Program Evaluation: Clinical Nurse Specialist Led Program for Diabetes Health

Elizabeth Kassulke

University of Virginia- School of Nursing

GNUR 9600

Dr. Beth Quatrara: Advisor

March 29, 2022

"I pledge that I have neither given nor received help on this assignment"

Signed: Elizabeth L Kassulke

Table of Contents

Abstract

The increasing prevalence of diabetes in the United States indicates that healthcare providers will likely encounter patients in the acute care setting with a diagnosis of diabetes, even if that is not the chief complaint or medical concern that led to the hospital admission. A systematic literature search shows that Advanced Practice Nurses (APRNs) deliver care that is comparable to physician colleagues in meeting target blood glucose levels. Utilizing the Agency for Clinical Innovation's (ACI) program evaluation framework, a program evaluation was conducted on the Clinical Nurse Specialist (CNS)-led Program for Diabetes Health (PDH). The program evaluation examined clinical outcomes achieved by the PDH providers compared to clinical outcomes achieved by providers prior to the initiation of the PDH. Utilizing a retrospective electronic health record review, data were collected on patients over a three-month period prior to the implementation of the PDH and the same three-month period nearly two-and-a-half years post implementation. Data points were collected on nine different variables to compare demographics and diabetes management during the two time periods. Data were analyzed. There were statistically significant differences in the results for difference in group ages, admitting blood glucose levels, length of stay, use of basal/bolus insulin and use of sole correctional insulin. The results of the statistical tests and further analysis show that the CNSs of the PDH provide care that is consistent with the current clinical guidelines. Additionally, despite increased blood glucose values on admission, the results point to an increased number of patients who achieved target blood glucoses with a reduced number of hypoglycemic events while under the care of the CNS team. CNSs are effective in helping patients and providers achieve enhanced management of diabetes during hospital admissions.

Program Evaluation: Clinical Nurse Specialist Led Program for Diabetes Health

Introduction & Background

The National Diabetes Statistics Report, published by the Centers for Disease Control and Prevention (CDC), reported that in 2018, 34.1 million adults in the United States (US) carried the medical diagnosis of diabetes, a prevalence of 13.0% (Centers for Disease Control and Prevention, 2020). Additionally, 7.3 million adults met the laboratory criteria for diabetes but were unaware of or did not report having diabetes (Centers for Disease Control and Prevention, 2020). This same report states that the prevalence of diabetes increased among adults from 9.5% in 1999-2002 to 12.0% in 2013-2016 (Centers for Disease Control and Prevention, 2020). According to the Virginia Department of Health, 631,194 Virginians have been diagnosed with diabetes, which equates to a prevalence of 9.6% (Virginia Department of Health [VDH], 2018). In 2017, the total estimated cost of medical care related to diabetes was $327 million, which represents a 26% increase from 2012 to 2017 (Karam et al., 2020). In 2015, diabetes was the seventh leading cause of death in the US and Virginia (Virginia Department of Health [VDH], 2018).

The prevalence of diabetes in the US indicates that healthcare providers will likely encounter patients in the acute care setting with a diagnosis of diabetes, even if that is not the chief complaint or medical concern that led to the hospital admission. Patients with diabetes have a three-fold greater chance of hospitalization compared to those without diabetes (Dhatariya et al., 2020). The CDC reported in their National Diabetes Statistics Report that in 2016 a total of 7.8 million hospital discharges were reported with diabetes listed on the patient's diagnosis list (Centers for Disease Control and Prevention, 2020). Another study found that over one-quarter of hospitalized Americans have diabetes (Wexler et al., 2007). This prevalence of diabetic

patients indicates an opportunity for specialty-trained advance practice nurses (APNs) to collaborate with providers and consult in the inpatient management of patients with diabetes.

Uncontrolled diabetes is associated with many serious health complications including diabetic ketoacidosis, retinopathy, neuropathy, nephropathy, cardiovascular disease, high blood pressure and stroke (*Diabetes Overview*, n.d.). In critically ill and non-critically ill people with and without diabetes, hyperglycemia has a strong association with poor clinical outcomes, such as increased mortality, infections and other hospital complications (Dhatariya et al., 2020). Tight glycemic control has been proven to reduce mortality in hospitalized patients (Wexler et al., 2007). In a retrospective analysis performed to gain insight into the care of patients with hyperglycemia admitted to a teaching hospital, data showed that more than 20% of the participants experienced sustained hyperglycemia (Cook et al., 2007). Furthermore, 42% of patients who showed poor control of blood glucose levels during the first 24 hours of their admission were also discharged in poor control (Cook et al., 2007). In this same study, the patients who did receive insulin during their hospitalization were often given short-acting insulin at low doses and had less than optimal intensification of therapy (clinical inertia); in fact, insulin doses were often decreased despite persistent hyperglycemia (Cook et al., 2007).

Clinical inertia is a term that refers to the failure of clinicians to intensify therapy when clinically indicated (Pantalone et al., 2018). In a study conducted at the Cleveland Clinic, researchers examined and analyzed the electronic health records of 7,389 patients with type 2 adult-onset diabetes. Every patient in this study had a hemoglobin A1C value greater than 7%, indicating poor glycemic control (Pantalone et al., 2018). Of these patients, nearly 63% had no evidence of intensification in their antihyperglycemic therapy during the six months following the reported elevated hemoglobin A1C result (Pantalone et al., 2018). In a quality improvement

(QI) project, Apsey et al. (2014) sought to overcome the use of ineffective sliding scale insulin (correctional insulin) protocols. Providers on a postoperative hospital unit initiated this QI project because the current practice of utilizing sliding scale insulin without the use of basal insulin resulted in ineffective inpatient glycemic control. The authors of the study observed clinical inertia in their hospital with regard to insulin prescribing and administration (Apsey et al., 2014). The authors noted overutilization of correctional insulin alone and underutilization of the recommended basal-bolus insulin, which led to the development of a QI project to overcome clinical inertia and achieve inpatient glycemic control (Apsey et al., 2014).

Another study explored the role of APN and physician teams in the primary care management of patients with diabetes (Willens et al., 2011). After randomization of participants to either the intervention group which was managed by an APN-MD team or the control group managed by their usual primary care provider, participants were followed for 12-months. After 12-months the intervention group's participants saw greater improvements in hemoglobin A1C levels compared to the control group (Willens et al., 2011). Notably, nine of eleven measures including hemoglobin A1C, influenza vaccination, foot exams, smoking cessation and weight control showed statistically significant differences ($p = <0.001$) comparing APN-MD team care to usual care (Willens et al., 2011). This study indicates that in primary care, the use of a team approach with APNs and physicians can be a powerful tool to address the needs of patients with diabetes which potentially will lead to improved outcomes (Willens et al., 2011).

The purpose of this evidence-based review of literature is to answer the following clinical practice question: In adult patients (18 years and older) with a diagnosis of diabetes, what is the effect of a CNS-led diabetes management team on blood glucose levels during inpatient hospitalization?

Review of Literature Methods

A systematic literature search was conducted in four electronic databases: Cumulated Index to Nursing and Allied Health Literature (CINAHL), PubMed, Web of Science (WoS) and Cochrane Library. A health sciences librarian was consulted for search accuracy and fidelity to the PICO question. Keywords for the literature search were diabetes, nurse-led and glucose. Additionally, the search criteria in PubMed included the following medical subject headings (MeSH) terms: diabetes mellitus and glucose and title and abstract search for "Clinical Nurse Specialist". The following search string was specifically utilized for the literature search in PubMed: (diabetes[tiab] OR diabetic[tiab] OR "diabetes mellitus" [MeSH]) AND ("Clinical nurse specialist" [tiab] OR nurse-led[tiab]) AND (glucose [MeSH] OR glucose [tiab]). The search was limited to publication dates between 2010 and 2021 and English language. A total of 201 articles were initially obtained. After removing duplicate articles, 145 articles were retained for title review.

During the initial title review 105 additional articles were removed because they deviated from the primary focus and included: community-based (44), nursing education (8), other medical specialty focused (37), pediatric patients (7) and not studies but reviews of existing guidelines (9). Forty articles were retained for abstract review. A more in-depth abstract review removed an additional 21 articles. The articles were removed for the following reasons: other medical specialties (8), psychiatric or mental health (3), pediatric patients (1), review of guidelines (5) and nurse education (4). Nineteen articles were retained for full text review and analysis. Finally, ten articles were appraised and determined to be acceptable for inclusion. The PRISMA flowsheet outlining the integrative literature search described above can be found in Appendix A.

Review of Literature Results

Ten total articles were appraised utilizing the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) worksheets to assess the level of evidence and applicability to the topic as described in Appendix B. The appraised articles included one randomized controlled trial, four quality improvement projects, one systematic review, two quasi-experimental studies, one non-experimental study and one qualitative study. Overall, the quality of evidence ranged from level I-B to level V-B. Appendix C provides a summary of the appraised articles with study design, outcomes and JHNEBP level of evidence and quality. The main reasons articles were rated as "B Good Quality" instead of "A High Quality" were limited sample sizes and single setting studies which could affect applicability of the studies. Three major themes developed during the article appraisal process. The first theme was the comparison of care provided by APNs, both CNSs and nurse practitioners (NPs), to their physician colleagues. The second major theme was the effectiveness of nurse-led interventions and multi-disciplinary teams. The third theme was the focus on patient experience.

Comparison of APN Care to Physician Colleagues

The comparison of care provided by CNSs and other APNs to physician colleagues was a theme that was explored in multiple articles. Arts et al. (2012) examined the effectiveness of both physician care and care provided by a diabetes nurse specialist. In this study a diabetes specialist nurse was defined as a doctoral- or Master's-prepared Registered Nurse with a focus on the specialized diabetes mellitus population (Arts et al., 2012). Through the study, the authors examined clinical outcomes such as hemoglobin A1C and body mass index (BMI) for patients who received care from nurse specialists or physicians, and found that there was no statistical difference in clinical parameters between the two groups (Arts et al., 2012). Furthermore, the

authors found that utilizing nurse specialists as central healthcare providers yielded comparable (no statistical differences, $p = 0.14$) quality of life for the patients when measured using the quote-diabetes questionnaire (Arts et al., 2012). Furthermore, although not statistically significant, cost savings were noted in the long term when care was provided by diabetes nurse specialists (Arts et al., 2012). These findings show that the utilization of diabetes nurse specialists can deliver diabetes healthcare at levels equivalent to physician peers.

Garg et al. (2016) evaluated the effectiveness of nurse practitioner mediated interventions on reducing fasting blood glucose levels for diabetic patients undergoing elective surgery. The outcomes of patients evaluated by nurse practitioners was compared to the outcomes of patients evaluated by physicians. This study found that patients examined by nurse practitioners experienced statistically significant ($p = <0.01$) lower fasting blood glucose levels on their day of surgery compared to patients seen by the physician group (Garg et al., 2016). The data from this study showed that a nurse practitioner intervention was more effective than physician alone interventions in achieving target blood glucose levels on day of surgery (Garg et al., 2016). In addition to achieving target blood glucose levels, the utilization of nurse practitioners enabled the healthcare team to evaluate a greater number of eligible patients, which led to effective preoperative blood glucose management for more eligible patients and improved clinical outcomes (Garg et al., 2016).

Patrick Conlon (2010) conducted a pilot study to explore practice behaviors of diabetes nurse practitioners compared to physician colleagues in a primary care setting. In comparison to physician colleagues, the diabetes nurse practitioners' interventions lowered hemoglobin A1C and glucose levels to a greater degree (Conlon, 2010). One hundred percent of patients seen by a nurse practitioner experienced a decrease in hemoglobin A1C compared to only 24% of patients

seen by a physician (Conlon, 2010). The average degree of decrease in hemoglobin A1C was 2.5% in patients seen by NPs compared to 0.2% in patients seen by physician providers (Conlon, 2010). In addition to clinical outcomes, patient education related to their diabetes was initiated, documented and offered more consistently by the nurse practitioners than their physician colleagues (Conlon, 2010). This study is limited by a relatively small sample size at a single institution and no discussion on patient acuity or comorbidity burden. The results of this pilot study, however, reveal that interventions by diabetes nurse practitioners were equal to, and in some cases better than, that of the physician (Conlon, 2010).

Virani et al. (2016) also conducted a study to compare the quality of diabetes care between advanced practice providers and physicians in patients receiving primary care at Veterans Affairs facilities. In over one million patients, diabetes care quality was comparable between advanced practice providers and physicians (Virani et al., 2016). Diabetic patients receiving care from advanced practice providers were more likely to have optimized glycemic control, indicated by a hemoglobin A1C of less than 7%, than patients receiving their care from physicians, though this finding was statistically insignificant (50% vs. 51.4%, odds ratio) (Virani et al., 2016).

As highlighted above, all four studies with the main focus of comparing clinical outcomes demonstrated that patients evaluated by advanced practice providers had equivalent or better outcomes compared to patients seen by physicians alone.

Effectiveness of Nurse-led Interventions and Multi-disciplinary Teams

Another major theme that developed while appraising articles was the effectiveness of nurse-led teams and the role of multi-disciplinary teams. In a three-phase quality improvement study, Oba et al. (2020) explored causes of uncontrolled diabetes, designed a program for

improving glycemic control and implemented the program. The program was titled the "Nurse-led Multidisciplinary Based Program for People with Uncontrolled Diabetes," and the main goals were to decrease fasting blood glycose levels, decrease hemoglobin A1C and prevent hospital admissions (Oba et al., 2020). Patients who participated in the program had statistically significantly ($p = < 0.01$) lower A1C levels compared to their baseline values and no hospitalizations for hyper- or hypoglycemia (Oba et al., 2020). These findings indicate that a nurse-led team approach is safe and effective at lowering blood glucose levels in patients with diabetes, therefore, can optimized outcomes

In a similar study, authors sought to evaluate the effectiveness of a diabetes specialist nurse program on reducing 30-day readmission rates, decreasing length of stay and reducing the 30-day mortality rate for patients with diabetes on multiple acute care wards (Knee et al., 2020). In this program, a master's-prepared diabetes specialist nurse was able to use point-of-care test results to quickly identify hospitalized patients with abnormal blood glucose levels and intervene appropriately (Knee et al., 2020). After the implementation of the diabetes specialist nurse program, there was a statistically significant ($p = 0.001$) reduction in the 30-day readmission rates (Knee et al., 2020). While this finding shows that APNs are effective in reducing 30-day readmission rates, the same study found that interventions by the diabetes nurse specialist did not significantly reduce the 30-day mortality rates or hospital length of stay (Knee et al., 2020). The reduction in 30-day readmission rates was consistent with literature reviewed prior to the study that showed patient education performed by a specialized team, specifically diabetes specialist nurses, decreases readmission rates and improves patient adherence to treatment even after patient discharge (Knee et al., 2020). The neutral findings on the impact of the diabetes specialist nurse program on length of stay and 30-day mortality rates in this study, could potentially be

attributed to the fact that the authors only included patients admitted to the acute medical emergency units where, by definition, the patients were more acutely ill and these findings could be attributed to the medical cause for admission rather than issues specifically related to diabetes (Knee et al., 2020). The fact that 30-day mortality did not increase, shows that patients were not negatively impacted by this intervention.

In two separate QI projects, Klinkner and Murray (2014) and Powell et al. (2018) studied the effect that CNS and NP led teams would have on mean blood glucose and hemoglobin A1C on patients with diabetes. Both studies found that the APN-led teams were effective in managing patients with diabetes. Klinkner and Murray (2014) found that the implementation of nurse specialist led teams were able to quickly identify hyperglycemia, initiate an insulin infusion protocol and improve postoperative glycemic control, specifically reducing morning blood glucoses results greater than 200 mg/dL by 83.3% compared to usual postoperative care. Similarly, Powell et al. (2018) found a statistically significant ($p = 0.01$) improvement in patients' fasting blood glucose levels and hemoglobin A1C after the initiation of a NP-driven protocol for medication intensification. During the implementation of this study, patients participated in every-two-week telephone calls and fasting blood glucose evaluations with APNs, allowing for medication intensification when needed (Powell et al., 2018). These quality improvement projects illustrate that APNs are effective in managing blood glucose and hemoglobin A1C levels for patients with diabetes.

Patient Experience

The third major theme that was identified during the literature review was the effect of CNSs and NPs on the overall patient experience. A national survey of patient experience was conducted in Ireland in 2017. The report's aim was to measure the overall patient experience as

part of an evaluation of a nurse specialist-led diabetes integrated care service (Riordan et al., 2017). Over 300 patients completed surveys with questions that included aspects of care relating to the consultation with the CNS such as privacy during consultation, nurse-patient communication and general feedback (Riordan et al., 2017). The majority (97.8%), of the respondents felt that the CNS explained their condition in clear and concise language that the patient understood (Riordan et al., 2017). Additionally, the majority of patients believed they received the right amount of information about their condition and received enough information to manage their diabetes (Riordan et al., 2017). In summary of their care, 91% of patients rated their experience with a CNS as very good and an additional 8% rated their experience as good (Riordan et al., 2017).

In a separate systematic review to determine the clinical effectiveness (glycemic control, other biological measures, cost-effectiveness and patient satisfaction) of primary care nurse-led interventions for diabetes, Crowe et al. (2019) found the majority of patients were more satisfied with nurse-led care than their usual care. This same study found that patients who were seen under a nurse-led model, reported developing confidence and independence in their management of diabetes (Crowe et al., 2019).

In summary of the current available body of evidence, APNs are effective at clinical management of diabetes. In comparison to physician colleagues, diabetes specialty nurses are able to deliver care that is as effective in meeting target blood glucose levels, and the majority of patients rate the care they receive from CNSs to be good or very good.

Review of Literature Limitations

Though the appraisal and analysis of the articles contributed to understanding the effectiveness of CNS led efforts in the management of diabetes, several limitations were

discovered. One limitation was the lack of distinction between advance practice providers. CNSs, NPs and PAs were often referred to as advance practice providers despite different roles and educational preparation. Within the articles, CNSs and NPs are often referred to as APRNs (advance practice registered nurses) or APNs (advance practice nurses) and no clear delineation between the roles is made.

Additionally, despite searching for articles related to hospitalized patients, some of the studies retained for analysis were set in a primary care setting. The author opted to include them in the analysis because the information regarding the care of patients with diabetes by APPs is relative to the topic and can be quite informative; however, it is noted that the settings of the studies do influence results and overall applicability. Patient comorbid conditions were often not discussed in the analyzed articles, though these conditions can have a drastic effect on the overall health and responsiveness of a patient to medical treatment. Oftentimes when patients with diabetes are admitted to a hospital, their diabetes care is managed by the admitting team (Mabrey & Setji, 2015). Upon admission, a patient's diabetes self-management routine is often replaced with sliding scale insulin when blood glucose levels are elevated, scheduled blood glucose level checks and structured dietary restrictions. Each of these interventions can affect overall diabetes management differently than when the patient is not hospitalized (Mabrey & Setji, 2015). Furthermore, multiple studies were conducted in other countries where the healthcare delivery system is different from that in the US, which may limit how the same interventions would affect patient care and outcomes in the US.

Recommendations

After reviewing the current body of evidence, there is consistent high-quality evidence supporting the implementation of APRN led diabetes management teams. The current body of

evidence shows that APRNs have similar or better patient outcomes compared to physician colleagues with reported high levels of patient satisfaction. In addition to current literature supporting the implementation of APRN led diabetes management teams, it is essential to highlight that none of the articles revealed an increase in negative patient outcomes when care was directed by CNSs and APRNs as compared to practice by physician colleagues. These findings support the benefits of CNS led diabetes management teams compared to the risks of CNS led teams. However, additional science is still needed to ultimately determine the effect of CNS led diabetes management teams for hospitalized patients. Specifically, future science needs additional focus on the management of complex patients in an inpatient hospital setting. Finally, science should clearly distinguish between CNSs and other APPs to truly determine their effectiveness in healthcare management of patients with diabetes.

Project Methods

The current science supports the utilization of CNS led teams in the inpatient management of patients with diabetes, but future science needs to distinguish between the care provided by CNSs, NPs and PAs. Based on available evidence highlighting the benefits of CNS practice and the need for more information contributing to the body of literature on this topic, an evaluation of the inpatient CNS-led Program for Diabetes Health (PDH) is beneficial to deepening our understanding. The PDH evaluated through this project is a consult-based inpatient diabetes management program. The PDH's mission is to be leaders in the approach to diabetes care in the local community in order to improve quality of life and long-term management of diabetes for people living with diabetes. They seek to meet this mission through improved delivery of acute diabetes care and improved transitions of care (Program for Diabetes Health [PDH], 2020). The inpatient providers of the PDH, a team of five CNSs in collaboration

with a lead endocrinologist, also seek to educate providers to deliver state-of-the-art diabetes care within their primary and specialty care practices (PDH, 2020). This program evaluation examined the diabetes-related clinical outcomes of this CNS-led diabetes management team as compared to clinical outcomes prior to the program's implementation.

The PDH CNSs collaborate with and mentor providers and nurses using a consult-based workflow. Providers, nurses and other specialty members of the healthcare team can initiate consults for evaluation of home diabetes management, insulin type and dose recommendations and titrations, specialty discharge education and referrals to be performed by the CNSs and management of patient insulin pumps. After the initial assessment of a patient, the CNS completes a consultant note with recommendations to the primary care team providers. The CNSs, under a practice agreement with an endocrinologist, make their recommendations and bill for their services, but ultimately, the primary provider is responsible to accept the recommendations and order the appropriate dose and timing of the insulin or other antihyperglycemic agents. The aim of this program evaluation is to evaluate the outcomes of the CNS-led PDH as compared to diabetes outcomes prior to the program's implementation.

Program Evaluation Framework

This program evaluation was conducted using the Agency for Clinical Innovation (ACI) Program Evaluation framework. The ACI is the lead agency for innovation in clinical care in New South Wales (NSW) (Agency for Clinical Innovation [ACI], 2021). ACI innovations are person-centered, clinically-led, evidence-based and value-driven (ACI, 2021). Established in 2010, ACI works to transform and realign the healthcare networks in NSW to enable greater collective expertise in addressing complex health problems (ACI, 2021). Based on ACI's primary principles of leveraging disruption and providing support for transformation change

while stiving for excellence and impact, it was evident that this framework would be appropriate for a program evaluation for the PDH (ACI, 2021).

Program evaluation in ACI is defined as a systematic process designed to examine the worth of a program in terms of effectiveness, efficiency and appropriateness (Agency for Clinical Innovation, 2013). In ACI, programs refer to projects, models of care, clinical pathways, guidelines and other innovations and interventions aimed at improving health outcomes (Agency for Clinical Innovation, 2013). ACI has three different types of program evaluations: formative evaluation, process evaluation and summative evaluation (Agency for Clinical Innovation, 2013). Since the PDH is an entity with now over two years of active engagement, a summative evaluation was most appropriate. A summative evaluation assesses quality, outcomes and impact of implemented projects to determine success towards achieving the stated outcomes. The summative evaluation generally occurs at the completion of a project or at least well after the implementation period (Agency for Clinical Innovation, 2013). According to ACI (2013), a summative evaluation may include both outcome evaluations and impact evaluations. An outcome evaluation assesses whether longer term goals of the initiative are met, such as changes in health and economic outcomes (effectiveness) (Agency for Clinical Innovation, 2013). Impact evaluation measures the impact of a program, such as the intended or unintended overall effects of the program (Agency for Clinical Innovation, 2013). To drive the evaluation process, the ACI evaluation cycle consists of eight steps.

Establish Evaluation Team

The first step in the ACI program evaluation cycle is to establish an evaluation team (Agency for Clinical Innovation, 2013). The members of the evaluation team consisted of the doctorate of nursing practice (DNP) student, her academic advisor and the CNSs from the PDH.

Additionally, the lead CNS and endocrinologist from the PDH provided oversight to the program evaluation. The DNP student consulted with a statistician from the UVA School of Nursing. Furthermore, the administration for the hospital system was notified of the program evaluation plan.

Planning

After establishing the evaluation team, the next step in the ACI program evaluation is planning (Agency for Clinical Innovation, 2013). During this step the members of the evaluation team developed their communication plan with stakeholder engagement and planned how to disseminate and report results (Agency for Clinical Innovation, 2013). Stakeholders for this program evaluation included the members of the PDH, hospital administration and providers and nurses in the hospital organization. The initial communication plan included weekly virtual meetings with DNP student and advisor as well as email communication with CNS lead from PDH. Weekly meetings between the DNP student and her DNP advisor remained consistent throughout the program evaluation. Email communication with the DNP student and members of the PDH shifted to an-as-needed basis, augmented with in-person communication as appropriate.

Approval from the Institutional Review Board (IRB) was requested after this program evaluation was approved by the DNP committee. This program evaluation was determined to not meet the criteria of Research with Human Subjects or a Clinical Investigation and therefore was not subject to IRB-HSR review (Appendix D).

Program Logic and Engaging Key Stakeholders

The third step in the ACI program evaluation cycle is program logic and engaging key stakeholders (Agency for Clinical Innovation, 2013). As part of program logic, the evaluation team identified inputs, activities, outputs and outcomes (Agency for Clinical Innovation, 2013).

Inputs, activities, outputs and outcomes are terms that ACI uses to identify elements that contribute to the implementation of the program or project that is being evaluated (Agency for Clinical Innovation, 2013). Inputs are the resources used to implement a project (Agency for Clinical Innovation, 2013). In this case, the inputs for the implementation of the PDH include the CNS staff and the resources necessary to employ them as part of the healthcare team. The resources involved with hiring CNSs included, but are not limited to, staff salary, credentialing costs, access to and utilization of electronic health records (EHR) and support from the hospital administration and providers. According to ACI (2013), activities are the actions undertaken by the project to achieve the desired goals. For the PDH, some activities for the CNSs included advanced diabetes management training by endocrinologist, certification exam for advanced diabetes management, training on billing procedures, engagement with physician and pharmacist colleagues, and consultations on complex patients with diabetes. Outputs are the immediate results or products from an action (Agency for Clinical Innovation, 2013). Outputs for the PDH included: increased knowledge on diabetes management, certifications in advance diabetes management, number of patients consulted on and services billed. Finally, outcomes are the changes that occur showing movement toward the ultimate goals and objectives of the project (Agency for Clinical Innovation, 2013). The outcomes for this program evaluation were to compare the management of diabetes by the CNSs of the PDH and their physician colleagues who directly cared for this patient population prior to PDH implementation.

Evaluation Design

The fourth main step in the ACI program evaluation cycle is evaluation design (Agency for Clinical Innovation, 2013). In this step, the evaluation team defined specific questions that examine the program objectives and desired outcomes (Agency for Clinical Innovation, 2013).

Similar to the outcomes in program logic, questions for the evaluation were based on the goals and objectives of the program (Agency for Clinical Innovation, 2013). During this step, the evaluation team members determined the exact purpose of this program evaluation, the parameters of the evaluation and developed the evaluation questions.

Questions for this program evaluation focused on comparing the care provided by the PDH compared to the care provided prior to the implementation. Initial questions were developed to compare data from the year prior to the implementation of the PDH to data from a year-and-a-half post-implementation. Questions for both groups of patients included:

1. What is the patient's blood glucose on admission and discharge?
2. What is the average time from admission to the inpatient target blood glucose range?
3. What is the number of patients with basal insulin ordered compared to number of patients with only correctional insulin ordered?
4. How many patients experienced at least one episode of hypoglycemia?

The most current recommendations from the American Diabetes Association (ADA) state that insulin therapy should be initiated for the treatment of persistent hyperglycemia starting at 180 mg/dL or greater with an inpatient goal of blood sugars between 140-180 mg/dL (American Diabetes Association [ADA], 2020). For hospitalized patients, outside of the critical care units, the ADA strongly discourages the sole use of sliding scale (correctional) insulin (ADA, 2020). The ADA makes specific insulin therapy recommendations based on the route of nutrition or intake that the patient is receiving. A randomized controlled trial reveals that basal-bolus treatment improved glycemic control and reduced hospital complications compared with sliding scale (correctional) insulin regimens in general surgery patients with type 2 diabetes (ADA, 2020). Prolonged use of sliding scale insulin regimens as the sole treatment of hyperglycemic

inpatients is strongly discouraged (ADA, 2020). Based on these current recommendations, this program evaluation analyzed the effectiveness of CNSs from the PDH in the management of inpatients with diabetes.

Data Plan

The fifth step of the ACI program evaluation cycle is data plan (Agency for Clinical Innovation, 2013). During this step, the evaluation team obtained the information needed to determine the outcomes of the PDH compared to outcomes prior to when the program was implemented (Agency for Clinical Innovation, 2013). In order to enable this comparison, the evaluation team required baseline data from prior to the PDH implementation and data from two-and-a-half-years post implementation. Data points were hand-collected from the EHR by the DNP student. The student conducted a chart audit of patients with any diagnosis of diabetes (but not other forms of hyperglycemia) during the designated timeframes. These data points were stored in an Excel spreadsheet on a secure server platform. Patients were coded with the last four digits of their phone number. Building upon the evaluation questions and overall objectives and goals of this program evaluation, the student extracted the following data points from the EHR: length of stay, blood glucose levels at admission and discharge, time to target blood glucose levels, number of patients with basal insulin therapy, number of patients with sole correctional insulin and patients with at least one episode of hypoglycemia.

With the purpose of describing demographics and allowing for comparison between the two patient groups, the DNP student also extracted age and gender information for each patient. Type of diabetes (type one, type two, gestational, steroid-induced, etc.) was not collected as the information obtained in the patient's history and physical and past medical history is not always correct or complete. To avoid inclusion of misinformation, solely a diagnosis of "diabetes" was

recorded. After consulting with a statistician, it was determined that an *n* of eighty (80) patients was the minimum number of patients for the pre- and post-implementation groups for a total *N* of 160 patients. The DNP student obtained initial and discharge blood glucose levels for all patients in both the pre- and post- groups from the EHR and then calculated group means. The DNP student also recorded amount of time from first documented blood glucose value to blood glucose level within the ADA's recommended target value of 140-180 mg/dL, unless another target glucose level was identified in the patient's EHR. Group means for these data points were calculated for both groups. The DNP student captured the number of patients with basal/bolus insulin and the number of patients with solely correctional insulin ordered in each group of patients. Finally, the DNP student also recorded patients who had any documented hypoglycemic events. In accordance with ADA's current guidelines, any laboratory finding with a blood glucose of less than 70 signified a hypoglycemic event (ADA, 2020). Total number of hypoglycemic events was not recorded as patients had different blood glucose check protocols and one hypoglycemic episode could actually result in multiple reported low blood glucose levels, thus skewing the data.

Implementation

The sixth step in the ACI program evaluation cycle is implementation (Agency for Clinical Innovation, 2013). In this step the evaluation team collected data, analyzed the data and interpreted the results (Agency for Clinical Innovation, 2013). The implementation of this program evaluation consisted of gathering baseline data on inpatient diabetes management prior to the initiation of the PDH. Baseline data were collected on 81 patients admitted to the hospital over a three-month period preceding the implementation of the PDH. Post-implementation data

were collected on 81 patients seen by the CNSs of the PDH over the same three-month time period two-and-a-half years post-implementation.

After all the necessary data were collected from the EHR, the DNP student converted the raw data into the appropriate format for statistical analysis and imported all data points from the Excel document into SPSS Statistics software. In collaboration with the statistician the data were analyzed using Independent-samples Mann-Whitney U and Chi-Square statistical testing.

Communicating Results

According to ACI the seventh step in the program evaluation cycle is communicating results (Agency for Clinical Innovation, 2013). This step was accomplished in multiple different approaches. Initially the results were analyzed for statistical and clinical significance. After thorough analysis of findings, the results were shared with all members of the PDH, including the clinical lead, administrators and outpatient providers. The results of this evaluation were communicated by the DNP student at her doctoral defense and uploaded into the Libra database. Finally, the manuscript will be submitted to an Advance practice or diabetes-related nursing journal for publishing.

Results

A total *N* of 162 patients were included in the statistical analysis (*n* of 81 patients in each group). Complete data sets were collected on every patient. The first step was analyzing the demographics of the entire patient group as a whole. The demographic characteristics that were collected included age and gender for each patient. The median age in the entire patient population was 67 years old with a minimum age of 18 and maximum age of 97. Additionally, demographics were compared between Time 1 (pre-implementation) and Time 2 (post-implementation). The median age for Time 1 was 71 years with a minimum age of 27 and

maximum age of 97. The median age for Time 2 was 61 with a minimum age of 18 and maximum age of 92. After running an independent-samples Mann-Whitney U test, the resulting significant p-value (<.001) indicated that the distribution of age between the two groups differed. A comparison of the median ages between Time 1 (71) and Time 2 (61) showed that the ages in Time 1 were higher than the ages in Time 2 (see Table 1/Appendix E).

Genders were also analyzed for the total patient set as well as each group. In the total group there were 75 male patients and 87 female patients. There were 35 males and 46 females in Time 1, compared to Time 2 when there were 40 males and 41 females. A Chi-square analysis of genders in Time 1 and Time 2 resulted with a p-value of 0.529. This finding retains the null hypothesis, showing that there is no statistical difference in the gender distributions in the pre- and post- implementation groups.

The next data points analyzed included admitting blood glucose levels, time to target blood glucose, length of stay and discharge blood glucose levels. For each variable the data were analyzed using the independent-samples Mann-Whitney U Test. Additionally group mean, median, standard deviation and mean rank were also calculated (see Table 2/Appendix F). The admitting blood glucose Mann-Whitney U test resulted with a significant p value (< 0.001) rejecting the null hypothesis that the distribution would be the same. On further examination the mean rank of the admitting blood glucose in Time 1 was 64.04 while the mean rank in Time 2 was 98.96, showing that the admitting blood glucose levels were higher during Time 2 than in Time 1.

Time from identification of an abnormal blood glucose level to the ADA's recommended target blood glucose range of 140-180 was collected from the EHR and inputted into SPSS in a format consisting of hours as the whole number and minutes as decimals (HH.MM). Patients

whose blood glucose levels were within the recommended range at the time of admission were given a time value of "0". Patients who did not have a laboratory value or point of care (POC) testing value recorded in the recommended range during the length of their admission were given the label of "did not achieve (DNA)" and excluded from the group statistical calculations. Eleven patients in Time 1 and three patients from Time 2 did not have a blood glucose level within the recommended range. The p-value from the Mann-Whitney U test was .296 indicating that the null hypothesis should be retained. The distribution of times to target blood glucose levels were statistically the same in Time 1 and Time 2.

Length of stay was collected from the EHR and recorded for all patients in terms of days. Any time less than 24 hours was recorded as one day. Of note, to be included in the data set all patients had to be admitted to the hospital and not held in an observation status. The p-value for the Mann-Whitney U test was .013 demonstrating that the null hypothesis should be rejected. Upon further assessment the mean rank for length of stay during Time 1 was 72.35 days while the mean rank for Time 2 was longer at 90.65 days.

The last blood glucose level recorded in the EHR was collected for each patient and labelled as "Discharge Blood Glucose". The p-value calculated for the Mann-Whitney U test was .984. This value indicates that the null hypothesis should be retained and that distributions of discharge blood glucose values were not statistically different among the time groups. All other calculated statistical values can be seen in Table 2.

Based on the clinically significant difference among admission blood glucose and clinically insignificant differences in discharge blood glucose levels, a new variable was calculated during the statistical analysis to determine the overall difference between admitting blood glucose levels and discharge blood glucose levels for both time periods as well as the

group as a whole. This variable was then tested using the Mann-Whitney U test with the null hypothesis that the distribution of the differences would be the same in Time 1 and Time 2. A statistically significant (p=<.001) finding indicated that the null hypothesis should be rejected, meaning that the distributions of differences were not statistically the same between the two groups. Additional information for this variable can be seen in Table 3 (Appendix G)

Categorical data were statistically analyzed using the Chi-Square test. In this program evaluation the categorical data included use of basal/bolus insulin, sole use of correctional (sliding scale) insulin and patients who experienced documented episodes of hypoglycemia (less than 70). All patient charts were thoroughly examined to identify the type of insulin ordered during the length of the patient's hospital admissions. In SPSS, the data points were coded to allow for statistical testing. Patients who had basal/bolus insulin ordered were given the value of "1", patients who did not have basal insulin ordered were given the value of "2". In similar fashion, patients who only had correctional insulin (sliding scale) ordered were given a value of "1" while any other form of insulin or anti-hyperglycemic agents were given the values "0" or "2". Finally, patients who had a recorded blood glucose of less than 70 were given a value of "1" while patients who did not have any hypoglycemic episodes in their EHR were given a value of "2".

As shown in Table 4 (Appendix H) basal/bolus insulin was ordered for 32 patients in Time 1 and 70 patients during Time 2. The Chi-Square p-value was <.001 indicating that there was a statistical difference in the use of basal/bolus insulin between the pre- and post-implementation groups. Thirty-five patients in Time 1 had solely correctional insulin ordered compared to nine patients in Time 2. A Chi-Square test produced a p-value of <.001 indicating a statistical difference in the use of solely correctional insulin between the two time periods.

Finally, 23 patients in Time 1 had episodes of hypoglycemia compared to 26 patients in Time 2. The calculated p-value for the Chi-Square test was .732 indicating no statistical significance between the two time periods.

Discussion

These results raise several discussion points. The first point that must be addressed was presented in the demographic section of the patient groups. The age of patients in the Time 1 group was statistically higher than the patients included in the Time 2 group. Ideally the two groups would be comprised of patients with similar ages and genders. No data were collected on comorbidities, years with a diabetes diagnosis, routine screening appointments with primary care providers or endocrinologist, most recent hemoglobin A1C or even admitting diagnosis. All of these data points could help to paint a more accurate picture of the patients included in the two groups, but obtaining full and accurate data on these factors was not feasible for this program evaluation. Future evaluations should strive to ensure that the makeup of the patient groups would be similar in demographic characteristics. The results of this program evaluation are still meaningful, but readers must keep in mind that there was a statistically significant difference in the ages of the two groups.

Another point that must be addressed is the statistically significant difference in admitting blood glucose levels. In this data, the admitting blood glucose levels were higher in the Time 2 group compared to the Time 1 group. Although providers cannot influence the blood glucose levels of patients when they present to the hospital for evaluation and possible admission, this difference is still worth noting. This difference could also indicate a difference in acuity of disease or state of unwellness that the patients were in when they were admitted to the hospital, but without additional data that cannot be confirmed.

While there was no statistically significant difference in the two groups for the time to target blood glucose, yet this still presents an interesting discussion point. As noted above, the admitting blood glucose levels in Time 2 were significantly higher, yet there is no difference in the time it took to get patients to the target blood glucose range. This is a clinically significant accomplishment. Despite a higher initial blood glucose reading, PDH providers were still able to effectively transition patients into the target blood glucose range in the same amount of time as the patients in Time 1. This finding correlates to the findings of Klinkner and Murray (2014) and Virani et al. (2016) who found that APPs, including CNSs, were able to optimize glycemic control and achieve target blood glucose ranges for patients with diabetes.

Interestingly, while this was not specifically one of the evaluation questions, the data showed that there were patients in both groups who did not have a blood glucose measurement within the target range through the duration of their admission. Upon further evaluation there were 11 patients in Time 1 and three patients in Time 2 who did not achieve the recommended inpatient goal prior to discharge. These data were then tested using the Chi-Square test. The number of patients in each group that did not reach target blood glucoses were found to be statistically (p-value 0.05 continuity correction) significantly different. This is also clinically significant because fewer patients in the group cared for by the PDH CNSs did not achieve the target goal. While the target blood glucose range for this program evaluation was within a tight window, it does reflect the current recommendation from the ADA.

While statistically there was no significant difference in the discharge blood glucose levels between the two groups, it is important to reiterate that there was a difference between the two groups in the admitting blood glucose levels. Admitting blood glucose levels were significantly higher in Time 2, which led to further investigation on the differences in admitting

and discharge blood glucose levels. Analysis showed that patients in Time 2 had greater differences in their blood glucose levels compared to patients in Time 1. In fact, the 18 patients who achieved the greatest blood glucose reduction (including one with an admitting blood glucose of 1,096 and discharge blood glucose level of 121) were in Time 2.

The overall length of stay was statistically different between the two patient groups with patients in Time 2 having a longer length of stay. This is a valuable data point; however, many different aspects contribute to this variable. Similar to the length of stay findings of Knee et al. (2020), without knowing additional information including admitting diagnoses, comorbidities and overall patient acuities it is nearly impossible to pinpoint what influenced the increase in length of stay during Time 2. Of note, Time 2 occurred during the COVID-19 pandemic, a factor that affected many aspects of healthcare and could have an influence on length of stay for patients during this program evaluation.

In line with the most current ADA (2020) recommendations which state that the preferred treatment for patients with either poor oral intake or good nutritional intake is an insulin regimen that includes basal insulin, the utilization of basal/bolus insulin was recorded for patients in both time groups. Patients in Time 2 had a statistically (<.001) and clinically significant differences in the utilization of basal insulin. Seventy patients in Time 2 compared to 32 patients in Time 1 had basal insulin ordered during their hospital stay. Additionally, the ADA (2020) strongly discourages against the use of only correctional (sliding scale) insulin in the inpatient hospital setting. This data point was also collected on patients from both time groups. There was a statistically significant (<.001) difference in the utilization between the two groups. Thirty-four patients in Time 1 had the sole use of correctional insulin compared to just nine patients in Time

2. These findings demonstrate that the CNSs in the PDH are utilizing and adhering to the most current ADA guidelines in their clinical practice.

The last data points collected from patients' EHR were the number of patients who experienced at least one episode of hypoglycemia. There was no statistical (p-value .732) difference in the two groups for episodes of hypoglycemia. This is especially interesting when examined in terms of the increased use of basal insulin. While the CNSs of the PDH were recommending an increase use in basal insulin, there was not an increase in episodes of hypoglycemia. Similar to the findings of Oba et al. (2020), this shows that the insulin dosage recommendations were appropriate in reducing blood glucose levels to target range, but did not increase the incidence of episodes of dangerous hypoglycemia.

One final note for discussion is the acknowledgement that the PDH is a consult-based model. The CNSs make their evidence-based recommendations to the healthcare team, but the care team may choose to implement all, some or none of their recommendations. Upon further discussion with members of the CNSs team, it is not uncommon for providers to initiate insulin regimens at doses lower than what is initially recommended by the CNSs, this can account for an increase in time to target and increase in length of stay. Furthermore, it was outside of the scope of this program evaluation to analyze when the PDH was actually consulted. For some patients, the CNSs of the PDH are consulted by a provider when the patient is still in the Emergency Room awaiting their bed placement for the admission; other times the patient has already been admitted and undergoing medical management for several days or even weeks prior to consultation. All of the patients in Time 2 were consulted on by the CNSs of the PDH, but the full extent of their recommendations and adherence to those recommendations is still difficult to quantify.

Incorporating Findings

The final step in the ACI program evaluation cycle is to incorporate the findings (Agency for Clinical Innovation, 2013). The evaluation results will be used to support and contribute to the evidence-based decision making and ultimately influence the future aspects of the PDH program through redesign, expansion or discontinuation (Agency for Clinical Innovation, 2013). The results of this program evaluation will assist in shaping the future of the PDH and how the CNSs tailor their services to meet the needs of the hospital organization and patients with diabetes.

The results of this program evaluation will be instrumental in the ongoing work of the PDH and the role of CNSs in a variety of healthcare settings. These findings confirm that the CNSs are making recommendations in line with the current clinical guidelines, providing clinically effective medical interventions, appropriately adjusting complex medications and delivering high-quality medical care. As this program moves forward the results of this program evaluation will serve as a baseline to build from and measure future successes against. This program evaluation shows the value in maintaining the PDH. The CNSs in this program are force multipliers who are able to fulfill aspects of the endocrinologist role in managing complex patients with diabetes and achieve similar clinical outcomes, while simultaneously pulling in aspects of the certified diabetes educator role with no increase in adverse outcomes. The PDH will, no doubt, be transformed as CNSs move forward in their practice with the introduction of prescriptive authority and additional evaluations and analyses of the program will need to be conducted at that time. The results of this program evaluation can also provide meaningful insight to healthcare organizations who want to adopt similar programs in specialty areas within

their organizations. This evaluation supports and expands upon the current available knowledge base regarding the role and practice of CNSs in today's complex healthcare settings.

Conclusion

With 34.1 million adults in the US carrying a diagnosis of diabetes, CNSs are well-prepared and poised to contribute to the management of this population safely and effectively. They collaboratively work with physician colleagues to overcome clinical inertia, ensure proper medication regimens are ordered and administrated appropriately all while adhering to the most recent and applicable clinical guidelines. Expertly trained CNSs are impacting the status quo within hospital organizations by expanding their role and sphere of impact to positively affect patient outcomes.

Importance of this Project

The PDH is a unique program that utilizes CNSs in a consultant-based role to manage complex medical patients with diabetes. This program evaluation highlights the impact that the PDH has had on the hospital organization in less than two years. While this data is meaningful on its own, it also paves the way for future evaluative endeavors especially as CNSs move their practice forward to include prescriptive authority. This CNS model can be used in other specialty practices and areas within a hospital organization to deliver high-quality direct patient care to all patients no matter the diagnosis.

References

Agency for Clinical Innovation. (2013). *Understanding program evaluation: An ACI framework* (Version 1.0) [Framework]. https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0008/192437/Framework-Program-Evaluation.pdf

Agency for Clinical Innovation. (2021). *What we do*. NSW Government Agency for Clinical Innovation. Retrieved June 22, 2021, from https://aci.health.nsw.gov.au/about/about-us

American Diabetes Association. (2020). 15. Diabetes care in the hospital: Standards of medical care in diabetes-2020. *Diabetes Care*, *43*(Supplement 1), S193–S202. https://doi.org/10.2337/dc20-S015

Apsey, H. A., Coan, K. E., Castro, J. C., Jameson, K. A., Schlinkert, R. T., & Cook, C. B. (2014). Overcoming clinical inertia in the management of postoperative patients with diabetes. *Endocrine Practice*, *20*(4), 320–328. https://doi.org/10.4158/EP13366.OR

Arts, E., Landewe-Cleuren, S., Schaper, N., & Vrijhoef, H. (2012). The cost-effectiveness of substituting physicians with diabetes nurse specialists: A randomized control study with two-year follow-up. *Journal of Advanced Nursing*, *68*(6), 1224–1234. https://doi.org/10.1111/j.1365-2648.2011.05797.x

Centers for Disease Control and Prevention. (2020). *National Diabetes Statistics Report* [Report]. US Department of Health and Human Services. https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf

Conlon, P. (2010). Diabetes outcomes in primary care: evaluation of diabetes nurse practitioner compared to the physician. *Primary Health Care*, *20*(5), 26–31. https://doi.org/10.7748/phc2010.06.20.5.26.c7809

Cook, C. B., Castro, J. C., Schmidt, R. E., Gauthier, S. M., Whitaker, M. D., Roust, L. R., Argueta, R., Hull, B. P., & Zimmerman, R. S. (2007). Diabetes care in hospitalized noncritically ill patients: More evidence for clinical inertia and negative therapeutic momentum. *Journal of Hospital Medicine*, *2*(4), 203–211. https://doi.org/10.1002/jhm.188

Crowe, M., Jones, V., Stone, M.-A., & Coe, G. (2019). The clinical effectiveness of nursing models of diabetes care: A synthesis of evidence. *Journal of Nursing Studies*, *93*, 119–128. https://doi.org/10.1016/j.ijnurstu.2019.03.004

Dhatariya, K., Corsino, L., & Umpierrez, G. (2020). *Management of diabetes and hyperglycemia in hospitalized patients*. Endotext. https://www.ncbi.nlm.nih.gov/books/NBK279093/

Diabetes overview. (n.d.). American Diabetes Association. Retrieved February 14, 2021, from https://www.diabetes.org/diabetes/complications

Garg, R., Metzger, C., Rein, R., Lortie, M., Underwood, P., Hurwitz, S., Bader, A., Carbone, K., & Schuman, B. (2016). Nurse practitioner-mediated intervention for preoperative control of diabetes in elective surgery patients. *Journal of the American Association of Nurse Practitioners*, *28*(10), 528–533. https://doi.org/10.1002/2327-6924.12356

Karam, S., Dendy, J., Polu, S., & Blonde, L. (2020). Overview of therapeutic inertia in diabetes; Prevalence, causes and consequences. *Diabetes Spectrum*, *33*(1), 8–15. https://doi.org/10/2337/ds19-0029

Kim, S., & Boye, K. S. (2009). Excessive hospitalizations and its associated economic burden among people with diabetes in the United States. *Value Health*, *12*(2), 267–272. https://doi.org/10.111/j.1542-4733.2008.00443.x.

Klinkner, G., & Murray, M. (2014). Clinical nurse specialist led teams to impact glycemic control after cardiac surgery. *Clinical Nurse Specialist*, *28*(4), 240–246. https://doi.org/10.1097/NUR.0000000000000056

Knee, M., Hussain, Z., Alkharaiji, M., Sugunendran, S., & Idris, I. (2020). Diabetes specialist nurse point-of-car review service: Improving clinical outcomes for people with diabetes on emergency wards. *Practical Diabetes*, *37*(2), 50–54. https://doi.org/10.1002/pdi.2263

Mabrey, M. E., & Setji, T. L. (2015). Patients' self-management of diabetes care in the inpatient setting: Pro. *Journal of Diabetes Science and Technology*, *9*(5), 1152–1154. https://doi.org/10.1177%2F1932296815590827

Oba, N., Barry, C. D., Gordon, S. C., & Chutipanyaporn, N. (2020). Development of a nurse-led multidisciplinary based program to improve glycemic control for people with uncontrolled diabetes mellitus in a community hospital, Thailand. *Pacific Rim International Journal of Nursing Research*, *24*(3), 349–362. http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=c8h&AN=144611053&site=ehost-live

Pantalone, K. M., Misra-Herbert, A. D., Hobbs, T. M., Ji, X., Kong, S. X., Milinovich, A., Weng, W., Bauman, J., Ganguly, R., Berguera, B., Kattan, M. W., & Zimmerman, R. S. (2018). Clinical inertia in type 2 diabetes management: Evidence from a large, real-world data set. *Diabetes Care*, *41*(7), e113–e114. https://doi.org/10.2337/dc18-0116

Powell, E. L., Engberg, S., & Siminerio, L. (2018). Nurse practitioner implementation of a glycemic management protocol. *Journal for Nurse Practitioners*, *14*(4), 81–84. https://doi.org/10.1016/j.nurpra.2017.12.023

Program for Diabetes Health. (2020). *Mission Statement* [Statement].

Riordan, F., Lynch, C., Kearney, P., Twamley, H., Ledwith, A., Lowe, J., O'Riordan, A., Walsh, M., Fitzgerald, A., & O'Mahony, C. (2017). *Clinical nurse specialists' diabetes integrated care (CNSp); A national survey of patient experience* (National Diabetes Integrated Care Nurse Network Group) [Report]. https://www.hse.ie/eng/about/who/cspd/ncps/diabetes/resources/clinical-nurse-specialists-diabetes-integrated-care-cnsp-.pdf

St. Mary's hospital. (n.d.). Bon Secours. Retrieved February 13, 2021, from https://www.bonsecours.com/locations/hospitals-medical-centers/richmond/st-marys-hospital

Virani, S., Akeroyd, J., Ramsey, D., Chan, W., Frazier, L., Nasir, K., Rajan, S., Ballantyne, C., & Petersen, L. (2016). Comparative effectiveness of outpatient cardiovascular disease and diabetes care delivery between advanced practice providers and physician providers in primary care: Implications for care under the Affordable Care Act. *American Heart Journal*, *181*(0), 74–82. https://doi.org/10.1016/j.ahj.2016/07.020

Virginia Department of Health. (2018). *Diabetes burden in Virginia* (2017-2018) [Report]. Virginia Department of Health. https://www.vdh.virginia.gov/content/uploads/sites/25/2016/05/Diabetes-in-Virginia-2017_final_7_17.pdf

Wexler, D. J., Meigs, J. B., Cagliero, E., Nathan, D. M., & Grant, R. W. (2007). Prevalence of hyper- and hypoglycemia among inpatients with diabetes. *Diabetes Care*, *30*(2), 367–369. https://doi.org/10.2337/dc06-1715

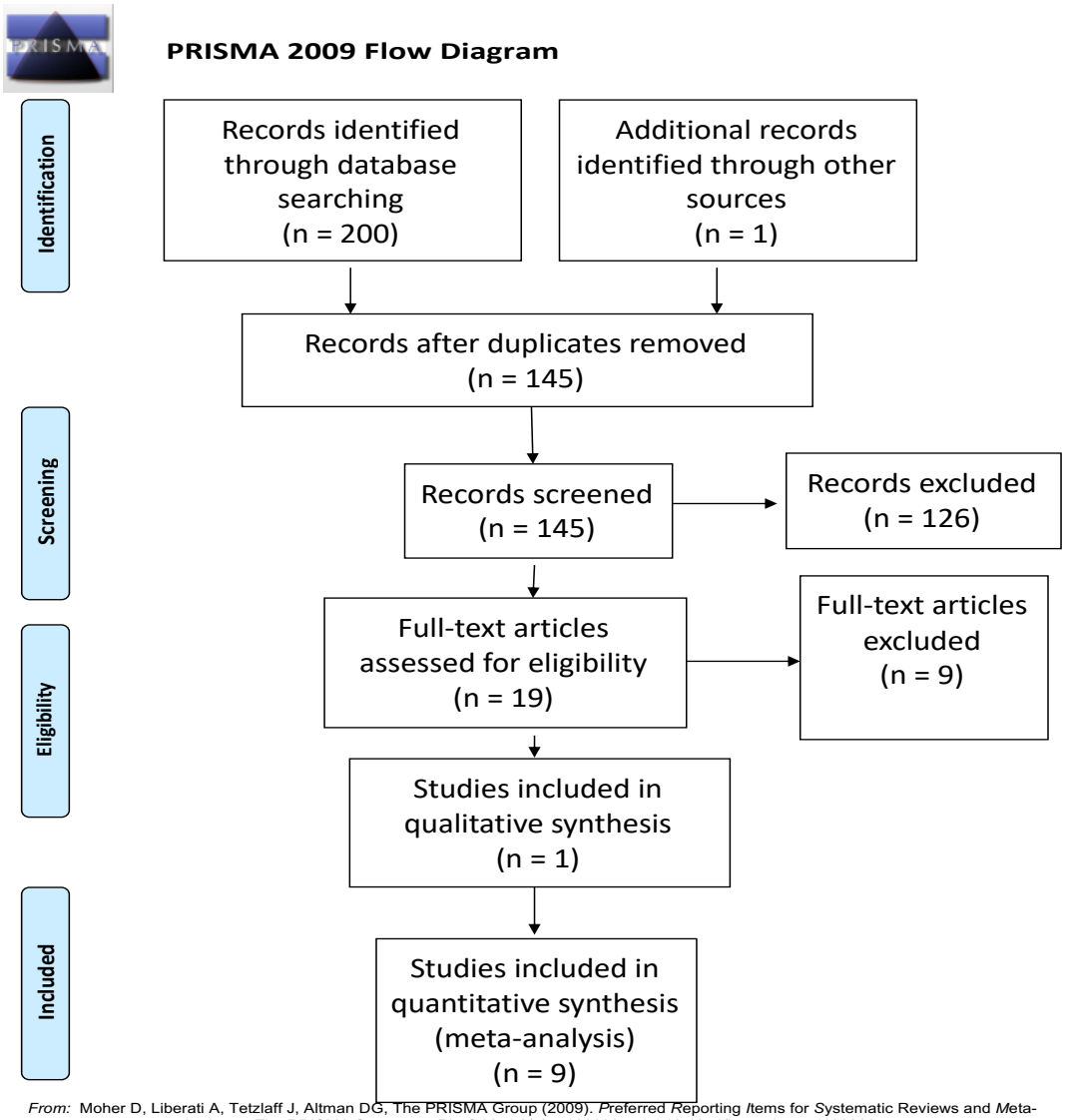
Willens, D., Cripps, R., Wilson, A., Wolff, K., & Rothman, R. (2011). Interdisciplinary team care for diabetic patients by primary care physicians, advanced practice nurses, and

clinical pharmacists. *Clinical Diabetes*, *29*(2), 60–68.

https://doi.org/10.2337/diaclin.29.2.60

Appendix A

PRISMA Flowsheet



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

Appendix B

Johns Hopkins Nursing Evidence-Based Practice Evidence Level and Quality Guide

Evidence Levels	Quality Ratings
Level I Experimental study, randomized controlled trial (RCT) Explanatory mixed method design that includes only a level I quaNtitative study Systematic review of RCTs, with or without meta-analysis	**QuaNtitative Studies** **A High quality**: Consistent, generalizable results; sufficient sample size for the study design; adequate control; definitive conclusions; consistent recommendations based on comprehensive literature review that includes thorough reference to scientific evidence. **B Good quality**: Reasonably consistent results; sufficient sample size for the study design; some control, fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence. **C Low quality or major flaws**: Little evidence with inconsistent results; insufficient sample size for the study design; conclusions cannot be drawn.
Level II Quasi-experimental study Explanatory mixed method design that includes only a level II quaNtitative study Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis	**QuaLitative Studies** No commonly agreed-on principles exist for judging the quality of quaLitative studies. It is a subjective process based on the extent to which study data contributes to synthesis and how much information is known about the researchers' efforts to meet the appraisal criteria. *For meta-synthesis, there is preliminary agreement that quality assessments of individual studies should be made before synthesis to screen out poor-quality studies[1].* **A/B High/Good quality** is used for single studies and meta-syntheses[2]. The report discusses efforts to enhance or evaluate the quality of the data and the overall inquiry in sufficient detail; and it describes the specific techniques used to enhance the quality of the inquiry. Evidence of some or all of the following is found in the report: • Transparency: Describes how information was documented to justify decisions, how data were reviewed by others, and how themes and categories were formulated. • Diligence: Reads and rereads data to check interpretations; seeks opportunity to find multiple sources to corroborate evidence. • Verification: The process of checking, confirming, and ensuring methodologic coherence. • Self-reflection and scrutiny: Being continuously aware of how a researcher's experiences, background, or prejudices might shape and bias analysis and interpretations. • Participant-driven inquiry: Participants shape the scope and breadth of questions; analysis and interpretation give voice to those who participated. • Insightful interpretation: Data and knowledge are linked in meaningful ways to relevant literature. **C Low quality** studies contribute little to the overall review of findings and have few, if any, of the features listed for high/good quality.
Level III Nonexperimental study Systematic review of a combination of RCTs, quasi-experimental and nonexperimental studies, or nonexperimental studies only, with or without meta-analysis Exploratory, convergent, or multiphasic mixed methods studies Explanatory mixed method design that includes only a level III quaNtitative study QuaLitative study Meta-synthesis	

Evidence Levels	Quality Ratings
Level IV Opinion of respected authorities and/or nationally recognized expert committees or consensus panels based on scientific evidence Includes: • Clinical practice guidelines • Consensus panels/position statements	**A High quality:** Material officially sponsored by a professional, public, or private organization or a government agency; documentation of a systematic literature search strategy; consistent results with sufficient numbers of well-designed studies; criteria-based evaluation of overall scientific strength and quality of included studies and definitive conclusions; national expertise clearly evident; developed or revised within the past five years **B Good quality:** Material officially sponsored by a professional, public, or private organization or a government agency; reasonably thorough and appropriate systematic literature search strategy; reasonably consistent results, sufficient numbers of well-designed studies; evaluation of strengths and limitations of included studies with fairly definitive conclusions; national expertise clearly evident; developed or revised within the past five years **C Low quality or major flaws:** Material not sponsored by an official organization or agency; undefined, poorly defined, or limited literature search strategy; no evaluation of strengths and limitations of included studies, insufficient evidence with inconsistent results, conclusions cannot be drawn; not revised within the past five years
Level V Based on experiential and nonresearch evidence Includes: • Integrative reviews • Literature reviews • Quality improvement, program, or financial evaluation • Case reports • Opinion of nationally recognized expert(s) based on experiential evidence	**Organizational Experience (quality improvement, program or financial evaluation)** **A High quality**: Clear aims and objectives; consistent results across multiple settings; formal quality improvement, financial, or program evaluation methods used; definitive conclusions; consistent recommendations with thorough reference to scientific evidence **B Good quality**: Clear aims and objectives; consistent results in a single setting; formal quality improvement, financial, or program evaluation methods used; reasonably consistent recommendations with some reference to scientific evidence **C Low quality or major flaws**: Unclear or missing aims and objectives; inconsistent results; poorly defined quality improvement, financial, or program evaluation methods; recommendations cannot be made **Integrative Review, Literature Review, Expert Opinion, Case Report, Community Standard, Clinician Experience, Consumer Preference** **A High quality**: Expertise is clearly evident; draws definitive conclusions; provides scientific rationale; thought leader(s) in the field **B Good quality**: Expertise appears to be credible; draws fairly definitive conclusions; provides logical argument for opinions **C Low quality or major flaws**: Expertise is not discernable or is dubious; conclusions cannot be drawn

1 https://www.york.ac.uk/crd/SysRev/ISSLI/WebHelp/6_4_ASSESSMENT_OF_QUALITATIVE_RESEARCH.htm
2 Adapted from Polit & Beck (2017).

Reprinted with permission: Dang, D., & Dearholt, S. (2017). *Johns Hopkins nursing evidence-based practice: model and guidelines.* 3rd ed. Indianapolis, IN: Sigma Theta Tau International

Appendix C

Review of Literature

Author, year	Design	Study aim	Study outcome	Level of Evidence and Quality Grade
Arts et al. (2012)	Randomized, non-blinded clinical trial	Assess the economic value of diabetes nurse specialists as substitutes for physicians in particular areas of diabetes care and the effect of such a centralized role for nurse specialists on the quality of life of patients	No statistical differences in control and intervention group. This study suggests that nurse specialists give care comparable to care provided by physicians in terms of care and disease control	Level I B
Crowe et al. (2019)	Systematic review	To determine the clinical effectiveness of primary care nurse-led interventions for diabetes	There is developing evidence from well-designed trials that nurse-led models may be more clinically effective than usual care in improving hemoglobin A1C and other biological outcomes	Level III A/B
Garg et al. (2016)	Quality Improvement	To evaluate the effect of nurse practitioner mediated interventions on diabetes control before elective surgery	Nurse practitioner mediated interventions increased access to care and resulted in lower blood glucose levels and may be a good strategy for preoperative diabetes control	Level V A
Klinkner & Murray. (2014)	Quality Improvement	Evaluate the effectiveness of clinical nurse specialist led teams on improving blood glucose control after cardiac surgery	Results reflected a desired increase in mean glucose with a decrease in overall hypoglycemia when compared to historical control period. Glucose results were also in target range more often. The expertise of CNSs enable them to optimize	Level V A

Author, year	Design	Study aim	Study outcome	Level of Evidence and Quality Grade
			diabetes care for cardiac surgery patients	
Knee et al. (2020)	Quasi-experimental	Investigate the effects of introducing a point-of-care ward-based glucose and ketones assessment to trigger a diabetes inpatient specialist nurse proactive review to the ward on length of stay, 30-day readmission rate and 30-day mortality rate	There was a significant reduction in 30-day readmission rates following intervention implementation. There was no significant change in 30-day mortality rate and overall length of stay	Level II A
Oba et al. (2020)	Quasi-experimental	To understand the causes of uncontrolled plasma glucose among individuals with diabetes and develop a program for improving glycemic control among people with uncontrolled diabetes using a multidisciplinary approach	After implementation of nurse-led multidisciplinary based program for people with uncontrolled diabetes, there was significantly lower hemoglobin A1C levels among patient with diabetes. Nurse-led multidisciplinary teams are an effective approach to managing glycemic control for patients with diabetes	Level II A
Conlon. (2010)	Quality improvement	To view practice behaviors of the diabetes nurse practitioner and compare them with physician colleagues	Nurse practitioner cohort had an overall reduction in hemoglobin A1C of 2.5 percentage points, while physician cohort had an overall increase of 1.5 percentage points. Diabetes nurse practitioners had a significant role and effect on blood glucose levels and diabetes management.	Level V B

Author, year	Design	Study aim	Study outcome	Level of Evidence and Quality Grade
Powell et al. (2018	Quality improvement	To determine if nurse practitioner utilization of a glycemic protocol for medication intensification in patients with type 2 diabetes would result in a reduction of fasting blood glucose concentrations and hemoglobin A1C levels	There was a statistically significant reduction in fasting blood glucose levels and hemoglobin A1C levels from baseline to post-intervention. Patients with type 2 diabetes who are closely followed by an advance practice provider who utilizes glycemic management protocol can experience significant improvement in fasting blood glucose and hemoglobin A1C	Level V B
Virani et al. (2016)	Non-experimental cohort study	To compare quality of diabetes and cardiovascular disease care between advanced practice providers and physicians	Patient with diabetes receiving care from advanced practice providers were more likely to have better or comparable glycemic control compared with physician providers	Level II A
Lowe et al. (2018)	Qualitative study	To measure the overall patient experience as part of an evaluation of nurse specialist-led diabetes integrated care service	Most participants rated their diabetes care with the CNS as very good (91%) or good (8%). Quality of communication, manner and disposition of the CNS, CNS support of self-management and CNS practicality were positive themes identified	Level III A/B

Appendix D

FOR IRB-HSR OFFICE USE ONLY

UVA IRB-HSR Study Tracking # 23331

☒ **Project is determined to NOT meet the criteria of Research with Human Subjects or a Clinical Investigation and therefore is not subject to IRB-HSR Review.**

All project team personnel are required to follow all requirements described in this form and follow:

- *Procurement requirements if participants will be compensated for their time*
- *UVA Information Security policies to protect the data: See Appendix B: Privacy Plan.*
-

Pick One

☐ No health information/specimens are to be collected or used for this project

☒ Health information/specimens to be collected or used for this project meet the criteria of Deidentified under HIPAA (No identifiers as noted in Appendix A may be collected/ used.) If data/specimens are from dbGaP, keep Appendix C on file with your project documents and contact School of Medicine Office of Grants and Contracts to obtain an Agreement and a dbGaP Data Request Form/Institutional Certification.

☐ Health information collected meets the criteria of identifiable. Follow the Privacy Plan Appendix B.

☐ Health Information meets the criteria of Limited Dataset. HIPAA Data Use Agreement is required to share data outside of UVA. Complete Appendix E.

☐ Data/Specimens used in this project are coded: Complete Appendix D.

☒ Your project was determined to be non human subject research. If you decide to publish results of this project you must describe the project in the publication as non-human subject research and NOT as human subject research.

IF SENDING OR RECEIVING DATA/SPECIMENS

☒ Provide this signed form to School of Medicine Office of Grants and Contracts and/or Medical Center Procurement if your project has external funding or plans to share data/specimens outside of UVA.

Contact the IRB if anything concerning this project changes that might affect the non-human subject determination.

☐ **Project is determined to be Human Subjects Research or a Clinical Investigation** and must be submitted to the IRB-HSR for review and approval prior to implementation. Please go the Protocol Builder to create your submission.

Name of IRB Staff: **Kristin Shelby**	***Date:*** **07-27-21**

Appendix E

Table 1

Group Age and Gender Demographics

	Group Total	Time 1	Time 2
N	162	81	81
Median Age	67	71	61
Minimum Age	18	27	18
Maximum Age	97	97	92
Mean Rank		95.08	67.92
Male	75	35	40
Female	87	46	41

Note. Independent-samples Mann Whitney U test for age exact p=0.0002227. Chi-square for gender p=0.529.

Appendix F

Table 2

Distribution of Admitting Blood Glucose, Time to Target Blood Glucose, Length of Stay and Discharge Blood Glucose

	Time 1	Time 2	Mann-Whitney U
Admitting BG:			<0.0001*
Mean	186.94	333.23	
Std. Deviation	104.68	234.60	
Median	162.00	250.00	
Mean Rank	64.04	98.96	
Time to Target[a]			.296
Mean	24.43	21.56	
Std. Deviation	28.04	25.44	
Median	17.04	10.90	
Mean Rank	78.37	71.03	
Length of Stay			.013*
Mean	6.06	9.96	
Std. Deviation	4.41	9.99	
Median	5.00	6.00	
Mean Rank	72.35	90.65	
Discharge BG			.984
Mean	171.38	166.51	
Std. Deviation	69.06	61.32	

Median	158.00	162.00
Mean Rank	81.57	81.43

Note. Independent-sample Mann Whitney U test actual p-value for admitting blood glucose p=0.000002.
[a] = Time 1 *n*=70 Time 2 *n*= 78

Appendix G

Table 3

Differences between Admitting Blood Glucose and Discharge Blood Glucose

	Group Total	Time 1	Time 2
Mean	-91.14	-15.56	-166.73
Std. Deviation	202.79	89.05	251.52
Median	-27.00	-9.00	-76.00
Minimum	-975.00	-308.00	-975.00
Maximum	174.00	174.00	162.00

Note. Independent-samples Mann Whitney U test for differences between admitting blood glucose and discharge blood glucose actual p=0.000115

Appendix H

Table 4

Use of Basal Insulin, Sole Correction Insulin and Episodes of Hypoglycemia

	Time 1	Time 2	Chi-Square
Basal/Bolus Insulin			<.001*
Basal Ordered	32	70	
No Basal Ordered	44	11	
Correctional Insulin			<.001*
Sole Correctional	35	9	
Not Sole Correctional	29	70	
Oral Anti-Hyperglycemics	12	2	
Episodes of Hypoglycemia	23	26	.732

Appendix I

Definitions for Common Phrases and Abbreviations

Phrase or Abbreviation	Definition
Hyperglycemia	Persistent blood glucose greater than or equal to 180 mg/dL
Clinical inertia	Failure to escalate insulin doses or prescribe additional appropriate anti-hyperglycemic agents despite persistent hyperglycemia
Hemoglobin A1C	Blood test that measures average blood glucose levels over the past 3 months. Results between 5.7 to 6.4% indicate prediabetes and a result over 6.5% indicates diabetes
Correctional insulin	Rapid acting insulin given to bring high blood glucose levels down to target range
Basal insulin	Slow acting insulin (Glargine, Detemir and Degludec) used to control blood glucose levels outside of oral intake
Body Mass Index (BMI)	Measure of body fat based on height and weight that applies to adult men and women
Advance Practice Nurse (APN)	Umbrella term for nursing professionals who have earned a master's or doctoral degree to take on advanced roles in healthcare including clinical nurse specialists, nurse practitioners, certified nurse midwives and nurse anesthetists
Nurse Practitioner (NP)	One of four roles of APNs; extensively trained to diagnose illnesses, deliver services and care for patients
Clinical Nurse Specialist (CNS)	One of four roles of APNs; responsible for applying expert knowledge and experience to a specific patient population in a clinical setting
Program for Diabetes Health (PDH)	Consultant-based inpatient diabetes management program staffed by a lead endocrinologist and CNSs
Agency for Clinical Innovation (ACI)	Lead agency for innovation in clinical care in New South Wales; uniting patients, clinicians and managers together to support the design and implementation of innovation in healthcare
Target blood glucose level	American Diabetes Association recommends target glucose range of 140-180 mg/dL for the majority of critically and noncritically ill patients
American Diabetes Association (ADA)	United States-based nonprofit organization with the mission to prevent and cure diabetes and improve the lives of all people affected by diabetes
Electronic Health Record (EHR)	Digital version of a patient's paper chart
Hypoglycemia	Blood glucose levels of less than 70 mg/dL