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Research Article

Advanced Nursing Education: Family Nurse Practitioner Students Improve Health Outcomes for the Medically Underserved at Nurse-Managed Student-Run Free Clinics

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Abstract

Purpose: The purpose of the paper is to describe the implementation of the Advanced Practice Nurse Intervention (APNI). The APNI was created to develop curriculum and clinical sites for family nurse practitioner (FNP) students to address five disease states (asthma, depression, diabetes, hypercholesterolemia, and hypertension) in medically underserved people residing in San Diego County.

Background: Chronic diseases are prevalent in medically underserved populations. In response to the need for free healthcare for vulnerable people living in San Diego County, the Student Healthcare Project was developed at five point-of-care sites. The APNI was implemented at these locations.

Methods: The Effectiveness Evaluation for this project used a time series design of specified outcomes of interest at the five Student Healthcare Project sites.

Results: The total patient sample for the intervention was 1,854 patients. Major depressive episodes in patients previously diagnosed with depression (n = 122) decreased from 15 in Year One to five in Year four of the project (Cochran's Q (13, n = 122) = 24.22, $p < .05$). The number of diabetic patients with A1c values over nine percent (n = 22) dropped from the initial measurements (M = 11.25, SD = 4.17) to subsequent measurements (M = 8.43, SD = 2.56), Z = -2.174, p = < .05) with zero patients having A1c values over nine percent in Year Four of the project. For those patients diagnosed with hypercholesterolemia (Total cholesterol (TC) > 240 mgs/dl), TC values dropped from the initial measurements (M = 234.04, SD = 38.85) to the subsequent measurements (M = 204.92, SD 8.07), Z = -3.13, $p < .01$). A decrease in systolic and diastolic blood pressures (BP) was observed for those patients diagnosed with hypertension (BP > 130/90) at the beginning of the project compared to subsequent BP readings over the course of the intervention (Systolic Mean difference = 12.65, SD = 20.39, t (148) = 7.58, $p < .01$; Diastolic Mean Difference = 6.98, SD = 13.30, t (148) = 6.41, $p < .01$). The number of short-acting inhaled beta agonist canisters that were prescribed increased over the course of the project; however, this prescribing practice was not due to an increase in asthma symptoms but rather to greater prescriber access to quick relief medications.

Conclusions: Major depressive episodes, A1c values, total cholesterol levels, and systolic and diastolic blood pressure significantly decreased during the APNI, which was conducted by FNP students at five Student Healthcare Project sites. The extended period of data collection at each clinic for each patient allowed for greater confidence in attribution of the observed changes to the intervention. Project findings suggest that FNP students participating in the APNI improved identified outcomes for patients with two or more chronic diseases at one or more of five nurse-managed student-run free clinics.

Keywords: Chronic disease; Free clinic; Nurse practitioner; Outcomes; Transdisciplinary; Underserved

Introduction

A healthcare crisis is visible and projected to grow in America. Reducing health disparities in underserved communities is a complex issue that has been of interest to healthcare consumers and policymakers across the United States (U.S.). Although the greater San Diego region enjoys a reputation as an international tourist destination, its ethnically diverse population of over three million residents, growing numbers of homeless, underserved, working poor, and migrants and refugees demanded action and resources from the local government and non-governmental organizations. The predominance of low-paying jobs in the service and tourism industries, in the face of high living costs and unemployment, have placed enormous strain on families and their children. These factors contribute to the alarming rate of poverty in this region. In San Diego County, 397,860 people lived in persistent poverty (11.9%) in 2018 [1], well above the national average [2]. In San Diego, 216,000 (6.4%) people do not have health insurance [3].

Homelessness is a significant problem in San Diego. In fact, it is estimated that there were 8,102 (4,476 unsheltered; 3,626 sheltered) homeless individuals living in San Diego in 2018, the fourth highest homeless population in the nation [4]. San Diego is home to a large military population. Many veterans leaving the military tend to stay in the area. San Diego has a high cost of living, and there is a lack of employment opportunities for the many homeless veterans (1,312 during most recent count) [4]. According to the 2018 WEALLCOUNT report [5], of the homeless in San Diego, 43 percent have a chronic illness, 23 percent abuse substances and alcohol, and 43 percent are suffering from mental illnesses such as depression. The homeless population has limited or no economic resources, are often without health insurance, and cannot navigate the healthcare system without assistance. This population is often stigmatized by healthcare providers and the community at large [6,7].

Refugees and migrants that resettle in the United States are a vulnerable population with limited economic and social resources [8]. People arriving in this country often find barriers to accessing healthcare services. Migrants and refugees are often without health insurance and the ability to pay for healthcare services [8]. For migrants, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 [9] has a mandatory five-year delay for lawfully present migrants to obtain Medicaid coverage, and the Patient Protection and Affordable Care Act of 2010 [10] left migrant families out of the expansion on healthcare access. Refugee populations may have insurance due to the Patient Protection and Affordable Care Act of 2010, but access to that care has been limited.

Chronic diseases are prevalent in medically underserved populations, often at a rate higher than the general population [11]. These chronic illnesses often go undiagnosed or unmanaged for an extended period because these people live in poverty and are unable to afford healthcare or health insurance, even at reduced rates. Poor health can be both a cause and result of living in conditions of poverty [11]. Vulnerable populations have experienced barriers related to culture, language, fear of stigmatization, and concerns about navigating the healthcare system [8,11]. Issues such as mental illness and a deep culture of mistrust of healthcare providers make it difficult to find or care for medically underserved people. Many routinely turn away from seeking needed healthcare and offers of free medical attention. In response to the need for free healthcare for medically underserved populations of San Diego County, graduate students, and their faculty developed the Student Healthcare Project. This project has grown from one to five free nurse-managed student-run primary care clinics in communities with some of the highest numbers of medically underserved.

The Student Healthcare Project provided (and continues to provide) free medical care for acute and chronic diseases, case management, social services, health promotion, and patient education services. Clinic spaces were donated (or very low rent was asked) by local churches. The free clinics were staffed by volunteer nursing faculty, volunteer providers, and graduate and undergraduate nursing students. The Student Healthcare Project sites served as clinical placements for educating graduate and undergraduate nursing students. Students were mentored and supervised by nursing faculty, volunteer physicians, and volunteer nurse practitioners. This project exposed students to medically underserved populations and increased their skill in providing high-quality, culturally sensitive healthcare to people who might not otherwise receive any healthcare.

The Project

The School of Nursing received a grant to develop the Advanced Practice Nurse Intervention (APNI), an education program to increase knowledge about underserved health, integrative healthcare, and clinical experiences in providing care to underserved populations. The project provided expertise in interprofessional collaborative practice among disciplines. Three new courses were developed, including Underserved Healthcare, Introduction to Integrative Healthcare, and Interprofessional Collaboration. The critical components from these new courses were integrated into selected existing courses in the curriculum for advanced practice nursing students. Family Nurse Practitioner (FNP) students selected for the grant project were assigned to the Student Healthcare Project free clinics for clinical experiences in their final year in the program. Over that year, students completed the new courses in addition to the core FNP curriculum. The chronic diseases selected for the clinical outcome evaluation

included asthma, depression, diabetes, hypercholesterolemia, and hypertension. Data for the clinical outcome study were collected from the Student Healthcare Project Electronic Health Record (EHR).

Review of Literature

Chronic diseases of underserved populations have been studied in free clinics and student-run free clinics. Asthma is a chronic illness that is found in poor, homeless, and underserved populations. Notaro, et al. [12] completed a descriptive study to evaluate the health of homeless patients using a free urban clinic (n = 122). They found that the prevalence of asthma was not statistically significant in homeless patients (n = 6; OR = 0.722). The authors concluded that homelessness did not increase the risk of developing asthma; however, homeless people required improved access to adequate healthcare. Children living in poverty were more frequently diagnosed with asthma [13]. Investigators reviewed national survey data from 2003 to 2012 and found the lifetime prevalence of asthma was 25.8 percent in the most impoverished children and 57.9 percent in uninsured children. There is a high prevalence of depression in underserved populations. In a free mental health clinic in the Intermountain West, Kamimura, et al. [14] found that the most common diagnosis among their patient population was depression (n = 65; 41.4%). Those diagnosed with this illness were more likely to receive inadequate treatment [12,15].

Liberman, et al. [16] conducted a retrospective medical record review and found that the quality of depression care at a student-run free clinic exceeded care for patients with public or private health insurance in New York. Using the Healthcare Effectiveness Data and Information Set (HEDIS) parameters, the investigators compared the quality of care of New York State Medicaid and commercially insured populations with data from a student-run free clinic in Harlem. They found the student-run free clinic patients had significantly more appropriate physician contacts (13/29; 45%) than those with commercial insurance (2617/11595; 26%; p = .008) and Medicaid (2112/7358; 29%; p = .09). The student-run free clinic patients had better pharmacological treatment in the acute phase (15/18; 83%) than patients with Medicaid (3079/7358; 42%) (p = .001) and in the continuous phase (9/18; 50%) than patients with Medicaid (1963/7358; 27%) (p = .049).

According to the Centers for Disease Control and Prevention [17], 30.3 million Americans have diabetes. This chronic disease has been coupled with social and economic conditions. Higher rates of diabetes were found in minorities, particularly Blacks, Latinos, and American Indians, and those with low socioeconomic status. Hindocha, et al. [18] studied outcomes of 539 underserved patients at a free clinic in Providence, Rhode Island. They collected data at enrollment and after one year from their EHR. During the first 12 months of enrollment to the clinic, diabetic patients showed significant improvements ($p < .01$) in both A1c (n = 24) and blood glucose levels (n = 46). Chronic hypertension has been studied the most in medically underserved populations. Hypertension is a significant but modifiable risk factor for cardiovascular disease [18,19]. The free clinics and student-run free clinics have developed and implemented successful strategies to identify and treat hypertension in homeless, uninsured, and ethnically diverse patients.

Student-run clinics in Indianapolis and San Diego used an electronic health record to evaluate outcomes on hypertension management of their patients. Wahle, et al. [19] found significant differences in blood pressure control in patients (n = 64) before and after the study period at the Indianapolis clinic using both JNC-7 and JNC-8 guidelines (p = .006 and p = .027 respectively). Smith, et al. [20] had similar findings at the San Diego free clinics. Blood pressure was significantly reduced in their patients after the first month of treatment and sustained throughout the follow-up phase of the study (n = 496; $p < .0001$). Both student-run free clinics achieved rates of control of hypertension comparable to or exceeding national averages. There are apparent disparities correlated to race and socioeconomic status in relation to cardiovascular disease [21]. Using a pre-post design, researchers evaluated the initial African American, and Caucasian participants enrolled in the Healthy Aging in Neighborhoods of Diversity across the Life Span Study (HANDLS) for relations of race and poverty status to cardiovascular risk factors. The results showed that as an effect of race African Americans had higher levels of A1c and systolic blood pressure and Caucasians had more elevated total cholesterol (p = <.05). Other studies looked at the effects of interventions on A1c and total cholesterol.

Medically underserved populations are at higher risk for cardiovascular disease [22]. Investigators evaluated a nurse management system with augmented telemedicine communication for a reduction in cardiovascular risk in medically underserved patients living in urban and rural communities. They enrolled 348 participants in the study. Using a pre-post design, they found cardiovascular risk was significantly reduced with the interventions. For patients with hypertension, there was a significant reduction in blood pressure from baseline to final readings for those receiving nurse management (n = 195; p = <.05) and telemedicine (n = 193; p = <.05). For total cholesterol (mg/dl), there was a significant decrease from baseline to final values in participants receiving nurse management (n = 195; p = <.05) and telemedicine (n = 193; p = <.05).

Minimal published research could be found that included patient outcomes of underserved populations that received care at free or student-run free clinics. The published studies that could be located focused on care provided by physicians, medical students, pharmacists, and nurses who followed patients and provided

case management. No studies were found that included nurse practitioners and nurse practitioner students as providers of care for underserved people. The purpose of the Advanced Practice Nurse Intervention was to develop curriculum and clinical experiences in underserved health for nurse practitioner students and to measure outcomes for asthma, depression, diabetes, hypercholesterolemia and hypertension These chronic diseases were selected due to their frequent presentation in the student-run free clinics.

Theoretical Framework

Satterfield, et al. [23] developed the Transdisciplinary Model of Evidence-Based Practice (TMEBP) for medicine, nursing, psychology, social work, and public health. The TMEBP was selected for the project. The model promotes interprofessional practice among disciplines, an ecological framework and shared decision making when caring for a population of patients in acute care or the community. The model incorporates best available evidence from research findings, client, population or community characteristics, values, preferences and needs, and practitioner expertise and other resources in an environmental and organizational context. The TMEBP model is illustrated in (Figure 1).

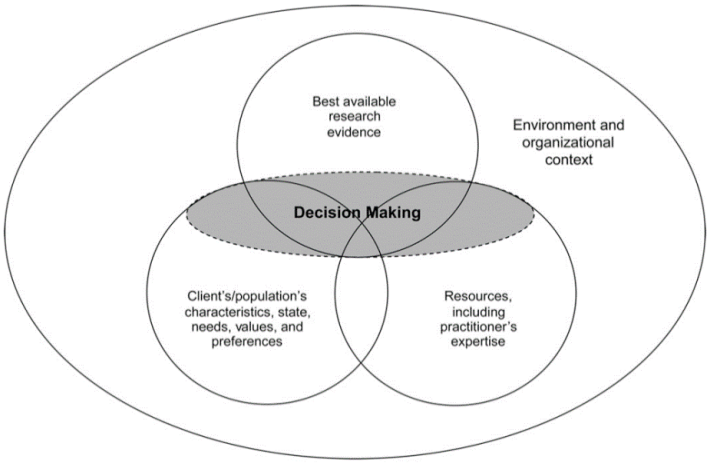

Figure 1: The Transdisciplinary Model of Evidence-Based Practice [23].

The TMEBP [23] served as a framework for the Student Healthcare Project and guided the development of the APNI. The three educational courses for the graduate nurse practitioner students used the concepts of interprofessional practice and shared decision-making in a community clinic setting and in caring for individuals with multiple chronic diseases. In addition, social determinants of health impacting this population were identified and considered in assessment, diagnosis and treatment of patients. Key concepts from the courses were applied in the clinical setting.

Best practices of transdisciplinary collaboration at all levels and a patient-centered approach were integral to how care was organized. Undergraduate nursing students acted as clinic managers and nursing care providers. Care of patients began with rooming patients, reviewing health history and reason for visit, and performing health assessment needed for intake before reporting to the FNP. Family nurse practitioner and nursing students saw patients together and collaborated to present the patient and to develop patient plans of care. Due to the financial challenges for this population, FNP and undergraduate nursing students worked with nursing faculty to locate low-cost and free options for medications, supplies, and referrals. Mental health counseling was provided with collaboration between FNP students, Psychiatric Mental Health Clinical Nurse Specialists (PMHCNS), physicians, and other providers. Both FNP and undergraduate nursing students collaborated on patient teaching in lifestyle modification and with the diabetes educator. Nursing students provided case management services to patients. Through a patient-centered approach, patient goals and preferences were supported.

Methods

The Effectiveness Evaluation for this project was made possible using a time series design of specified outcomes of interest using five (5) point-of-care sites. Data were collected every three months over four years. All patients that met the inclusion criteria of two or more of the five identified chronic conditions were included in the sample. Historical data for the year before initiation of the project (identified as Year One) were collected to establish timing and directionality of events [24,25]. Univariate frequency distributions were examined for each variable. Paired and independent t-tests and one-way, two-way, and repeated measures Analyses of Variances (ANOVAs) were performed to answer the question, "Does participation in the Advanced Practice Nurse Intervention (APNI) result in a change in the specified outcomes of interest?" Nonparametric techniques were used when the data did not meet the assumptions of the proposed parametric technique(s). All analyses were considered statistically significant at .05 unless otherwise specified.

Results:

The results of the data analyses for the Effectiveness Evaluation are presented and include a description of the overall sample. Effectiveness was demonstrated by determining the impact of the intervention on the patient-centered outcomes of interest for five chronic diseases, specifically, asthma, depression, diabetes, hypercholesterolemia, and hypertension.

Sampling Frame

The sampling frame included 2,204 free clinic patients that attended one or more of five free clinics. Gender, race, and ethnicity were examined. Of the 2,204 clinic patients, approximately 877 self-identified as female (43.3%) and 1,247 (56.6%) identified as male. Many of the patients in the sampling frame identified as White (n = 1,395 (63.3 %), followed by Hispanic (n = 586 (26.6%), Black

or African American (n = 110 (5%), and 113 (5.1%) of patients chose not to characterize their race/ethnicity.

Sample

The total patient sample for the intervention consisted of 1,854 unique patients. To be included in the sample, patients received care at one or more of five free clinics for two or more of the focus chronic diseases over a four-year period. Sample size, age, and gender identity are presented for each patient-centered outcome of interest below. Post hoc power analyses of effective sample sizes for each analytic technique were performed. Power was calculated using sample size, effect size, and significance level. The analyses revealed a power of greater than .80 for all samples and analytic techniques.

Patient-Centered Outcomes

The patient centered outcomes of interest included data points for physiologic measures and screening instruments for the identified chronic disease diagnoses. Data concerning FNP student-prescribing behavior were also collected for the chronic disease, asthma.

Asthma patients who use more than one canister of short-acting inhaled beta-agonist per month: For the 77 patients who were diagnosed with asthma, the mean age was 40 years (SD = 16.30) with an age range of 11 to 72 years; 40 (52%) identified as female and 37 (48%) identified as male. Nonparametric repeated measures analytic techniques (i.e., χ^2 and Friedman test) were used to evaluate the change in prescribing practices of short-acting inhaled medication from Time One Year One (3rd Quarter, 2014) to Time 14 (4th Quarter, 2017). A statistically significant change was found in prescribing practices throughout the project, χ^2 (13, n = 77) = 23.57, p < .05. The most significant change occurred from Year One (historical data), in which four patients (5.2%) had been prescribed at least one rescue inhaler during the quarter, to 10 patients (13%) in Year Two, 4th Quarter, followed by nine patients (11.7 %) in Year Four, 1st Quarter.

Adults and adolescents who experience a major depressive episode: All patients (100%) were screened for depression at each visit. The Patient Health Questionnaire-2 (PHQ-2) [26] was used to screen for depression. If a patient scored three (3) or higher, the PHQ-9 [27] was administered. The PHQ-9 score aided the provider in making the diagnosis of depression. For the 122 patients diagnosed with depression, the mean age was 45.79 years (SD = 14.19) with an age range of 16 -79 years; 70 (57%) identified as female and 52 (43%) identified as male. The nonparametric repeated measures analytic technique Cochran's Q for dichotomous outcomes was used to evaluate change. Of those 122 patients diagnosed with depression, a statistically significant decrease in the number of major depressive episodes was identified during the project, Cochran's Q (13, n = 122) = 24.22, p < .05. In Year One, 3rd Quarter, 15 (12.3%) patients were identified with a major depressive episode, dropping to 12 (10%) in Year Two, 2nd Quarter and finally to five (4%) in the 2nd Quarter of Year Four.

Diabetic patients with an A1c value greater than nine percent: For the 50 patients who were diagnosed with diabetes, the mean age was 58.17 years (SD = 11.86) with an age range of 37 to 78 years; 34 (68%) identified as female and 16 (32%) as male. All 50 patients had at least one A1c documented in their medical record; however, only 22 patients had more than one A1c documented in their chart during the course of the project, the majority only having two measurements; therefore, the nonparametric equivalent of the paired t-test, the Wilcoxon Sign Rank test was performed. Results revealed that A1c values dropped from the initial measurements (M = 11.25, SD = 4.17) to subsequent measurements (M = 8.43, SD = 2.56), Z = -2.174, p = < .05) with four patients (18%) having an A1c value above nine percent at the initial measurement; at the second measurement, no patient (0%) with a documented A1c had a value above nine percent.

Adults with high total blood cholesterol levels: For the 59 patients who had been diagnosed with hypercholesterolemia (Total Cholesterol > 240 mg/dl (Office of Disease Prevention and Promotion [28], the mean age was 53 years (SD = 12.76) with an age range of 16 to 77 years; 34 (57.6%) identified as female and 25 (42.4%) identified as male. Of the 59 patients diagnosed with elevated total cholesterol (TC), only 24 individuals had more than one TC documented in their chart throughout the project; therefore, the nonparametric equivalent of the paired t-test, the Wilcoxon Sign Rank test was performed. Results revealed that TC values dropped significantly from the initial measurements (M = 234.04, SD = 38.85) to the subsequent measurements (M = 204.92, SD = 28.07), Z = -3.13, p < .01). Despite the documented decrease in the total cholesterol, 42 (71.12%) of the 59 patients had a cholesterol above 200 mg/dl as currently documented in their medical record.

Adults with hypertension whose blood pressure is under control: For the 237 patients that had been diagnosed with hypertension by JNC7 Guidelines [29], the definition for "Blood pressure under control" for this project was defined as a Blood Pressure (BP) less than 130 systolic and less than 90 diastolic. The project team elected to adopt the more stringent guideline usually applied to patients with diabetes and kidney disease for this effectiveness evaluation. For those patients with hypertension, the mean age was 55.2 years (SD = 11.52) with an age range of 27 - 95 years; 100 (42.2%) identified as female and 137 (57.8%) identified as male. Systolic and diastolic BPs were analyzed separately. At Time One (Year One, 1st Quarter) 27.5 percent of systolic BP readings for patients with a diagnosis of hypertension were measured at 130 mmHg or less, and 52.5 percent of diastolic BP readings were 90 mmHg or less. At Time 14 (Year 4, 4th Quarter) 53.5 percent of systolic BP readings for patients with a diagnosis

of hypertension were 130 or less, and 81 percent of diastolic BP readings were 90 or less.

For the 237 patients diagnosed with hypertension, t-tests (for those patients that only had two BP measurements in their medical record) and the repeated measures ANOVA (for patients that had at least four readings in their medical records over the course of the project) of systolic and diastolic BPs were performed. The paired samples t-test was performed on the systolic and diastolic BPs of 149 patients. Comparing the initial measurements of the systolic BP (M = 148.20, SD = 20.28) to the second measurement of the systolic BP reading (M = 135.55, SD = 15.99); a statistically significant difference was found (M = 12.65, SD = 20.39, t (148) = 7.58, $p < .01$). Comparing the initial measurement of the diastolic BP (M = 91.34, SD = 12.19) to the second measurements of the diastolic BP (M = 84.36, SD = 10.91); a statistically significant difference was found (M = 6.98, SD = 13.30, t (148) = 6.41, $p < .01$).

The repeated-measures ANOVA was performed for 30 patients who had at least four BP readings in their medical record since the beginning of the project. A one-way within subject's ANOVA was conducted to compare the effect of the intervention on systolic and diastolic BP readings measured quarterly over the course of the project. Results revealed that there was a significant effect on systolic BP, Wilks Lambda = .75, F (3,27) = 3.03, p = .047. Post Hoc pairwise comparisons were conducted on systolic BPs using the Bonferroni technique. A statistically significant difference was found between systolic measurements at time one (M = 147.43, SE = 4.19) and measurements at time three (M = 134.37, SE = 2.21). Although the analysis did not reveal a statistically significant effect on diastolic BPs over the four measurements (Wilks Lambda = .85, F (3,27) = 1.61, p = .21), a 10 mmHg mean decrease in diastolic BP was found; this 10 mm mean Hg decrease was considered clinically significant.

Discussion

The discussion section addresses the main findings of the statistically and clinically significant patient-centered outcomes of interest, including the clinical and theoretical application of the results. Strengths and limitations of the evaluation design are presented. Implications of and recommendations for nursing research and FNP clinical education are presented. Proportion of asthma patients who use more than one canister of short-acting inhaled beta-agonist per month. The number of short-acting inhaled beta-agonist cartridges also referred to as "Quick-Relief" medications, that were prescribed increased throughout the project. Upon chart review, this rise in prescribing was not due to an increase in asthma symptoms but rather to greater prescriber access to quick-relief medications (e.g., albuterol); thus, allowing for asthma patients to have a rescue inhaler as part of their evidence-based care [30].

In retrospect, the measurement of the number of short-acting inhaled beta-agonist canisters prescribed was not considered useful for the assessment of asthma control in this project. Other measures of asthma control have been reviewed and include individualized asthma action plans, number of asthma symptoms, number of asthma exacerbations, emergency department visits, missed schooldays/workdays due to asthma symptoms and change in peak flow values. Asthma control is especially challenging in the medically underserved [31]. Evidence has shown an improvement in self-management in adults that have an asthma action plan. The decision was made to ensure that all asthma patients had individualized asthma action plans in their medical records in keeping with 2014 National Heart, Lung, and Blood Institute (NHLBI) recommendations and the 2007 Guidelines for the Diagnosis and Management of Asthma [32,33].

In a 2016 review of the evidence for asthma action plans, Kelso examined five heterogenous quantitative research studies (N = 736 children and 135 adults) [34] and concluded that, although there was sufficient evidence for the use of asthma action plans in adults, asthma action plans did not make a difference in symptoms, quality of life or asthma exacerbations in children and adolescents. Providing parent and child education at the time of asthma diagnosis and reinforcing that education at each visit made the most significant difference in asthma-related outcomes. Thus, the documentation of patient/parent education at each visit as well as other indicators are being considered for children and adults alike.

Proportion of adults and adolescents who experience a major depressive episode: Of the patients diagnosed with depression, there was a statistically significant decrease in the number of major depressive events, a reduction from 15 episodes in year one to five episodes in year four. The decline in major depressive episodes was attributed to the implementation of a universal depression screening, diagnosis, and management program. While screening at every visit increased the recognition of individuals with depression, the rate of major depressive episodes decreased. Although physician and nurse practitioner providers were responsible for diagnosing depression, FNP students participated in the screening and used evidence-based guidelines to establish treatment plans in collaboration with physicians, nurse practitioner faculty, volunteer nurses, and clinical nurse specialists (who provided mental health counseling).

Treatment of patients for depression included counseling, medications, support services, evidence-based complementary and alternative measures, and referrals. At the onset of the study period, the 2010 Practice Guideline for the Treatment of Patients with a Major Depressive Disorder for evidence-based clinical practices that supported diagnosis, treatment, and follow-up were implemented. These guidelines were replaced with the 2016

publication of the Canadian Network for Mood and Anxiety Treatment (CANMET) guidelines.

Outcomes comparable to those demonstrated by FNP students using the APNI have been achieved by medical students. In their retrospective review of free clinic patients (N = 215), depression screening of adults by medical students using the PHQ-2 or PHQ-9 [27] increased the rate of depression diagnosed from 19.1 percent (n = 41) prior to screening to 27.9 percent (n = 60) after implementation of screening. Of the patients not previously diagnosed with depression and who had two or more PHQ-9 evaluations (n = 14), eight patients (57.1 %) had a clinically significant improvement in their PHQ-9 score, Clinical improvement was defined as a decrease of more than five points in the total PHQ-9 score [35].

Proportion of the diabetic population with an A1c value greater than nine percent: Results included an average decrease in A1c from greater than 11 to less than nine percent for all patients who had an initial value of greater than nine percent. Of those patients zero (0) had an A1c of greater than nine percent at the end of the evaluation. Decreases in A1c were attributed to the implementation of collaborative evidence-based diabetes care. The APNI included training of FNP students in diabetes care. Instruction in diabetes care included interprofessional medication management, eye and foot exams, diet and exercise recommendations, laboratory screening, use of low-cost medications and diabetic supplies, and appropriate referrals per guidelines [36]. Additionally, a baccalaureate-prepared bilingual diabetic nurse educator instructed patients on diabetic care and lifestyle management. A newly instituted drug adherence program may demonstrate further reductions in A1c values.

Reductions in A1c have been demonstrated in patients in other academic free clinic settings with medical students and underserved patients. One free clinic used medical students to instruct patients in diabetes care along with providing standard of care medical treatment [37]. Investigators measured the A1cs of 45 patients at initial presentation and twelve months later (12.5 ± 1.5 months). Mean hemoglobin A1c values improved significantly ($p < .0001$) from 9.6 (SD = 2.3) to 7.9 percent (SD = 1.8) with an average change of 1.7 percent. A positive association was observed between the increased number of patient education encounters and improvement in A1c values ($r = .06$, $p = .10$). Proportion of adults with high total blood cholesterol levels. Decreases in total cholesterol (TC) in patients identified with elevated TC were attributed to the education of FNP students in the screening and treatment of elevated cholesterol. Studies have evaluated the impact of treatment for underserved patients following Low-Density Lipid Cholesterol (LDL) levels, but few have evaluated TC as a clinical outcome [38,39].

The IMPACT study, a multi-center study of the influence of a patient-centered, interdisciplinary healthcare intervention on clinical outcomes in people with diabetes, included TC as a clinical outcome [40]. In this study, pharmacists were integrated into the interdisciplinary care teams. Investigators enrolled 1,836 participants from 25 communities in the U.S., including free clinic patients. Investigators completed an observational, multivariate, pre-post comparison to evaluate outcomes following the intervention that included individualized counseling on medications and treatment plans. After collecting baseline data, completing the intervention and collecting post-intervention data, the results showed a significant decrease in A1c levels (n = 1,667; p = <.001) and total cholesterol (n = 1,299; p = <.001). Total cholesterol decreased from 179.4 mg/dl (SE = 2.3) to 170.7 mg/dl (SE = 2.2) with a decrease of 8.8l mg/dl (p = <.001). Patients represented individuals from many health centers, including free clinics and positive clinical outcomes for total cholesterol were found with multidisciplinary care for patients at high-risk for cardiovascular events.

For patients with elevated A1c and TC in the APNI study, there were insufficient A1c and TC data points to perform a repeated measures analyses as planned; therefore, the analyses took the form of a pre-post design for this portion of the evaluation. Failure to make or keep follow-up appointments is not uncommon in medically underserved people, and the barriers are not solely financial. In fact, non-financial barriers are more common than financial barriers in causing delayed or missed appointments in underserved patients [41]. Nonfinancial obstacles, including lack of transportation and clinic office hour restraints, are frequently cited by patients of low socioeconomic status for missed scheduled appointments [42]. The Student Healthcare Project has five point-of-care free clinic sites and a variety of hours, including weekend hours, to meet some of these needs. Due to the lack of research studies that used TC as an outcome, future studies should include additional lipid measurements of Low-Density Lipid Cholesterol (LDL) and High-Density Lipid Cholesterol (HDL) in addition to TC. Newer American Heart Association Task Force (ATP) IV Guidelines [43] used blood pressure, TC, and HDL to calculate cardiovascular risk [44]. It is projected that with the implementation of patient medication adherence program and the recent 2018 Guideline on the Management of Blood Cholesterol [45], patients will achieve improved lipid control and a reduction in cardiovascular risk.

Proportion of adults with hypertension whose blood pressure is under control: Statistically and clinically significant decreases in systolic blood pressure were observed for patients diagnosed with hypertension in the year preceding the intervention that attended one or more of the student-run free clinics throughout the project; statistically and clinically significant decreases in diastolic blood pressure were also noted. Depending on the analytic technique (e.g., t-test or ANOVA), systolic BPs decreased by 13 mmHg, and diastolic BPs decreased by 7-10 mmHg. According to the JNC7

Report [29], a systolic BP decrease of 10 mmHg and a diastolic BP decrease of 5 mmHg can reduce the risk of cardiac and cerebrovascular events by 25 and 33 percent respectively.

The reductions of systolic and diastolic blood pressures were attributed to screening and evidence-based treatment, to include exercise and patient education in Dietary Approaches to Stop Hypertension (DASH) diet [46]. Faculty, FNP, and undergraduate nursing students collaborated to establish education priorities for patients and participated in the patient adherence education program. Kibria, et al. [47] completed a review of hypertension guidelines at a free clinic in Providence, Rhode Island. They completed a retrospective record review, evaluated treatment outcomes of their patients (n = 57) compared with standard criteria for hypertension. The study compared their outcomes with the National Health and Nutrition Examination Survey (NHANES) data, and they found that 50 percent of their patients met treatment goals and findings were comparable or better than national appraisals.

Strengths and Limitations of the Evaluation Design

Although a randomized controlled trial is considered the gold standard for evaluation of interventions, randomization was not possible at the student-run free clinics; therefore, the time-series design was used to evaluate the intervention at the five free clinics over four years. Historical data were gathered for the year preceding the intervention (Year One of the project) with patients acting as their own controls throughout the intervention; thus, decreasing historical and selection threats to internal validity [24]. The extended period of data collection at each clinic for each patient with the specified outcome of interest allowed for greater confidence in the attribution of the observed changes, both statistical and clinical, to the intervention.

Although large numbers of data points are necessary for time-series designs, for most outcomes of interest this was not a problem and the ANOVA or its nonparametric equivalent (e.g., Chi-square, Kruskal-Wallis H test) was performed. For those outcomes for which all necessary data points were not available, alternative analytic techniques were used (e.g., t-test and nonparametric equivalents), effectively changing the design in those instances to a before and after design. Pretest-posttest designs have inherent weaknesses in causal inference and can introduce threats to internal validity (e.g., maturation, history) [24,25].

Recommendations for Future Use of the Transdisciplinary Model

The Transdisciplinary Model of Evidence-Based Practice (TMEBP) guided the development of the Advanced Practice Nurse Intervention (APNI). Transdisciplinary teams have evolved from the team approach in healthcare. The transdisciplinary model incorporates shared knowledge, skills, and responsibilities of team members. These activities blurred traditional lines of healthcare duties between the disciplines and engendered respect, flexibility, and sharing among team members. Through effective communication among members, the transdisciplinary care approach has been found to promote effective, comprehensive healthcare services [48,49].

As the gap in health disparities continues to widen, it is vital to develop a healthcare workforce capable of providing efficient, high-quality care. The focus should be placed on education and training of transdisciplinary healthcare teams that can offer culturally appropriate services [50]. Training opportunities such as those experienced by the FNP students that participated in the APNI have been supported by the Institute of Medicine [51]. A harmonized multidisciplinary process for clinical decision-making allows for the implementation of evidence-based healthcare at the individual, community, and population levels and has been shown to improve health outcomes and reduce disparities [23].

Recommendation for Future FNP Education

The nursing profession is the largest segment of the nation's health care workforce, with more than three million members. According to the IOM [52], nursing education should promote higher levels of education for nurses to become full partners with physicians and other healthcare professionals. Healthcare education should be redesigned to allow for multidisciplinary educational and clinical opportunities where these diverse disciplines can communicate, develop strategies of shared decision-making, and provide care services. This model of healthcare education has been shown to promote comprehensive, accessible, quality care with improved patient outcomes [51]. Study results demonstrated the positive effect of the APNI, specifically provided by FNP students, on health status for this sample of underserved patients. Further recommendations include continuing to use the TMEBP model in FNP education and clinical practice. Vulnerable populations present to the healthcare system with specific challenges and require unique care options. A transdisciplinary model of healthcare can meet the needs of the medically underserved while simultaneously offering a rich transdisciplinary learning experience.

Recommendations for Future Research

Recommendations for future research include the incorporation of multiple time series designs that include one or more non-equivalent control groups. These designs will make inferences about outcome results more convincing because external factors would be presumed to be the same for all groups [24,25]. This design was not possible in the current study as FNP students rotated through all five clinics; no one clinic was without FNP students. At the time of this writing, no other studies were found that reported on outcomes of FNP students as providers of care for underserved people. Given the positive results observed in this project, future research should include studies that evaluate

the care provided to vulnerable populations by FNP and other nurse practitioner students.

Conclusion

Chronic diseases are prevalent in medically underserved populations. This project highlighted the effectiveness of nurse-managed student-run free clinics for medically underserved populations, specifically homeless people, and those individuals that are, by definition, migrant and refugee peoples. Guided by the TMEBP, the APNI was developed and implemented at five point-of-care sites. Statistically and clinically significant improvements in outcomes of interest were observed. The strength of the time series design allowed for attribution of results to care the intervention. The findings suggest that the APNI helped prepare FNP students to deliver care that led to improved outcome indicators for patients diagnosed with depression, diabetes, hypercholesterolemia, and hypertension. Evaluation of the APNI included identification of and recommendations for improvement. Incorporation of individualized asthma action plans and documentation of asthma education has been instituted and additional evidence-based indicators for asthma control are being considered. Future reports of change in cholesterol will include TC, HDL, and LDL measurement. Recommendations for future research include the incorporation of the TMEBP to guide the development of interventions and educational programs of study and the use of longitudinal designs that allow simultaneous evaluation of multiple interventions and patient populations.

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