-sale terminals. This caused confusion with some patients, who were expecting their medicines to be covered, and for a specific co-payment amount. One solution to this might be the MCOs providing the tool the same access to the formulary and co-pay data available to pharmacies.
- Pharmacists and providers suggested more than 30 new medicines or new medicine doses that were incorporated into the tool during the project. Thus, future projects should be able to incorporate new medicines during the project.
- The tool's user interface was redesigned to move more frequently used fields to the top of the screen, based on pharmacist and provider suggestions. This saved data entry time. User interface and general human-factors design are critical to the adoption of new tools.
- While the tool displays ten regimen options, more diversity in medication class is needed within those ten options. For example, it might be more useful for the provider and patient if all ten options do not contain the same classes of medicines, because if a class of medicine is not acceptable to the patient or provider, then all 10 regimen options are unacceptable.

Lessons learned in the identification of eligible populations include:

- The project benefitted by having a team identify eligible patients in advance using EHR records, rather than relying on providers to review patients for eligibility during office visit.
- Provider buy-in to the project was improved by allowing providers to exclude inappropriate patients in advance.
- When inviting patients to participate in the project, positive language was used to explain the purpose of the project (e.g., "to help improve your diabetes control"), rather than negative language ("your diabetes is not under control").
- It was helpful to tell patients that their providers supported the study.

A summary lesson-learned is that clinical inertia can be avoided by having pharmacists review current drug regimens for potential improvement.

Deliverable H: Summary of Differences in Medication Classes

The question of the impact of this study on the costs is complicated due to several factors. The first is that the Managed Care Organizations (MCOs) consider medication formulary costs proprietary information based upon their negotiated status. In assessing differences in individual medications and medication classes surrogate measures may be used. They consist of directional pricing and the second is data available from the CMS in the form of the Centers for Medicare & Medicaid Services' (CMS) National Average Drug Acquisition Cost (NADAC) database.

As discussed in the Design section, a second complication concerns the direct Medicaid system costs attributable to Diabetes for a patient. The prevalence of comorbidities among the patients makes it very difficult to isolate and associate the costs attributable to a single condition.

System Costs

A second approach to determine the impact on costs is an assessment of system costs to Medicaid based upon diabetes-related treatments. As discussed, the presence of co-morbidities makes the assessment of costs complicated and challenging. The methodology employed for this analysis was a chart review by the lead-physician on this project. Charts for the control and study group were examined for diabetes related unplanned claims. Table 15 provides a summary for the two groups.

Table 16: Cost Comparison Unplanned Diabetes Related Claims

	Study Group	Control Group
Sample Size	156	147
Number of Unplanned Claims	8	28
Total Charges	$111,034	$355,722
Mean Cost/Group Member	$712	$2,419
Mean Cost/Claim	$13,879	$12,704

This result indicates that members of the study group were less likely to have an unplanned diabetes-related medical claim. The difference is striking with 28 claims in the control group and eight in the study group. The mean cost per group number was $2,419 in the control group vs. $712 in the study group. The mean cost per claim is roughly equivalent, which would be expected in that the characteristics of a diabetes-related encounter should be similar. Savings appear attributable to a decreased likelihood of an unplanned diabetes related claim.

These groups' pre- and post-intervention changes are significant and need to be assessed in the context of improved outcomes and potential lower system costs for encounters over timeframes that extend beyond the length of this project.

Patient Costs

An outcome of this project was to analyze member medication costs when available. As discussed, actual costs are not available owing to their proprietary nature and prevalence of discounting against listed formulary prices. Attempts to use proxy measures proved not to be reliable or valid. Therefore, no per member costs are provided in this assessment.
A consideration on patient costs, is that while there are system costs on a per member basis for medications, the out-of-pocket costs to an individual patient is limited to a co-pay ranging from $10 to $20 per month.

Difference Between Classes

Table 17 summarizes the number of times each medication class was suggested in the patient's current medication regimen and the regimen proposed by the electronic decision support tool.

Table 17: Difference between Classes of Drugs Prescribed

	Study Group		Full Group		Partial Group		Alternate Group	
	Current	Post-Intervention	Current	Post-Intervention	Current	Post-Intervention	Current	Post-Intervention
Alpha-Glucosidase Inhibitor	0	2	0	2	0	0	0	0
Biguanide	78	81	47	46	7	9	15	17
Diet	N/A	55	N/A	38	N/A	7	N/A	10
DPP4	14	18	10	9	1	2	1	5
Exercise	N/A	53	N/A	38	N/A	4	N/A	11
GLP1	39	76	23	53	4	5	8	14
Insulin (Basal)	53	68	31	41	4	5	14	18
Insulin (Prandial)	13	16	6	10	2	1	2	2
Nothing	11	4	6	2	1	0	2	0
SGLT2	25	44	14	26	3	5	5	10
Sulfonylurea	30	27	19	13	1	1	7	10
TZD	6	20	5	16	0	3	1	1
Total Medications (excl diet, exercise, "nothing")	**258**	**352**	**155**	**216**	**22**	**31**	**53**	**77**

For each drug class, an exact binomial confidence interval was calculated for the current and post-intervention frequency of recommendation. A significant difference is shown when the two confidence intervals do not overlap. The following drug classes show a significant difference in the current and post-intervention regimens:

- GLP1: Study Group, Full Group

In addition, the following drug classes show a significant difference in the number of times the class is used in post-intervention regimens as compared to the regimens in the control group:

- GLP1
  - Test and Control
  - Full Recommendation and Control
  - Alternate Recommendation and Control
  - Full Recommendation and Partial Recommendation

- Prandial Insulin
  - Test and Control

- SGLT2
  - Test and Control

- TZD
  - Test and Control
  - Full Recommendation and Control

As indicated in Table 18 there were no differences in medication classes for the No Change category within the study group:

Table 18: Medication Class Differences for the No Change Category in The Study Group

	No Change Group
	Current and Post-Intervention
Absorption	0
Biguanide	9
Diet	N/A
DPP4	2
Exercise	N/A
GLP1	4
Insulin (Basal)	4
Insulin (Prandial)	3
Nothing	2
SGLT2	3
Sulfonylurea	3
TZD	0
Total Medications (excl diet, exercise, "nothing")	28

Implications for Differences Between Drug Class Recommendations

While glucose normalization remains the primary goal of anti-diabetic regimens, professional societies like the ADA and AACE have recognized the importance of mitigating comorbid conditions, particularly heart and kidney disease.

One advantage of computerized decision support tools is the rapid, uniform application of evidence-based, personalized drug regimens based on these recommendations.

Two classes of DM medications - GLP1 agonists and SGLT2 inhibitors - have demonstrated reduced risk of Major Adverse Cardiovascular Events, hospitalization for heart failure, and progression of renal disease. GLP1 agonists are also associated with weight loss, lipid, and blood pressure reductions.

High-cost adverse events, such as hospitalizations for heart failure, or progression towards dialysis, may be prevented by the ability to target specific patients with these higher-cost medicines.

Cardiovascular disease (Coronary artery disease, Cerebrovascular disease, Peripheral artery disease, and Congestive Heart Failure) was observed in 51 of the 116 patients of the study group and 32 of the 147 patients in the control group. Of the 51 patients with cardiovascular disease in the study group, 37 of the 51 patients (72.5%) were prescribed an SGLT2 inhibitor, GLP1 agonist, or both. In contrast, of the 32 patients in the control group with cardiovascular disease, only 9 (28.1%) patients were prescribed an SGLT2 inhibitor, GLP1 agonist, or both.

Deliverable I: Analyze Patient Outcomes Based upon Regimens

This deliverable was satisfied under the analysis and discussion included within the Deliverable E section.

Discussion

This quality improvement project examined ways that team-based care combined with a point-of-care decision support tool could lead to improved outcomes, lower costs, and increased patient adherence. This represents an intersection of patient engagement, team-based care, and clinical decision support. Overall, the project showed statistically significant positive results in terms of patient outcomes showing a 1.9 point (xx%) improvement in A1c measures for patients who used a regimen recommended by the CDS tool and was engaged by the team led by a pharmacist.

Relative to costs, measurement was somewhat complicated by the proprietary nature of formulary costs. Through the use of proxy measures, there is evidence of fewer encounters with the healthcare system and lower aggregate costs for those having a treatment regimen changed. There appears to be a higher cost to the healthcare system in terms of the treatment regimens for which were changed through the project. This does not consider downstream costs of encounters and treatments for those patients who have their DIABETES under control and previously did not.

The use of team-based care was well received by the providers and pharmacists in this study, both citing the positive benefits. Workflow was identified as a major barrier to the process, primarily due to lack of integration of the CDS tool with the EHR and the associated data entry. There appears to be provider resistance to the introduction of new components to the workflow. While 104 providers signed a Collaborative Care Agreement required under this project, only 43 participated in the initiative.

A more detailed assessment of each of these areas within the context of the terms of the deliverables are provided below.

Outcomes

In terms of measuring patient outcomes in relation to the level of utilization of the CDS tool, and measurements of patient outcomes, over the course of the project the results clearly indicated a statistically significant benefit to the patient based upon A1c measures. When compared to the control group the difference in mean A1c measure for the combined categories of patients using the partial and full recommended regimens was statistically significant. When comparisons made within the study group between the full and partial recommendation treatments, differences were apparent, but they were not statistically significant. A parallel result of apparent difference but lack of statistical significance was found when the partial and full groups were compared individually to the control group. Small sample size appears to be an issue.

For patients with regimens of based upon the full recommendation, A1c measures show a mean decline of 2.03 for patient's regimens based upon the full recommendation and 2.33 for patient's regimen's based upon partial recommendations. Both showed almost a 20% improvement in A1c based upon before and after measurements for the treatment change.

When a comparative analysis is done between the full and partial treatment patients and those in the study group where the provider introduced an alternate regimen (e.g., new treatment not recommended by the CDS tool) or when no change was made to the treatment, an improvement in the A1c measure is apparent (a minimum difference of .xx improvement) for the full and partial treatments. This was not statistically significant, but inference is constrained by the sample size.

When compared against the control group, the full recommendation showed an improvement in the A1c measure that was 0.77 higher than the improvement in the measure for the control group and partial recommendation group showed a higher mean improvement of 1.07. Neither of these differences were statistically significant. However, when the full and partial recommendation are combined, that is, patients where the regimen was altered by the CDS tool, statistical significance was achieved. This speaks to the issue of the limitations sub-group statistical inferential power owing to size.

An intervening factor in this analysis was a parallel clinical quality improvement program focused on diabetes. The program provided financial incentives to providers targeted at achieving an A1c measure of 8.0 or less. This may explain the improved A1c measures for the control group. Additionally, the control group may represent a patient population more likely to adhere to their treatment regimen as they were selected based upon the availability of follow-up data, while the study group was engaged by direct activities encouraging follow-up appointments.

In sum, the evidence indicates the use of the team-based care approach combined with the CDS tool results in improved outcomes for Kentucky Medicaid patients in the study group with uncontrolled diabetes.

Costs

A goal of this project was to determine if team-based care and use of CDS tool could result in lower costs. The results are encouraging. Claims for unplanned claims for treatment related to Diabetes show a total of 8 for the study group and 28 for the control group. On a per member basis this was a reduction of $1,541 in charges. Unlike other cost analyses, these figures are not estimated or use proxy measures. They are based upon actual charges.

There is a need for greater transparency in medication costs for both the provider and patient. The absence of transparency goes beyond system and patient costs and is associated with delays in prior authorization, treatment, provider frustration, and patient frustration and engagement.

Team-Based Care & Clinical Decision Support

The engagement of providers in the project was consistent with the literature of clinical inertia. Providers have a conservative approach to treatment and workflow changes. Of the 104 providers who signed a collaborative care agreement with pharmacists, 43 participated in this clinical improvement project.

Barriers to Adoption

While non-participants were not surveyed, anecdotal evidence from discussion with providers and team members indicated the following could be factors:

- Willingness to examine options outside of traditional prescribing habits
- Value seen in the exploration of the full spectrum of medications available
- Willingness to look critically at their own prescribing habits
- Decision to trade off time and new workflows with potential outcome improvements

The trade-off involving time with an uncertain or potentially negative outcome is a substantial barrier to the adoption of new applications and processes. The resolution to this barrier is providing evidenced-based data as to the value of both the CDS tool and team-based approach.

For those providers involved in the project, the principal barriers or issues were workflow based. Summary barriers were:

- Time required to use the CDS tool
- Lack of integration with the EHR
- Need for training on use of the CDS tool

A significant result is that 25% of the providers found no barriers in the continued use of the CDS tool. The first and second barriers should be ameliorated as the CDS tool is currently being integrated into the health system's EHR. Less than 10% of the responding providers indicated disagreement with the treatment recommendation or that they were just not interested as a barrier. Thus, workflow appears key to provider adoption.

Pharmacists identified a separate set of barriers to the successful adoption of the CDS tool and team-based approach. The barrier of patient adherence, being the primary one, is discussed in the patient engagement section. Other barriers identified by pharmacists focused on issues with the software including the response time and software errors. With the lack of EHR integration, data input into the software was a major issue.

The pharmacists also indicated the data output was very similar across runs after inputs had been changed, but that could be a result of the guidelines the software is based on rather than technical issues. The most common workflow issue cited by 5 of the 7 pharmacists in an unprompted question is that it is time consuming to run the CDS tool. This parallels a similar observation by providers.

Besides workflow, five of seven pharmacists indicated the principal barrier to provider adoption was that there were too many medications recommended and the recommendations were too aggressive.

Four of seven pharmacists also indicated that they considered the CDS tool as recommending too many medication changes.

Enhancements to Adoption

The collaboration between the pharmacists and providers was overwhelmingly positively reviewed by the participants. Forty percent of the providers identified collaboration with the pharmacist as what they liked best about the project. Likewise, 6 of the 7 pharmacists indicated that providers were very positive and appreciative for the information provided to them. Two of the seven pharmacists suggested that the continued involvement of pharmacists would be needed to continue to integrate the tool into the care process.

Not surprisingly improved patient outcomes were a leading benefit identified by the responding providers, as well as cost efficient decision-making and an expansion of medication repertoire. Linking change to evidence-based studies has been shown to be the key to physician adoption of both new drugs and new technologies. Such a linkage to the approach in this project would undoubtedly enhance provider adoption.

Pharmacists indicated benefits that could enhance adoption that parallel those of the providers including formulary transparency, more treatment options for providers, and helping patients in the context of general engagement.

Patient Engagement

Pharmacist identified the principal challenge in the project as the general issue of patient adherence to the medication regimen. The pharmacists were on the front-line of the patient engagement and dealing with a complex population with multiple comorbidities and complex social issues. Six of the seven pharmacists involved identified patient adherence as a major barrier. The team-based interactions and the questions prompted by the software were identified by the pharmacists as partially solving this adherence problem, specifically:

- Engagement and asking “the right questions” leading to accurate adherence information
- Co-pay information and pre-authorization minimized patient frustration
- Patients awareness that their preferences are being heard

The timeframe of this project is a relatively short duration and the design focuses on team-based care at the point of the encounter and use of CDS tool. Most patient engagement studies focus on traditional diabetes education models. In effect, this project examines one part of the care continuum. The fact that patient outcomes were significantly improved suggests that patients were adherent to their treatment regimen. The degree to which the engagement or the change in regimen can be associated with that improvement is difficult to assess. The results are better than those in studies of focused only on CDS in diabetes and better than those in most studies of patient engagement in diabetes. This suggests the need for further project particularly with a focus on the role of pharmacists in engagement.

APPENDIX A: DESCRIPTIVE STATISTICS

Comparison of Treatment Regimens

Table A1 provides descriptive statistics and tests of significance for each of the provider utilization approaches. The table indicates the percentage of the average A1c improvement during the project within each treatment category. Each of the recommendations involving a change to the regimen showed a statistically significant improvement in the A1c. When no change was implemented there was no statistically significant change in the A1c measure. Patients treated with the regimen following the partial recommendation from the CDS application showed a 20.96% reduction in A1c (a decline of 2.33 in the measure; patients treated with the regimen following the full recommendation from the CDS application showed a 17.80% reduction in A1c (a decline of 2.03 in the measure), changing treatment to an alternative regimen that was not recommendation by the CDS application resulted in a 13.66% reduction (a decline of 1.48 in the measure). The no change treatment resulted in 5.55% increase in A1c (an increase of 0.42 in measure).

TABLE A1: LONGITUDINAL ASSESMENT OF T-TEST OF MEAN DIFFERENCES BY TREATMENT REGIMENS

	Mean	Std. Deviation	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	df	Sig. (2-tailed)	A1C Decline%
Partial	2.3	2.7	1.0	3.7	17	0.002	20.96%
Full	2.0	2.7	1.4	2.7	73	0	17.80%
Alternate	1.5	2.1	0.6	2.4	21	0.003	13.66%
Control	1.3	2.3	0.9	1.6	146	0	11.38%
No change	-0.4	3.4	-2.6	1.7	11	0.677	-5.55%

Comparisons of Study and Control Groups

Comparison of the Full Recommendation and Control Group

Table A2 provides descriptive statistics of the two groups, Full Recommendation and Control Group on initial A1c. As shown in Table A2, the two groups have similar mean initial A1C (u_{full}=10.13, $u_{control}$=9.91) and standard deviation (sd_{full} =1.79, $sd_{control}$ =1.77)

TABLE A2: INITIAL MEASURE A1c DESCRIPTIVE STATISTICS COMPARING FULL AND CONTROL GROUPS

Initial A1c	Full	Control
Mean	10.13	9.91
Std. Deviation	1.79	1.77
95% Confidence Interval for Mean Upper	9.71	9.62
95% Confidence Interval for Mean Lower	10.54	10.20
Minimum	8.00	8.00
Maximum	15.00	15.00

Table A3 shows the mean Final A1C for the full group is 8.10 whereas the mean Final A1C for the control group is 8.66. The 95% confidence interval for the Full is between 7.62 and 8.58 whereas the 95% confidence interval for the control is 8.3 and 9.01.

TABLE A3: FINAL MEASURE A1c DESCRIPTIVE STATISTICS BETWEEN FULL AND CONTROL GROUPS

Final A1c	Full	Control
Mean	8.10	8.66
Std. Deviation	2.07	2.17
95% Confidence Interval for Mean Lower	7.62	8.30
95% Confidence Interval for Mean Upper	8.58	9.01
Minimum	5.40	4.50
Maximum	14.40	16.90

Table A4 depicts the difference in A1c improvement from the initial to final measure. In terms of the A1c improvement, the Full group has an average A1c decline of 2.03 whereas the control group has an average decline of 1.26. The data show that the Full group has better A1c control.

TABLE A4: COMPARISON OF THE CHANGE IN FINAL AND INITIAL MEASURES BETWEEN FULL AND CONTROL GROUPS

A1c Decline	Full	Control
Mean	-2.03	-1.26
95% Confidence Interval for Mean Upper	-2.66	-1.63
95% Confidence Interval for Mean Lower	-1.40	-0.88
Std. Deviation	2.72	2.29
Minimum	-8.90	-6.50
Maximum	5.60	7.20

Comparison of the Partial Recommendation and the Control Group

The sample size for the partial group is 18 and the sample size for the control is 147. Mann-Whitney test was used to compare the difference on the median of the two groups with a resulting p value of 0.055. Table A5 depicts the descriptive statistics for the Partial and Control groups on initial A1c. As shown in the table, the two groups have a similar mean initial A1c ($u_{partial}$=10.16, $u_{control}$=9.91) and standard deviation (sd_{full} =1.93, $sd_{control}$=1.77). Therefore, concerns about a skewed Table A6 shows the mean Final A1c for the partial group is 7.83 whereas the mean Final A1c for the control group is 8.66. The 95% confidence interval for the Partial is between 6.8 and 8.86 whereas the 95% confidence interval for the Control is 8.30 and 9.01. Table A7 shows A1c improvement. A1c improvement is calculated by using final A1c minus initial A1c.

TABLE A5: INITIAL MEASURE A1c DESCRIPTIVE STATISTICS COMPARING PARTIAL AND CONTROL GROUPS

Initial A1c	Partial	Control
Mean	10.16	9.91
Std. Deviation	1.93	1.77
95% Confidence Interval for Upper	9.20	9.62
95% Confidence Interval for Lower	11.11	10.20
Minimum	8.00	8.00
Maximum	16.40	15.00

TABLE A6: FINAL MEASURE A1c DESCRIPTIVE STATISTICS BETWEEN PARTIAL AND CONTROL GROUPS

Final A1c	Partial	Control
Mean	7.83	8.66
Std. Deviation	2.07	2.17
95% Confidence Interval for Mean Upper	6.80	8.30
95% Confidence Interval for Mean Lower	8.86	9.01
Minimum	5.30	4.50
Maximum	14.70	16.90

Table A7 shows A1c improvement. A1c improvement is calculated by using final A1c minus initial A1c. In terms of the A1c improvement, the Partial group has an average A1c decline of 2.33 whereas the control group has an average decline of 1.26. The data shows that the Partial group has better A1c control.

TABLE A7: COMPARISON OF THE CHANGE IN FINAL AND INITIAL MEASURES BETWEEN PARTIAL AND CONTROL GROUP

A1C Improvement	Partial	Control
Mean	-2.33	-1.26
Std. Deviation	2.69	2.29
95% Confidence Interval for Mean Upper	-3.67	-1.63
95% Confidence Interval for Mean Lower	-0.99	-0.88
Minimum	-7.30	-6.50
Maximum	6.30	7.20

Comparison of the Combined Study Groups (Partial and Full) and the Control Group

Combining patients that were "treated" that is, both Full and Partial Recommendation Groups, resulted in a sample of 92. The "treated" group was compared to the 147-patient sample control group. Table A8 shows the descriptive statistics on initial A1c, Final A1c between the Study "treated" group and Control Group. The initial A1c for the control group is 9.91 and the final A1c is 8.66. The initial A1c for the Study Group is 10.13 and the final A1C is 8.05. Descriptively, there are A1C declines in both groups. The final A1c confidence interval of the 95% confidence interval for the Study Group is between 7.62 and 8.47 and for the control group is 8.30 and 9.01.

TABLE A8: DESCRIPTIVE STATISTICS FOR THE COMBINED "TREATED" GROUPS AND THE CONTROL GROUP

Treated/Control		Mean	Std. Deviation	95% Confidence Interval for Lower	95% Confidence Interval for Upper	Minimum	Maximum
Control	Initial A1c	9.91	1.77	9.62	10.20	8.00	15.00
	Final A1c	8.66	2.17	8.30	9.01	4.50	16.90
Treated (Full+Partial)	Initial A1c	10.13	1.80	9.76	10.51	8.00	16.40
	Final A1c	8.05	2.06	7.62	8.47	5.30	14.70

To test the statistical differences between the final A1c on these two groups, a T-test was performed ($t=2.15$, $df=237$, $p=0.03$). The final A1c of the treated Group is significantly lower than that in the control group.

Comparison of the Description Statistics for the Study and Control Groups

Table A9: DESCRIPTIVE STATISTICS FOR THE STUDY GROUP AND THE CONTROL GROUP on Initial A1c, Final A1c, A1c Decline, A1c Decline%

Group	D-Stat	Control	Study
Initial A1c	Mean	9.91	10.11
	Std. Deviation	1.77	1.68
	95% Confidence Interval for Mean Upper	9.62	9.82
	95% Confidence Interval for Mean Lower	10.20	10.41
	Minimum	8.00	8.00
	Maximum	15.00	16.40
Final A1c	Mean	8.66	8.37
	Std. Deviation	2.17	2.23
	95% Confidence Interval for Mean Upper	8.30	7.98
	95% Confidence Interval for Mean Lower	9.01	8.76
	Minimum	4.50	5.30
	Maximum	16.90	16.00
A1c Decline	Mean	-1.26	-1.74
	95% Confidence Interval for Mean Upper	-1.63	-2.23
	95% Confidence Interval for Mean Lower	-0.88	-1.26
	Std. Deviation	2.29	2.75
	Minimum	-6.50	-8.90
	Maximum	7.20	6.30
A1c Decline%	Mean	-11.38%	-15.30%
	95% Confidence Interval for Mean Upper	-0.15	-0.20
	95% Confidence Interval for Mean Lower	-0.08	-0.11
	Std. Deviation	0.22	0.26
	Minimum	-0.53	-0.61
	Maximum	0.74	0.75

APPENDIX B: CONTROL GROUP CLINICAL CONSIDERATIONS

Multiple confounding factors may impact the make-up of the control group. First, patients were selected in the control group based on the presence of more than one HgA1c value over the 2-year period of the study. During this time, multiple interventions may have taken place, as the data recorded reflects the medications in the patient's medication list at the time of the second hemoglobin A1c measure.

Second, a group of 8 patients out of the 147 in the control group account for over 21% of the total A1C reduction observed in the entire control group over the course of the project. These patients had atypical A1C reductions, atypical use of medicines, and comorbidities that may indicate secondary diabetes:

- Five patients in the control group who were prescribed metformin as a monotherapy have A1c reductions that fall more than 4.8 standard deviations from metformin's mean A1c reduction listed on its FDA label.[xxi]
    - Samples that fall 3 or more standard deviations from the mean are typically excluded from results. [xxii][xxiii]They are not excluded from this study.
    - No patients in the study group were prescribed metformin as a monotherapy.
- One patient in the control group who was prescribed glyburide as a monotherapy has an A1c reduction that is more than 2.5 standard deviations from the mean A1c reduction for twice the dosage prescribed, in a peer-reviewed study.[xxiv]
    - No patients in the study group were prescribed glyburide as a monotherapy.
- One patient in the control group was prescribed rapid-acting insulin lispro (Humalog) as a monotherapy, which is not the typical administration as directed in the drug's FDA label. The patient had an A1c reduction more than 2.5 standard deviations from the FDA label mean for insulin lispro when combined with a basal insulin.
    - No patients in the study group were prescribed insulin lispro as a monotherapy.
- At least two of six patients in the control group with pancreatitis have other characteristics such as Body Mass Index under 25.0 that may indicate secondary diabetes through pancreatitis. One was excluded from the control group, and one was not.

The presence of follow up A1c itself is selective for engaged patients and providers. The concept of "therapeutic inertia", where patient and provider fail to make therapeutic change despite poorly controlled disease is thought to be a large driver of poor outcomes. A second visit with evaluation suggests action which is demonstrated by the drug regimen in the control group, which is substantially more aggressive than the national distribution of therapeutics.

APPENDIX C: ASSESSMENT OF COST DIFFERENCES USING PROXY MEASURES

A goal of this project was to assess the difference in medication costs between the patient's current medication regimen and the regimen proposed by the electronic decision support tool. However, medication system costs were not available from either DMS or the MCOs, as these system costs are considered proprietary trade secrets. Nor were estimated or "directional" system costs available.

The Medicaid.gov website provides a database called NADAC (National Average Drug Acquisition Cost) in which the price of a drug is "a simple average of the drug acquisition costs submitted by retail community pharmacies" across the United States. For example, the NADAC cost of a month supply of the medication semaglutide (Ozempic®) - two 1 mg dose pens - was approximately $520 in January 2020, the last month for which semaglutide prices were available.

This NADAC is substantially higher than the actual price paid by DMS and MCOs for medicines. Among other factors, the NADAC does not reflect the contract prices negotiated by DMS or the MCOs, nor do the NADAC reflect negotiated or mandated rebates for those medicines.

Those negotiated prices can substantially reduce the cost of these medicines to DMS and the MCOs. For example, at least one MCO has a negotiated price for semaglutide (Ozempic®) that is less than 50% of the NADAC shown below.

Table B1 below shows the difference in NADAC for the control group's patients' current medication regimen and the regimen proposed by the electronic decision support tool for the study groups. The study groups were compared to 100 randomly selected, same-size sample groups from the 147-patient control group, where the group's samples were selected to match the mean Initial A1c of the study group. The mean differences shown are the means across all 100 randomly selected control group samples. Prices are rounded to the nearest dollar.

TABLE B1: COST COMPARISON
CURRENT VS. PROPOSED DRUGS USING PROXIES

Study Group	N	Mean NADAC Cost	Std Deviation	Minimum NADAC Cost	Maximum NADAC Cost	Starting A1c	Starting A1c of Control Group for Matched Comparison	Matched Control Group Mean NADAC Cost
Control Group	147	$504	$481	$0	$2,067	9.912	N/A	N/A
Study Group	106	$720	$418	$0	$2,079	10.202	10.18	$509

Study Group	N	Mean NADAC Cost	Std Deviation	Minimum NADAC Cost	Maximum NADAC Cost	Starting A1c	Starting A1c of Control Group for Matched Comparison	Matched Control Group Mean NADAC Cost
Study – Full Recommendation	64	$734	$291	$0	$1,296	10.22	10.24	$506
Study – Partial Recommendation	12	$724	$593	$6	$2,040	10.05	10.05	$506
Study – Alternate	20	$786	$506	$2	$2,079	10.42	10.41	$500
Study – No Change	10	$489	$560	$0	$1.699	9.84	9.84	$522

Statistically significant differences were found between the entire study group and the control group in 96 of 100 trials; between the "full recommendations" study group and the control group 96 times; between the "partial recommendations" and control group 4 times; between the "alternate" study group and the control group 42 times; and between the "no changes" study group and the control group 0 times.

TABLE B2: COST COMPARISON FOR CONTROL GROUP CURRENT VS. PROPOSED DRUGS USING PROXIES

Group	N	Mean NADAC Cost Current Regimen	Std Deviation	Minimum NADAC Cost Current Regimen	Maximum NADAC Cost Current Regimen	Mean NADAC Cost Post-Intervention	Std Deviation	Minimum NADAC Cost Current Regimen	Maximum NADAC Cost Current Regimen	P-value
Study Group	106	$442	$475	$0	$2,082	$720	$418	$0	$2,079	3.3701821437395E-09
Study – Full Recommendation	64	$427	$447	$0	$1,817	$734	$291	$0	$1,296	7.7307135717095E-06
Study – Partial Recommendation	12	$419	$466	$0	$1,699	$724	$593	$6	$2,040	0.045967275058039
Std – Alternate	20	$480	$512	$0	$2,082	$786	$506	$2	$2,079	0.00070292
Study – No Change	10	$489	$560	$0	$1,699	$489	$560	$0	$1,699	N/A

NOTES

[i] 2019 Kentucky Diabetes Report, A Report to the Legislative Research Commission. April 2019. https://kyma.org/shared/content/uploads/2019/06/2019-Diabetes-Report-latest11610.pdf

[ii] https://www.drugs.com/condition/diabetes-mellitus-type-ii.html

[iii] https://dashboard.healthit.gov/quickstats/quickstats.php

[iv] O'Connor R., et al. Clinical Inertia in Outpatient Medical Errors. Advances in Patient Safety: Vol.2

[v] Pantalone, K. et al. Clinical inertia in type 2 diabetes management: Evidence from a large, real world data set. Diabetes Care, (41)7:e113-e114, July, 2018.

[vi] Khunti, S, Khunti, K., Seidu S. Therapeutic inertia in type 2 diabetes: prevalence, causes, consequences and methods to overcome inertia. Therapeutic Advances in Endocinology and Metabolism. 10:2042028829844694, May 2019.

[vii] Ruiz-Negron, N., et al. Factors associated with diabetes related clinical inertia in a managed care population and its effect of hemoglobin A1c goal attainment: A claims-based analysis. Journal of Managed Care 25(3):304-313, March, 2019.

[viii] Centers for Disease Control. Team care approaches for diabetes management, www.cdc.gov/diabetes/ndep/pdfs/ppod-guide-team-care-approach.pdf

[ix] Levengood, T. et al. Team-based care to improve diabetes management: A community guide meta-analysis. American Journal of Preventive Medicine,57(1): E17-E26, July, 2019.

[x] Sisson, E., Kuhn, C. Pharmacist roles in management of patients with diabetes. Journal of American Pharmacist Association, 49(4), Supplement 1:S41-S45, September 2009.

[xi] Wubben, D., Vivian, E. Effects of pharmacist outpatient interventions on adults with diabetes mellitus: A systematic review. Pharmacotherapy, 28(4):421-436, April 2008

[xii] Burridge, L., et al. A qualitative follow-up study of diabetes patient's appraisal of an integrated diabetes service in primary care. Health and Social Care in the Community, 25(3):1031-1040, May 2017.

[xiii] How doctors feel about electronic health records: National Physicians Poll. Stanford Medicine, The Harris Poll. August 2019. Available at http://www.med.stanford.edu/content/dam/sm/ehr/documents/EHR-Poll-Presentation.pdf.

[xiv] Jeffrey, R., Iserman, E., Haynes RB. Can computerized clinical decision support systems improve diabetes management? A systematic review and meta-analysis. Diabetic Medicine,30(6):739-745, June 2013.

[xv] Ali, M,. Griodano,R. Lakhani, S. Walker, DM. A review of randomized controlled trials of medical record powered clinical decision support system to improve quality of diabetes care. International Journal of Medical Informatics, 87:91-100, March 2016.

[xvi] Heselmans, et al. Computerized clinical decision support system for diabetes in primary care does not improve quality of care: A cluster-randomized controlled trial. Implementation Science, 15(1):5, January, 2020.

[xvii] Murphy, M., et al. Supporting care for suboptimally controlled type 2 diabete mellitus in general practice with a clinical decision support system: a mixed methods pilot randomized trial. BMJ Open 2020;10e032594

[xviii] https://www.hhs.gov/ohrp/regulations-and-policy/guidance/faq/quality-improvement-activities/index.html

[xix] The Control Group sample originally consisted of 150 patients, one was excluded during the analysis when it was determined that the patient was receiving treatment at a second non-SEP/SEH facility during the assessment period and two others had measurement issues.

[xx] As of June 12, 2020, data collection finished with 126 patients in the study group and 147 in the control group. In the study group, patient PR161 was recommended Alternate initially and then Full @ 9 month f/u. Patient PR 128 was recommended No changes initially, and then change to Full @ 6 month f/u. These two patients (PR161 and PR128) are placed in the Full group when comparing subgroups. Patient NK357 with no change recommendation had an initial A1c of 10.1 and final A1c of 16 showing A1c increase by 5.9 (58.4%). This is the patient in the study group that has a normalized final A1c of 3.4. Patient DS268 with alternate recommendation had an initial A1c of 16.4 and final A1c of 9.1 showing A1c decreases by 7.3 (44.5%). This is the patient in the study group that has a normalized final A1c of 3.7. An outlier analysis does not show these two patients (DS268 and NK357) are extreme outliers. All subgroups are positively skewed. Given the fact they skew in the same direction, we further test if they skew similarly. A test of homogeneity of variance was conducted based on the median with adjusted df resulting in a p value of 0.51 shows they skew similarly or their distributions are similar.

[xxi] Bloomgarden, Z., Handelsman, Y. Management and prevention of cardiovascular disease for type 2 diabetes: Integrating the Diabetes Management recommendations of AACE, ADA, EASD, AHA, ACC, and ESC. (2020): 100007

[xxii] Parrinello CM, Grams ME, Sang Y, et al. Iterative outlier removal: A method for identifying outliers in laboratory recalibration studies. Clin Chem. 2016;62(7):966-972. doi:10.1373/clinchem.2016.255216.

[xxiii] Jones, P.R. A note on detecting statistical outliers in psychophysical data. Atten Percept Psychophys 81, 1189–1196 (2019).

[xxiv] Sherifali D, Nerenberg K, Pullenayegum E, Cheng JE, Gerstein HC. The effect of oral antidiabetic agents on A1c levels: A systematic review and meta-analysis. Diabetes Care 2010 Aug; 33(8): 1859-1864.