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Impact of an Interprofessional Diabetes Education Model on Patient Health Outcomes: A Longitudinal Study

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Abstract

Background: Patient education programs encouraging diabetes self-management can improve clinical outcomes and lessen diabetes complications. This study implemented an innovative interprofessional student-led diabetes self-management and health promotion program for an underserved population and demonstrated an improvement in participant clinical outcomes and students' understanding of interprofessional aspects of diabetes care.

Methods and Findings: This community-based program was implemented at two sites that serve medically underserved individuals. Students from five health career professions led educational sessions designed to demonstrate critical components of diabetes self-management. The six-month longitudinal program covered topics within the Alphabet Strategy, including ***A***dvice, ***B***lood pressure, ***C***holesterol, ***D***iabetes control, ***D***ental care, ***D***iet, ***E***ye care, ***F***oot care, and ***G***uardian drugs. Participants completed surveys evaluating diabetes knowledge, understanding of diabetes care, and health behaviours. Clinical values were collected before and after the program. Student surveys assessed their understanding of diabetes self-management. Upon completion of the program, all assessments were repeated to determine if there were improvements in outcomes. Thirty-eight participants and thirty students completed the study. There were significant improvements in participants' diabetes knowledge, understanding of diabetes management, and clinical outcomes. There were significant improvements in the students' ability to educate patients about foot care, eye care, and guardian drugs, as well as increased awareness of the role of each health profession in diabetes care.

Conclusions: This interprofessional health promotion model showed significant improvements in patient and student outcomes. This innovative student-led program could be implemented in other settings and for the management of other chronic diseases.

Keywords: Interprofessional care; Colloboration; Diabetes; Clinical outcomes; Health promotion

Introduction

Diabetes is an important public health issue, particularly in underserved medical areas [1]. This disease has significant health and economic consequences for South Dakotans, a mostly rural population in the United States (U.S.), especially since current quality of care for this chronic condition is suboptimal. Diabetes affects approximately 6.7% of South Dakota's population, and its prevalence is expected to rise due to increased percentages of overweight and obese individuals [2]. Over two-thirds of the state is designated as medically underserved, and many South Dakotans with diabetes are frustrated by lack of access to diabetes educators and dietitians, lack of trans-

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portation to appointments, and the cost of healthcare [3]. Patient education programs encouraging self-management can lessen the burden of diabetes.

In the U.S. and other parts of the world, clinical trials have shown that focusing on diabetes self-management can improve the clinical management of type 2 diabetes or even prevent complications related to this disease [4-7]. Also, patient self-management can lessen the burden of diabetes management experienced by healthcare providers and improve patient outcomes. However, implementing the rigorous clinical standards of diabetes self-management education in a traditional clinical practice setting can be challenging, particularly among medically underserved patients who may have problems with access to healthcare. To address this issue, a group of researchers in the United Kingdom developed a new self-management education approach to improving diabetes management in routine clinical practice [8]. Utilizing a simplified model called the Alphabet Strategy, a tool with similar goals to those used in randomized clinical trials, Jaiveer and his team showed that the clinical outcomes of patients with diabetes can be improved through the delivery of outpatient diabetes education services (Table 1) [8].

The Alphabet Strategy is an innovative approach for educating patients about diabetes self-management. Using the first several letters of the alphabet, the Alphabet Strategy allows patients to easily remember how to self-manage their disease. With improved self-management, patients rely less on their healthcare providers for diabetes management, an issue already problematic due to access. In addition, this multifactorial mnemonic-based framework encompasses standards recommended by the American Diabetes Association (ADA) [9], which is important because suboptimal utilization of recommended diabetes monitoring parameters has been a challenge in the U.S. For example, the largest study of the management of patients with type 2 diabetes in the U.S. did not document for all patients the six ADA-recommended tests: hemoglobin A1C (HbA_{1c}), low-density lipoprotein (LDL) cholesterol, blood pressure, foot and eye examination, and micro albuminuria. Out of 356,760 patients, only 3% had a documentation record of all six tests [10]. The Alphabet Strategy helps to educate and remind patients about the different ADA-recommended diabetes monitoring parameters. Also, the use of the Alphabet Strategy has resulted in improved clinical outcomes, including hemoglobin A1C, blood pressure, and cholesterol compared to past diabetes management tools [8]. This tool can also be applied in all clinical settings, and it involves collaborative team-based care for patients with diabetes [11].

An interprofessional approach to care can improve health outcomes in patients with chronic conditions [12]. A randomized controlled trial examining the effectiveness of a chronic care model (CCM) demonstrated significant decreases in patients' hemoglobin A1C and non-high-density lipoprotein (HDL) cholesterol among diabetic patients attending a primary care clinic. This community-based trial improved the quality of care of patients with diabetes in an underserved urban community using a multifaceted framework for healthcare delivery [13]. In addition, other studies have shown that chronic disease management is successful when using an interprofessional healthcare team [14,15].

Despite the encouraging results from the application of the Alphabet Strategy in outpatient settings, this concept had not been previously applied to a population in the U.S. A pilot study was initially done in the U.S. by this team of investigators. Although the results showed some improvement in clinical outcomes, a small sample size hindered achievement of statistical significance. The current project builds upon the previous pilot study by utilizing a modified version of the Alphabet Strategy to improve diabetes self-management and outcomes among medically underserved individuals in South Dakota, U.S.

The Centre for the Advancement of Interprofessional Education (CAIPE) notes that interprofessional education occurs when at least two or more professions learn with, from, and about each other with a purpose of improving collaboration with each other and improving the quality of care delivered to individuals or groups [16]. The World Health Organization also recommends an interprofessional approach to education of students from health-related occupations, especially in the care of patients with diabetes [17].

This project was expected to increase health professionals' competencies in interprofessional diabetes care by integrating this unique diabetes care model in the clinical training of healthcare students from different health professions at two public universities.

The aims of this study were:

1. To implement an interprofessional health promotion delivery model to improve diabetes management and clinical outcomes in an underserved population. The specific objectives were to examine if participants' diabetes knowledge, understanding of diabetes care and management, clinical outcomes, health behaviour, and health literacy improved as a result of the program.
2. To examine if student's knowledge and understanding of diabetes management and their ability to appraise the work of other health professionals caring for diabetic patients improved at the end of the program.

Methods

Description of the intervention

This innovative model was implemented at two sites that serve medically underserved populations. One of the sites was a community clinic, and the other was a church/community centre. Forty-eight students from five healthcare professions (medicine, pharmacy, nursing, nutrition, and dental hygiene) and two universities taught group education sessions designed to focus on the critical components of diabetes care and self-management. In monthly evening sessions over a period of six months, students from each profession were assigned topics within their area of expertise to discuss in 1- to 2-hour interactive workshops. Covered topics include those within the educational model termed the Alphabet Strategy: ***A***dvice, ***B***lood pressure, ***C***holesterol, ***D***iabetes control, ***D***ental care, ***D***iet, ***E***ye care, ***F***oot care, and ***G***uardian drugs [8], where each letter represented a component of diabetes self-man-

agement. The Alphabet Strategy was modified in this study to include the topic of dental care and diet as added components of diabetes management. The authors made this modification to achieve a more comprehensive approach to the care of patients with diabetes and to educate participants on the relationship between diet, oral health, and diabetes [2,9,18]. Each monthly session focused on different letters from the Alphabet Strategy. For example, advice included information on tobacco cessation, exercise, and sick-day management. The overall clinical goals and behaviour change outcomes (Table 1) were emphasized in each session.

Table 1

Modified Alphabet Strategy: Management Targets (Adapted from Jaiveer, Saraswathy J, Lee J, Morrissey J, Patel V, 2003)

Advice	Stop smoking, optimize diet, exercise, and weight control
Blood pressure* [α]	Systolic ≤130 mmHg, Diastolic ≤80 mmHg
Cholesterol	TC† ≤5 mmol/L, LDL† ≤3 mmol/L, HDL† ≥1 mmol/L, TG† <3 mmol/L
D$_1$iabetes control	HbA1c ≤7%, Urine test for protein yearly, Flu shot yearly
D$_2$ental[β]	Brush twice daily, use dental floss daily, prevent dry mouth
D$_3$iet[δ]	See registered dietitian 1-4 times per year
Eye examination	Annually
Foot examination	Annually
Guardian drugs	Aspirin, ACE inhibitors, angiotensin II antagonists, and statins when indicated

*Blood pressure values changed to follow American Diabetes Association (ADA) standards of care. [α]Heart risk score (H) not included since it is not a standard measure used by ADA. [β δ]Added areas to follow ADA standards of care. † Total cholesterol, lipodensity protein, high density lipoprotein, triglycerides.

The group education sessions were designed to facilitate discussion among the students and participants and included interactive activities, question-and-answer sessions, and a discussion of the handouts. Participants were also involved in some healthy food sampling. Posters that were similar to the handouts and highlighted pertinent clinical or behavioural goals were displayed at each session. These posters helped to remind the participants of the educational objective of each assigned alphabet letter and to encourage them to know those related to their diabetes care. For example, if "C for cholesterol" was the topic for the month, posters on "A for advice" and "B for blood pressure" were also displayed.

Using class announcements, students from the five health professions were recruited from the classroom by a faculty member in each healthcare profession.

Participation was voluntary, but the nursing students received some class credit toward community clinical hours, the nutrition student implemented the program as part of her internship hours, and the pharmacy students received credit for their participation in the form of patient care hours. There was no financial remuneration for student participation. A 2- to 3-hour orientation session for all participating students was done prior to the start of the program. Students were oriented to the program to be implemented, session format, patient materials, and the patient survey and tests to be administered. They also received information about the interprofessional approach to care and its benefits as it relates to diabetes care. A 14-page informational booklet was distributed to the students, which included the timetable/schedule for the diabetes education sessions, workshop times, agenda, time allowed, student professions presenting topics in each session, faculty/student contact information, patient data collection forms, health literacy assessment materials, a description of the Alphabet Strategy, and maps/directions to the sites of the program. After the group orientation, students within each profession met with their supervising faculty member to individually deliberate on their discipline's approach to the program. Practice laboratory sessions among the students were then conducted as students worked together to familiarize themselves with the different medical equipment to be used and the various clinical tests to be performed for participating patients.

Medical and nutrition students taught the sessions on advice, blood pressure, cholesterol, and diabetes control and care (including exercise). In another session, pharmacy students educated participants on guardian drugs that are often included in their diabetes drug therapy, and dental hygiene students taught the participants about the importance of appropriate dental care as it related to diabetes [2]. Diet education was taught by a nutrition student who also provided online and printable resources related to carbohydrate counting and appropriate healthy meals and exercise for weight management. Eye and foot care was addressed by nursing students, who used demonstrations to explain how to assess and care for the feet. A student representative from each health profession attended each session and collaborated in the session. This enabled the students to learn from each other and understand the role each profession plays in diabetes care. Additionally, students had an opportunity to serve as a resource if questions arose related to a topic that was not covered at that session. At least one faculty member from each profession was available at each session to serve as an additional resource and to guide students. At the end of each session, one or more students led a debriefing session (which included all participating students and faculty) to discuss positive aspects of that day's session, areas for possible improvement, and any potential concerns that needed to be addressed. For the participants in the program, attendance of the sessions was documented throughout the program, and attrition was noted if participants did not attend as least two of the educational sessions.

Study design

This study used a one-group, quasi-experimental, non-randomized, pre- and post-intervention design [19,20].

Participants

Adult male and female individuals with diabetes who could read and understand English and were eighteen years of age or older were eligible to participate in the study. Participants were recruited by placing flyers in waiting rooms of participating clinics, public libraries, community centres, and church bulletin announcements. Potential participants were able to contact the nurse at the clinic and/or call the project director if they wanted to be included in the study.

Protection of human subjects

Institutional review board (IRB) approval from the two universities involved in the project was obtained prior to the initiation of the study. All participants and students signed consent forms before starting the program.

Data collection

In the first session, baseline values for hemoglobin A1C (HbA_{1c}), blood pressure, total cholesterol, weight, height, and body mass index (BMI) were obtained. An oral health assessment was performed on all participants. In addition, a patient diabetes passport (a small booklet adapted from the original Alphabet Strategy study) was provided to all participants to record their laboratory values, weight, and blood pressure. Participant clinical information was recorded in this passport to encourage self-management of their diabetes. All participants completed surveys evaluating their diabetes knowledge, diabetes care, health behaviours, and health literacy. Participants' diabetes knowledge was assessed using a validated instrument [21]. The Rapid Estimate of Adult Literacy in Medicine (REALM) test, a validated instrument for examining health literacy, was used to determine participants' understanding of medical reading materials [22]. All other questions were newly developed by the investigators based on a literature review and the program objectives. The response options for the questions were based on a five-point Likert-type scale ranging from "strongly agree" to "strongly disagree." The surveys were administered in paper form and were anonymous. The pre-intervention survey was administered on the first day of the program, and the post-intervention survey was administered six months later at the conclusion of the program. Upon completion, all laboratory and outcome assessments were repeated to determine if participants had demonstrated improved outcomes. Individual feedback on their perception of the program, as well as comments about the strengths and areas for improvement, were requested from participants as they completed the post-intervention survey at the end of the program.

Using an email survey, students were also surveyed at the beginning and the conclusion of the program to determine their understanding of diabetes care and management, the role of the different healthcare professions in diabetes management, the ability to work with other health professionals, and the ability to help patients achieve their self-management goals (see appendices). Our previously developed and pilot-tested survey instrument was used [23]. The psychometric qualities of these measures were not taken in this sample. Feedback on the health promotion program, as well as

perceptions of the strengths and areas for improvement of the interprofessional experience, were assessed in the post-intervention survey.

Data analysis

All data analysis involved participants who completed the study. Descriptive statistics, including frequency tables and means, examined participants' socio-demographic and clinical characteristics. Paired samples *t*-tests and chi-square tests were utilized to examine differences between baseline and final assessments of continuous and categorical variables, respectively. All data analysis was performed using SPSS version 19.0.

Results

Thirty-eight students participated in the study, with 30 students completing both the pre and post survey. The majority of students were medical students with a mean age of 23.68 years (*SD* = 2.53).

Table 2

Descriptive characteristics of student participants (*n* = 38)

Socio-Demographic Characteristics	Number (%)	Mean (SD*)
Age (years)		23.68 (2.53)
Student Discipline		
Medical Student	20 (52.6)	
Pharmacy	9 (23.7)	
Dental Hygiene	5 (13.2)	
Nursing	3 (7.9)	
Nutrition	1 (2.6)	

*Standard deviation (SD)

Fifty-nine percent of the students agreed that they had an excellent understanding of the program, and 93% agreed that they had received adequate supervision during the program. Ninety-three percent of students learned more about diabetes care and became more confident in providing education to patients with diabetes. There were significant improvements in the students' ability to educate patients about foot care (t (-2.536), p = .017), guardian drugs (t (-2.827), p = .008), and eye care (t (3.90) = p = .021). These findings were encouraging since these aspects of diabetes care did not necessarily fall within the expertise of each profession.

Table 3

Mean differences in baseline and final outcomes for student participants (*n* = 30)

Variable	Mean (SD†) Pre-intervention	Mean (SD†) Post-intervention	*P* value
Understanding the Roles of Health Care Professionals	4.0 (0.695)	4.2 (0.551)	0.184
Ability to Work with Other Healthcare Professionals	4.43 (0.573)	4.5 (0.509)	0.626
Comfort Level Working with the Underserved Population	4.3 (0.702)	4.17 (0.592)	0.354
Ability to Use the Alphabet Strategy	3.37 (0.850)	3.63 (0.850)	0.199
Ability to Help Patients Achieve Cholesterol Goals	3.8 (0.664)	4.07 (0.640)	0.088
Ability to Help Patients Achieve Blood Sugar Goals	3.97 (0.765)	4.27 (0.640)	0.107
Ability to Help Patients Achieve Blood Pressure Goals	4.0 (0.455)	4.23 (0.430)	0.070
Ability to Help Patients Achieve Weight and Exercise Goals	3.97 (0.556)	4.10 (0.607)	0.442
Ability to Help Patients Change Health Behaviours	4.00 (0.535)	4.10 (0.557)	0.501
Ability to Educate Patients About Foot Care	3.53 (0.900)	4.00 (0.525)	0.017*
Ability to Educate Patients About Dental Care	3.86 (0.833)	3.90 (0.724)	0.856
Ability to Educate Patients About Guardian Drugs	3.53 (1.008)	4.13 (0.629)	0.008*
Ability to Educate Patients About Eye Care	3.47 (0.776)	3.90 (0.662)	0.021*

†Standard deviation; *p <0.05

There were also positive comments from the students who participated in this interprofessional experience. Some comments included:

> "I learned that the level of understanding among underserved diabetes patients is woefully below what I expected. As a future doctor, I will need to make sure I do a good job of explaining the disease and how important making life changes are to improving life quality."

> "I learned the roles that other health professionals have in managing patients' diabetes. I also learned how to better interact with and teach patients that may be underprivileged and not have the greatest access to care. I learned that it is important to look at things from their perspective and to give them realistic and manageable goals and to find ways to get them the care that is important to live healthy lives."

> "I learned how complex of a disease diabetes really is and how many different health professionals are involved in the care of an individual with diabetes. With the right attitude, a team approach is the best and most complete method for teaching an individual with diabetes on how to manage their disease."
>
> "I learned about each individual profession's role in a diabetes health program, and have a better understanding as to what type of education falls within each profession's scope of practice."
>
> "I learned about working with other disciplines. It gave me a better understanding of what other disciplines are telling diabetic patients, and how we can work together."

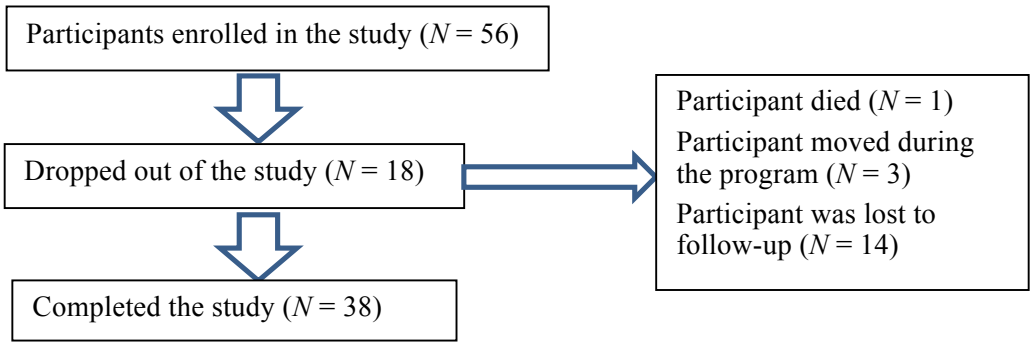
Students also commented on the strengths of the program:

> "Understanding the scope of practice of the different professions involved in the program and the expertise they have to offer."
>
> "The strength is that it incorporates many different people from different areas of health care. Also, it provides students a chance to grow as healthcare members and gain experience working with individuals."
>
> "Having so many different professions at one area to concentrate the diabetes education on the individuals and their needs."
>
> "It was great to have all professions present to answer questions some did not feel appropriate answering according to their profession, or were not comfortable answering the question."
>
> "I liked the students and teachers working together."

Some areas for improvement of the program included: "Getting more students involved, because it is a great experience." "More team building meetings prior to implementation of the program to build a better team to teach the program."

Figure 1

Study flow diagram



Fifty-six participants who met the study criteria were enrolled between the two study sites. Thirty-eight individuals completed the study (a retention rate of 67.8%) (Figure 1).

The mean age of participants was 57 years (*SD* = 15.32). The majority of participants were female, white, had some type of health insurance, and had been diagnosed with type 2 diabetes (Table 4).

Table 4

Descriptive characteristics of participants pre-intervention (*n* = 38)

Socio-Demographic Characteristics		Number (%)	Mean (SD*)
Age (years)			59.66 (15.468)
Race	White	35 (92.1)	
	Native American	3 (7.9)	
Gender	Male	14 (36.8)	
	Female	24 (63.2)	
Marital Status	Never married	8 (21.1)	
	Married	17 (44.7)	
	Separated/Divorced	8 (21.1)	
	Widowed	5 (13.2)	
Years of Schooling Completed	8 Grades or Less	1 (2.6)	
	High School Graduate/GED	8 (21.1)	
	Some College/Technical School	14 (36.8)	
	College Graduate	10 (26.3)	
	Graduate Degree	5 (13.2)	
Average Year of Diagnosis			9.24 (8.194)
Type of Diabetes	Type 1 Diabetes	4 (10.5)	
	Type 2 Diabetes	31 (81.6)	
	Unknown	3 (7.9)	
Current Overall Health Status	Poor	6 (15.8)	
	Fair	11 (28.9)	
	Good	13 (34.2)	
	Very good	7 (18.4)	
	Excellent	1 (2.6)	

Table 4 (continued)

Descriptive characteristics of participants pre-intervention (*n* = 38)

Socio-Demographic Characteristics		Number (%)	Mean (SD*)
Employment	Full Time (35+ hours/week)	8 (21.1)	
	Part time (less than 35 hours/week)	7 (18.4)	
	Unemployed/Laid Off (looking for work)	1 (2.6)	
	Unemployed/Laid Off (not looking for work)	1 (2.6)	
	Homemaker	1 (2.6)	
	Retired	13 (34.2)	
	In School	2 (5.3)	
	Disabled/Not Able to Work	4 (10.5)	
	Other	1 (2.6)	
Insurance	Individual Plan	5 (13.2)	
	Employer Plan	12 (31.6)	
	Military Plan	2 (5.3)	
	Medicaid	5 (13.2)	
	Medicare	11 (28.9)	
	None	3 (7.9)	

Before the intervention, 25 participants (65.8%) had never participated in a diabetes education class. Most participants received diabetes education from a physician at a regular clinic appointment (N = 27, 71.1%). Almost half of the participants monitored their blood glucose less than one time per day, and 54% followed a meal plan or diet for glucose control before the intervention, whereas 24 participants (63.2%) did both behaviours after the intervention was completed. After the intervention, 15 participants (39.5%) felt their health was better compared to before the program, whereas 17 (44.7%) felt their health status was the same.

Statistically significant changes were demonstrated for the following clinical outcomes: total cholesterol (t = 2.058, p = .047), systolic blood pressure (t (2.426), p = .021), diastolic blood pressure (t = 4.716, p = .000), weight (t (2.252), p = .030), and hemoglobin A1C (t (3.590), p = .001). Interestingly, high-density lipoprotein (HDL) showed a significant decrease (t (4.715), p = .000). There were no changes in participants' health literacy levels (Table 5). Other nonclinical outcomes with significant improvements included participants' diabetes knowledge (t (-2.645), p = .012), understanding of areas affecting diabetes (t (-2.538), p = .015), and understanding of aspects associ-

ated with diabetes (t (-4.190), p = .000) (Table 5), while significant health behaviour changes included taking special care of the eyes (χ^2 = 7.529, p = .014) and following an exercise or physical activity program (χ^2 = 8.049, p = .008) (Table 6).

Table 5

Mean differences in baseline and final outcomes for participants (n = 38)

Variable	Mean (SD†) Pre-intervention	Mean (SD†) Post-intervention	*P* value
Diabetes Knowledge (out of a score of 24)	19.11 (2.264)	19.92 (2.097)	0.012*
Understanding of Areas Affecting Diabetes (exercise, diet, smoking, alcohol use)	3.709 (1.001)	4.167 (0.803)	0.015*
Confidence in Abilities Affecting Diabetes (exercise, weight and blood sugar control, choosing appropriate foods)	3.605 (0.894)	3.862 (0.743)	0.079
Understanding of Aspects with Diabetes (medications, dental, eye, foot care)	3.143 (0.846)	3.84 (0.776)	0.000*
Compliance in Areas Affecting Diabetes (medication adherence, activities to improve diabetic outcomes)	4.0892 (0.659)	4.231 (0.751)	0.328
Height	65.57 (3.667)	65.46 (3.624)	0.312
Weight	213.9 (56.57)	211.11 (58.23)	0.030*
Body Mass Index (BMI)	34.95 (8.46)	34.57 (8.84)	0.085
Hemoglobin A1C	7.213 (1.34)	6.589 (1.16)	0.001*
Systolic Blood Pressure	134.69 (15.28)	126.17 (24.50)	0.021*
Diastolic Blood Pressure	78.72 (9.37)	72.97 (8.18)	0.000*
Total Cholesterol	168.29 (40.69)	154.50 (42.32)	0.047*
HDL	40.45 (11.94)	34.47 (10.85)	0.000*
Non-HDL	127.84 (40.46)	117.45 (39.42)	0.070
REALM	63.19 (6.22)	63.64 (5.71)	0.153

†Standard deviation; *p<0.05

Table 6

Differences in participants' health behaviour before and after the intervention (*n* = 38)

Variable		Frequencies		
		Number (%) Yes	Number (%) No	*P* value
Follows an Exercise Program	Yes No	17 (77.3) 5 (31.3)	5 (22.7) 11 (68.8)	0.008*
Follows a Meal Plan or Diet	Yes No	17 (89.5) 13 (72.2)	2 (10.5) 5 (27.8)	0.357
Takes Special Care of Eyes	Yes No	25 (92.6) 6 (54.5)	2 (7.4) 5 (45.5)	0.014*
Takes Special Care of Feet	Yes No	24 (85.7) 7 (70.0)	4 (14.3) 3 (30.0)	0.271

*$p<0.05$; *Statistically significant difference in following an exercise program ($\chi2 = 8.049$, $p = 0.008$) and taking special care of the eyes ($\chi2 = 7.529$, $p = 0.014$) and typical glucose monitoring frequency ($\chi2 = 42.76$, $p = 0.000$).

Participants provided some comments about the program, including the following:

> "I've been a diabetic for 25 years and this is the first real comprehensive class I've had."
>
> "I knew a lot and I can't believe how much more I learned."
>
> "I've had diabetes for a long time and it's a complex disease. These classes really helped me to get a better understanding."
>
> "The class I appreciated the most was the one on depression."

Discussion

The health profession students involved in delivering the program showed improved ability to educate patients about diabetes self-management in many different health areas. This study demonstrated improved clinical outcomes for participants at the end of the interprofessional program, with at least half of the participants being aware of the need to monitor their blood glucose and follow a meal plan or diet for glucose control.

Improvements were observed in students' ability to educate patients regarding proper foot care, eye care, and utilization of guardian drugs. This new model could be applied in other practice settings for the management of other chronic diseases, if proper training is achieved.

The interprofessional team approach to diabetes education provided to medically underserved individuals by health professional students shows the value of collaborative interprofessional care for patients with diabetes. A previous study by these investigators indicated improved student understanding of healthcare professional roles, knowledge of diabetes care, ability to work with the underserved and other healthcare

professionals, and educating patients about behaviour change [23]. Although there were no statistically significant improvements in most student outcomes (including understanding the roles of health care professionals, ability to work with other healthcare professionals, ability to help patients change their health behaviours and achieve their health goals), the pre-intervention mean values were already high among these students. It is possible that the students were already exposed to interprofessional teamwork and training in their curriculum and also helping patients'with their health goals, or the sample size was too small to detect any differences.

Though some changes observed in this study could be random due to the non-statistically significant results, the mean changes warrant mention. For example, the students in this study gained a greater appreciation for the roles of their profession and those of other healthcare professions and felt generally positive about the interprofessional experience. In a study of students involved in a rural interdisciplinary healthcare training program, program evaluations showed increased confidence in students' ability to provide interprofesssional care and to problem-solve interprofessionally in a team utilizing the knowledge of their specific discipline [24]. Similarly, an interprofessional rural health engagement program for students in pharmacy, nursing, and social work showed better knowledge of rural health and interprofessional teams [25].

Students' comfort working with the underserved population decreased at the end of the intervention, possibly because students' expectations were met with the reality of the complexity of working with this population. Also, some of the students' comments reflected this possibility. Opportunties for health career students to be exposed to the reality of working with the medically underserved need to be created and included in their educational trainings.

Students did not feel confident in using the Alphabet Strategy, possibly because only two hours were used to orient the students to the program and the new approach of educating patients on diabetes. This shows that adequate training is required when utilizing this approach for diabetes education.

This study model involved the utilization of a collaborative, interprofessional team-based approach to the care of patients with diabetes [11]. Utilizing this model of care for patients with chronic health conditions can improve their health outcomes [12]. Previous studies demonstrate successful management of chronic health conditions with use of an interprofessional healthcare team [13-15].

Significant improvements were observed in participants' diabetes knowledge and understanding of diabetes care and management. This reveals that the group diabetes education classes helped participants gain a better understanding of their disease and important aspects related to diabetes care, control, and management. This finding is consistent with previous studies that have demonstrated improvements in patient knowledge, attitude, and self-management behaviours with diabetes education [26,27]. Consistent with this study, a 10-week diabetes self-management program using group education sessions and delivered by trained community health workers demonstrated significant improvements in diabetes knowledge, self-care practicies such as foot care and self-monitoring of glucose levels, A1C, and systolic

blood pressure in an underserved population [28]. In addition, a six-month community-based diabetes self-management education program targeting an underserved population demonstrated a reduction in mean HbA_{1c} and a reduction in emergency department vists for uncontrolled diabetes [29]. Though not assesed in this study, group education classes offered in a small group format are likely to be a more cost-efficient means of providing diabetes education and teaching self-management techinques, if compared to an individual approach [27].

This innovative health promotion program led to an improvement in participant clinical outcomes such as systolic blood pressure, diastolic blood pressure, weight, and HbA_{1c}. Across several studies, result of changes in clinical outcomes after diabetes education interventions have not been consistent. Significant improvements in clinical outcomes such as HbA_{1c}, blood pressure, and BMI have been observed after three, six, and 14 months in diabetes education interventions [26,28-30]. In another study, improvements were observed after only 10 weeks of an intervention for an underserved population [28]. However, Lorig, Ritter, Villa, and Armas [31] conducted a six-month community-based peer-led diabetes self-management program which revealed no changes or improvements in HbA_{1c} or weight. The utlilization of the original Alphabet Strategy in the United Kingdom led to significant improvements in clinical outcomes (blood pressure, total cholesterol, HDL cholesterol, HbA_{1c}), as well as other specific aspects of the model, including eye and feet examinations and use of guardian drugs [8,32]. An application of the strategy in an economically deprived area of India also demonstrated improvements in the use of guardian drugs [32]. Though a modified Alphabet Strategy was used, results were consistent with the UK results, showing significant improvements in clinical outcomes and health behaviours such as eye care and utilization of a physical activity program. This confirms that the modification of the model did not negatively affect the expected result for patients. The modified Alphabet Strategy provides a simple, evidence-based model for diabetes care and management. With proper training, this approach could be incorporated into the education of diabetic patients in the primary care setting.

The interprofessional approach used in this model had potential benefits both for students and for patients. Students gained exposure to health professional roles and had the opportunity to work with other healthcare professionals, and patients experienced better clinical outcomes.

Study limitations

One limitation of this study was the lack of a comparison group in the design; therefore, we cannot determine a causal association between the improvements in clinical outcomes and/or behaviour changes and the intervention. However, program resources hindered the possibility of utilizing a comparison group with similar demographic and psychographic characteristics that could also be measured before and after the intervention. Also, there could be some selection bias associated with inclusion in the intervention, as participants could have self-selected to be in the program because of an inherent interest to change their behaviours and/or achieve con-

trol of their disease. In addition, there was an attrition rate of about 32% (18 of 56 participants), and all reasons for lack of follow-up were not assessed by the authors. However, these attrition rates are comparable to previous community-based diabetes education programs that target the needs of the underserved [28,29]. The questionnaires used to evaluate diabetes care and health behaviours, as well as those used to evaluate the student outcomes, were pilot tested but not pre-tested for validity and reliability.

Conclusions

As healthcare providers work to improve diabetes care and outcomes for patients with diabetes and other chronic illnesses, this evidence-based interprofessional model could be integrated into healthcare programs seeking to improve training for health career students and patient clinical outcomes. In a primary care setting, collaboration with members of the healthcare team and interprofessional training is warranted, especially in medically underserved areas. This innovative interprofessional community-based healthcare student experience makes this possible.

The use of the Alphabet Strategy served several purposes. It facilitated the interprofessional training of the students, improved students' knowledge about diabetes management, and enhanced the delivery of diabetes education in a group setting. Moreover, it resulted in improved clinical outcomes for the participants. This model is promising as a way to involve students in a hands-on interprofessional experience to improve diabetes outcomes among underserved populations. This model can be used in further research on diabetes in other populations, and in the management of other chronic illnesses.

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Abbreviations

American Diabetes Association (ADA)
Hemoglobin A1C (HbA_{1c})
Low density lipoprotein (LDL)
Body mass index (BMI)
The Rapid Estimate of Adult Literacy in Medicine (REALM) test

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Appendices

Pre-participation survey on students' perception of the diabetes health promotion program

Please answer the following questions by circling your level of agreement:
SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree

1. I have a good understanding of the role of pharmacists, dietitians, dental hygienists, nurses, and physicians in diabetes care.	SA	A	N	D	SD
2. I am confident I can work with other members of the healthcare team to promote health among patients with diabetes.	SA	A	N	D	SD
3. I am comfortable working with the underserved population.	SA	A	N	D	SD
4. I am confident I can use the Alphabet Strategy as an approach to work with clients with diabetes.	SA	A	N	D	SD
5. I am confident I can work with a client to achieve his/her blood pressure goal.	SA	A	N	D	SD
6. I am confident I can work with a client to achieve his/her cholesterol goal.	SA	A	N	D	SD
7. I am confident I can work with a client to reduce his/her blood sugar levels.	SA	A	N	D	SD
8. I am confident I can work with a client to achieve his/her weight/exercise goal.	SA	A	N	D	SD
9. I am confident I can work with a client to change his/her health behaviours to improve diabetes care.	SA	A	N	D	SD
10. I am confident I can work with a client to educate him/her about the importance of foot care.	SA	A	N	D	SD
11. I am confident I can work with a client to educate him/her about the importance of dental care.	SA	A	N	D	SD
12. I am confident I can work with a client to educate him/her about guardian drugs.	SA	A	N	D	SD
13. I am confident I can work with a client to educate him/her about the importance of eye care.	SA	A	N	D	SD

Please answer the following questions. It will help us to analyze the results of this study.
Degree (if any):
Major: _____
Age: _____
Previous involvement in patient diabetes education: _____
Previous experience working with other health career professionals: _____

Post-participation survey on students' perception of the diabetes health promotion program

Please answer the following questions by circling your level of agreement:
SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree

1. After participation in the diabetes education program, my understanding of the role of pharmacists, dietitians, dental hygienists, nurses, and physicians has improved.	SA	A	N	D	SD
2. I am confident I can work with other members of the healthcare team to promote health among patients with diabetes.	SA	A	N	D	SD
3. After participation in the diabetes education program, I am more comfortable working with the underserved population.	SA	A	N	D	SD
4. I am confident I can use the Alphabet Strategy as an approach to work with clients with diabetes.	SA	A	N	D	SD
5. I am confident I can work with a client to achieve his/her blood pressure goal.	SA	A	N	D	SD
6. I am confident I can work with a client to achieve his/her cholesterol goal.	SA	A	N	D	SD
7. I am confident I can work with a client to reduce his/her blood sugar levels.	SA	A	N	D	SD
8. I am confident I can work with a client to achieve his/her weight/exercise goal.	SA	A	N	D	SD
9. I am confident I can work with a client to change his/her health behaviours to improve diabetes care.	SA	A	N	D	SD
10. I am confident I can work with a client to educate him/her about the importance of foot care.	SA	A	N	D	SD
11. I am confident I can work with a client to educate him/her about the importance of dental care.	SA	A	N	D	SD
12. I am confident I can work with a client to educate him/her about guardian drugs.	SA	A	N	D	SD
13. I am confident I can work with a client to educate him/her about the importance of eye care.	SA	A	N	D	SD
14. After participation in the diabetes education program, I have learned more about diabetes care.	SA	A	N	D	SD
15. After participation in the diabetes education program, I am more confident providing education to patients with diabetes.	SA	A	N	D	SD
16. I had an excellent understanding of the health promotion program that was used in this project.	SA	A	N	D	SD
17. I received adequate supervision during this program.	SA	A	N	D	SD

Please respond to the following open-ended questions:

1. What did you learn from your participation in the Diabetes Health Promotion Program?

2. Please identify the strengths of this program.

3. Please identify areas for improvement with this program.

Please answer the following questions. It will help us to analyze the results of this study.

Degree (if any):

Major: _____

Age: _____

Previous involvement in patient diabetes education:

Previous experience working with other health career professionals: