JAANP

Enhancing medication adherence in older adults at two nurse practitioner–owned clinics

Cecily Kulsick, DNP, AGPCNP-BC (DNP Graduate)[1], Jennie Votta, DNP, FNP-C (DNP Graduate)[1], Wendy L. Wright, DNP, ANP-BC, FNP-BC, FAANP, FAAN, FNAP (Owner and Practitioner)[2], Patricia White, PhD, ANP-BC, FAANP (Associate Professor)[1], & Shelley Strowman, PhD (Associate Professor of Practice)[3]

ABSTRACT

Background: The World Health Organization identified medication adherence as the greatest opportunity to improve outcomes related to chronic disease. Adherence rates of 80% or greater, or taking medication as prescribed at least 80% of the time, can positively impact health outcomes.

Local problem: A prior study at two nurse practitioner (NP)–owned family practice clinics in New Hampshire measured medication adherence among adult type-2 diabetes mellitus (DM) patients at 77% and declining over a 4-year period. Patients' hemoglobin A1c rates were stagnant despite previous initiative to improve this biomarker.

Methods: Nurse practitioners were educated on provider-driven strategies to improve medication adherence in the older adult with DM, hypertension, and hyperlipidemia. A review of medical records was performed on patients for 52 weeks before seminar and 13 weeks after seminar to capture medication adherence rates and clinical biomarkers.

Intervention: Pre- and postseminar data were analyzed to determine whether the seminar resulted in improved adherence and clinical outcomes.

Results: Preseminar medication adherence rates exceeded evidence-based standards of 80% for each condition. Postseminar, statistically significant improved adherence rates were seen among DM patients with hypertension. Adherence worsened among hyperlipidemia patients, although this change was not statistically significant. Clinical biomarkers saw little change.

Conclusions: This quality improvement project found that educating NPs on strategies to improve medication adherence can improve adherence among DM and hypertension patients. Continued education and measurement of adherence and clinical biomarkers are encouraged to capture more postseminar visits. This project adds to the growing body of knowledge about patients managed by NPs and NP-owned practices.

Keywords: Diabetes mellitus type II; hyperlipidemia; hypertension; medication adherence; Nurse Practitioner; older adult.

Journal of the American Association of Nurse Practitioners 00 () 1–10, © 2020 American Association of Nurse Practitioners

DOI# 10.1097/JXX.0000000000000414

Introduction

Problem description

The World Health Organization (WHO) estimates that chronic disease has contributed to 41 million deaths globally each year (WHO, 2018) and requires diligent management. In 2003, WHO identified medication adherence, or the extent to which patients take medications as prescribed including correct doses and administration times, as the single greatest opportunity to combat undesired outcomes related to chronic conditions (Sarabi, Sadoughi, & Orak, 2016). Medication adherence greater than or equal to (≥) 80%, determined as a patient using medication as prescribed at least 80% of the time, has been found to improve individual health outcomes by stabilizing the disease progression and improving the quality of life (Yap, Thirumoorthy, & Kwan, 2016). It is estimated that up to 50% of patients in developed countries do not take medications as prescribed, with even lower adherence in chronic diagnoses such as diabetes mellitus type II (DM), hypertension, and hyperlipidemia (WHO, 2003).

[1]*UMASS Medical School, Graduate School of Nursing, Worcester, Massachusetts,* [2]*Wright & Associates Family Health Care, Amherst, New Hampshire and Concord, New Hampshire,* [3]*Department of Nursing, Simmons University, Boston, Massachusetts*

Correspondence: *Cecily Kulsick, DNP, AGPCNP-BC, UMASS Medical School, Graduate School of Nursing, Beth Israel Deaconess Medical Center, 185 Pilgrim Road, Palmer 6, Boston, MA 02215. Tel: 401-230-5325; Fax: 617-632-1040; E-mail: cecilykulsick@gmail.com*

Received: *29 August 2019; revised: 2 February 2020; accepted 6 February 2020*

The medication adherence gap identified by WHO in 2003 persists today. Annually, an estimated 1.6 billion prescriptions have not been taken as prescribed (Sarabi, Sadoughi, Orak, & Bahaadinbeigy, 2016). A 2013 survey of Americans aged 40 years or older with at least one chronic disease revealed that more than half did not take their prescription medications as prescribed. This national report gave a score of C+ for medication adherence (National Community Pharmacists Association, 2013).

Medication adherence is specifically an opportunity among patients aged 65 years and older ("older adults") for at least three reasons. First, the US population is aging, with the number of older adults doubling from 1975 to 2015 (US Department of Health and Human Services [US-HHS], 2017). Second, 61.6% of older adults are diagnosed with two or more chronic conditions, frequently requiring long-term prescription medication for proper management (US-HHS, 2017). Prescription medications have been used by 90.8% of older adults, and 42.2% patients have used five or more medications (US-HHS, 2017).

Third, medication adherence has been shown to improve outcomes in older adults. Among older adults prescribed at least one antihypertensive medication, those with adherence rates of ≥80%, or taking antihypertensive medication as prescribed at least 80% of the time, were found to have more positive outcomes. They had 56% lower risk for cardiovascular disease and ischemic heart disease, 61% lower risk for stroke or transient ischemic attack, and 43% lower risk for heart failure exacerbation over nearly 6 years of measured follow-up (Yap et al., 2016). These outcomes underscored the importance of improving adherence in this at-risk population.

Measuring medication adherence has proven to be a challenge. The most accurate methods of measurement have historically been high burden, high cost, and difficult to scale across multiple participants over time (Lehman et al., 2014). Examples include patient observation and serum testing for pharmacologic or biomarker properties. Other proxy methods of measurement exist but have not resolved the high-cost and high-burden nature of accurate measurement. These include electronic devices, self-reported instruments, pill counts, pharmacy refills, and prescription renewals (Lehman et al., 2014). These examples are also difficult to implement in smaller studies and smaller practices.

This quality improvement (QI) project focused on medication adherence at two nurse practitioner (NP)–owned and operated clinics in New Hampshire ("the clinics"), the NPs at these clinics, and the older adult population they serve. There are several reasons for this focus. First, the majority of chronic disease is managed in primary care, an ideal setting for prevention, detection, diagnosis, management, and education across stages of disease. Second, the provider role in medication adherence among older adults is profound, as this population makes more than 300 million provider visits per year (Rui & Okeyode, 2016). With this level of patient interaction, providers may have an impact on adherence rates that is low burden, low cost, and feasible to scale. Third, although the clinics treat patients across the lifespan, the older adult is of high relevance to medication adherence given this population's disproportionately high use of pharmacologic therapy.

Finally and importantly, a recent 4-year QI project studying the clinics' adult DM patient population identified medication adherence as an opportunity for improvement (Wright et al., 2019). Although the clinics were found to meet or exceed national benchmarks for adherence to multiple standards of care set by the American Diabetes Association, the QI project identified a decrease in estimated medication adherence among adult patients with DM, from 87.1% in 2013 to 77.0% in 2017 (Wright et al., 2019). This variability prioritized continuous improvement of medication adherence at the clinics. Of note, NPs in New Hampshire have full practice authority including privileges to prescribe medications.

Available knowledge on strategies to improve medication adherence

A literature search was conducted to identify provider-driven strategies that have improved medication adherence. PUBMED, Cochrane, and Google Scholar databases were used. Search terms included "medication adherence," "older adult," "older persons," "elderly," "primary care," "chronic disease management," "diabetes," "hypertension," "hyperlipidemia," and "medication compliance." The literature review focused on two systematic reviews and one retrospective cross-sectional cohort analysis, each focused on the older adult. Five additional studies were included for general population findings.

Based on the literature search, there are many factors contributing to nonadherence and a single patient's nonadherence can be multifactorial. Medication nonadherence can be categorized in two ways: intentional and unintentional (van Driel et al., 2016). Factors that may lead a patient to intentionally not take medications include financial barriers, side effect profiles, and lack of perceived benefits (van Driel et al., 2016). Unintentional barriers include complicated medication regimens and forgetting to take a dose (van Driel et al., 2016). Given that the multifactorial nature of medication adherence is indeed multifactorial, an intervention that addresses several barriers to adherence will likely demonstrate the most success.

The literature review identified four common themes with specific relevance to the provider: medication management, provider continuity, provider behavior, and reminders to patients. First, provider-driven medication management has proven to influence medication

adherence. For example, diligence in conducting medication reconciliations and screening for side effects during older adult patient visits correlated with improved medication adherence (Gellad, Grenard, & Marcum, 2011; Yap et al., 2016). Simplification of medication regimens can also positively impact medication adherence in older adults. Examples include the identification of polypharmacy and the opportunity for deprescribing, as well as the consolidation of medications and doses via combination pills, extended release formulas, and/or fewer dosage times per day (van Driel et al., 2016; Gellad et al., 2011; Nieuwlaat, Wilczynski, & Navarro, 2014; Schroeder, Fahey, & Ebrahim, 2004). One study noted that simplification of medication regimens increased adherence rates by up to 20% (Schroeder et al., 2004).

Second, older adult patients who consistently saw the same provider over time were found to be more adherent with medications (Maciejewski, Hammill, & Bayliss, 2017; Tamblyn, Eguale, & Huang, 2014; Warren, Falster, & Tran, 2015). Medication adherence was found to be worse among older adult patients with DM and/or hyperlipidemia who saw more than three prescribers in 1 year versus one prescriber (Maciejewski et al., 2017). Evidence was also significant among the general population, including a large cohort study with an average age of 61.6 years (Tamblyn, Eguale, Huang, Winslade, & Doran, 2014). Older adult patients with more frequent provider visits were found to have higher adherence rates as well (Gellad et al., 2011).

Third, several aspects of the provider-patient interaction are associated with medication adherence in older adults (Yap et al., 2016). Specifically, medication adherence was suboptimal among older adult patients in cases of dissatisfaction with the office visit, perception of provider unprofessionalism, low patient involvement, and poor communication. This reinforced the importance of provider presence, approach, communication styles, and collaborative practices.

Fourth, medication reminders have been shown to improve medication adherence. Specifically, technology-driven text messages, automated phone calls, and Internet-based care significantly increased medication adherence in the general population (Nieuwlaat et al., 2014; van Driel et al., 2016). More traditional methods were also effective including manual phone calls by a nurse or an at-home reminder calendar, which raised adherence rates from 70.4% to 82.4%, respectively (Schroeder et al., 2004).

Other provider-driven interventions yielded inconclusive results or were ineffective. Motivational interviewing was ineffective in more than half of studies included in one systematic review on the general population (Nieuwlaat et al., 2014). Patient education, such as written materials, was ineffective for the general population with improvement found in just one of seven studies (Schroeder et al., 2004).

Among the strengths of this literature search was the inclusion of multiple works that focused on DM, hypertension, and hyperlipidemia. The quality of evidence was also strong with five systematic reviews drawing from more than 1 million patients. These systematic reviews were diligent in identifying and accounting for cases of bias risk and design flaws. Two cohort studies represented another 50,000 patients collectively.

Limitations of the literature were also identified. First, the measurement of adherence itself was consistently identified as a challenge because it is difficult to measure. Measurement is attempted in various methods such as self-reporting, direct reporting, pill counts, and fill rates as well as electronic monitoring and serum drug levels. Also, given the nature of systematic reviews, results were not pooled statistically across studies, so the conclusions drawn across studies were limited.

There are many factors influencing medication adherence beyond the scope of this QI project. Adherence strategies can be activated by the provider as well the pharmacist, caregiver, or by the patient themselves. Furthermore, medication adherence is potentially complicated by health status, availability of a caregiver or visiting nursing services, and barriers to health care access such as transportation, beliefs about medications, cognitive function, depression, and ambulatory status (Yap et al., 2016). Financial challenges are a major barrier to medication adherence across all populations and, specifically, the older adult. Given that the current project focused exclusively on provider-driven interventions, financial barriers were beyond the project's scope.

Specific aims

This QI project addressed the following clinical question: does implementation of evidence-based, provider-driven strategies increase medication adherence in the clinics' older adult patients with diagnoses of DM, hypertension, and/or hyperlipidemia?

Methods

Context

The clinics have prioritized medication adherence for several reasons. First, a 4-year QI project conducted by NP students at a Boston-area graduate nursing school determined that medication adherence among the clinics' DM patients between 25 and 84 years was at 77.0% in 2017, meaning that nearly one-quarter of these patients took medications as prescribed less than 80% of the time (Wright et al., 2019). This rate of medication adherence had dropped from 87.1% in 2013 (Wright et al., 2019) and presented an opportunity for improved patient outcomes if the medication adherence rate again improved.

Furthermore, hemoglobin A1c levels among these patients did not consistently improve between 2013 and 2017, despite provider adherence to national DM management clinical guidelines that outpaced national rates (Wright et al., 2019). Finally, the clinics are incentivized by an accountable care organization (ACO) to meet quality metrics related to chronic disease management, including medication adherence. Providers are eager to enhance their practices to improve patient adherence, quality metrics, patient outcomes, and ACO incentives.

Intervention

On September 11, 2018, a 1-hour educational seminar for the clinics' providers was led by two students in a Doctor of Nursing Practice (DNP) program at a central Massachusetts medical school. Content included four evidence-based, provider-driven strategies to improve medication adherence in the older adult: medication management, prescriber consistency, provider-patient interaction, and medication reminders. A collaborative discussion was also held with the NPs and clinical staff to gain perspective on perceived barriers to adherence. Providers were given a pocket card that summarizes the four interventions for easy in-clinic reference (**Figure 1**). The main intervention of this QI project was the measurement of pre- and postseminar medication adherence and clinical biomarkers among older adult patients with specific chronic diseases.

Methodology

A preliminary review of medical records was conducted by the DNP students in September 2018 at the clinic in Amherst, NH. Data were collected for older adult patients of both clinics with diagnoses of hypertension, hyperlipidemia, and/or DM. This review of medical records established a preseminar baseline for medication adherence and clinical biomarkers over a 1-year period (September 1, 2017 to August 31, 2018). A proxy adherence rate was calculated based on estimated prescription refill frequency. This was measured based on patient requests to the clinics for medication refills, the frequency of which was compared with the expected timing of refill requests if the medication was being taken as directed.

In January 2019, a second review of medical records was conducted to capture 13-week postseminar data on adherence rates and clinical biomarkers. This established a measurement methodology that can be used to continue measuring postseminar adherence rates in the future.

Secondarily, NP feedback from both pre- and postseminar was collected using a five-item survey that asked NPs to rank the informativeness of the seminar and ease of implementing the strategies taught in the seminar. The survey was administered through SurveyMonkey, an online survey tool.

Participants. Participants in this QI project included 319 patients using the following inclusion criteria: patients aged 65 years and older with at least one of the following diagnoses: hypertension, hyperlipidemia, and/or DM; and medication prescribed by a provider of the clinics to manage one or more of these conditions.

Secondarily, the seminar participants included the clinics' 19 NPs and medical assistants. Nurse practitioners were required to be certified by the American Nurses Credentialing Center or American Association of Nurse Practitioners family nurse practitioner board with active licensing and prescribing credentials for treatment of older adults.

Setting. The clinics are NP-owned and NP-operated family medicine clinics serving patients of all ages with a panel of approximately 6,000 patients. They are located in rural Amherst, NH, and urban Concord, NH. The clinics are staffed by seven NPs and 12 medical assistants. All NPs are family NPs. Patients are seen during 30- and 60-minute visits.

Data set organization and security. A Microsoft Excel spreadsheet was organized with each medication for each patient listed in a row. Each row was populated across the following column fields: medical record number, age, diagnosis, most recent systolic and diastolic blood pressure (DBP) readings within the past year, most recent lipid panel within the past year, most recent hemoglobin A1c reading within the past year, medication name, and adherence rate. These fields were populated during both the pre- and postseminar chart reviews.

Risk related to data and information technology was relatively low. This project maintained a deidentified and protected environment for data use in three manners: (1) conducting data extracts in accordance with Health Insurance Portability and Accountability Act (HIPAA) and clinic guidelines, (2) limiting use of data to only the necessary data fields, and (3) limiting use of data to only the necessary end users with adequate laptop security measures.

Study of the intervention

The impact of the educational seminar was assessed by measuring change in adherence and clinical biomarkers over time. It was expected that if the seminar changed provider behavior with older adults, this may result in improved medication adherence, which may improve clinical biomarkers.

Measures

The primary outcome measure of this QI project was medication adherence rate. Given the difficulty of measuring actual medication adherence, a proxy medication adherence was calculated based on patient medication refill requests captured in the electronic medical record

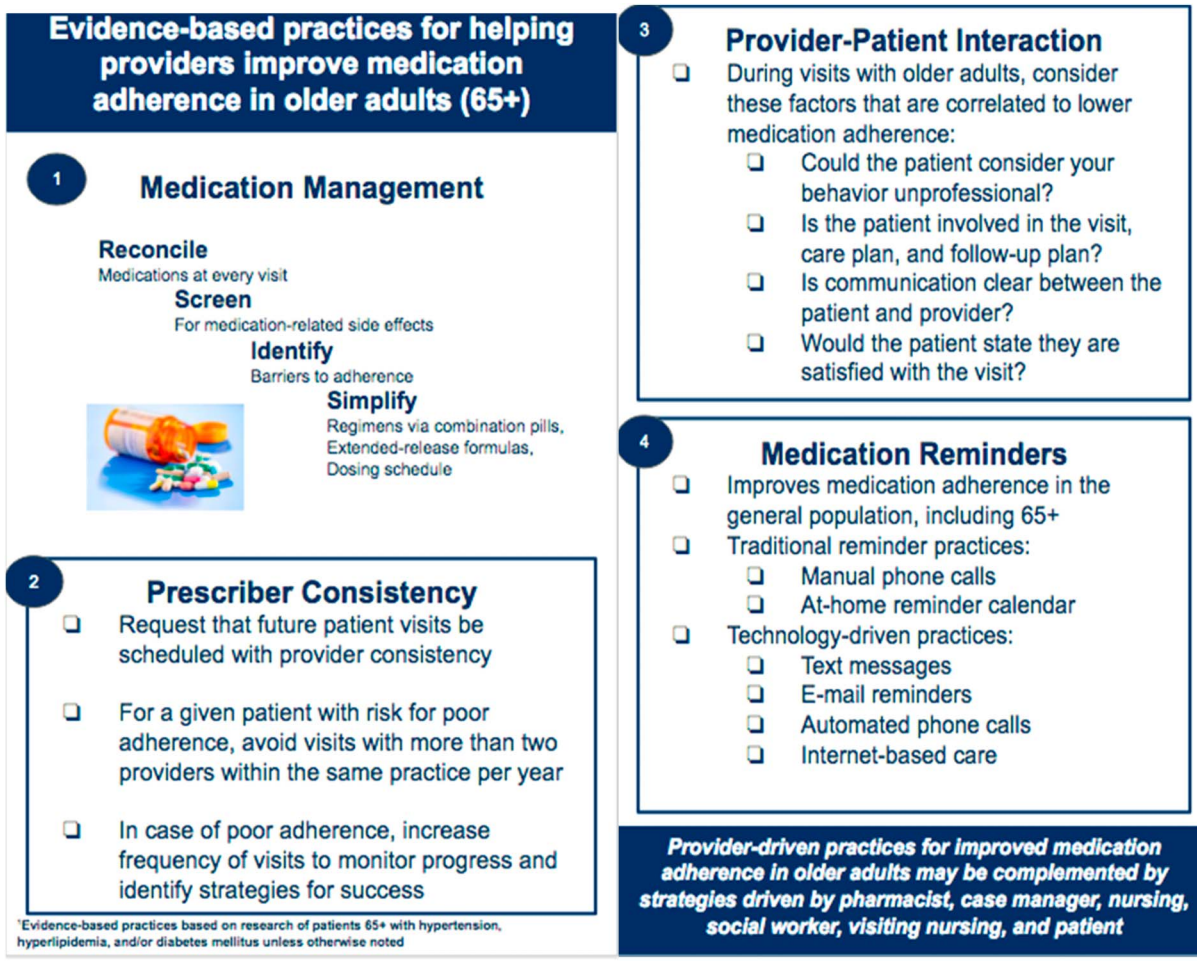

Figure 1. Provider Pocket Card. This reference card summarizes the four evidence-based provider-driven strategies presented in the educational intervention. This allowed for easy in-clinic access to the strategies for providers.

(EMR). By reviewing requests for each medication, it was estimated if the patient was refilling in accordance with usage as prescribed or if refill requests were not occurring at that frequency. Patients with estimated adherence rates of ≥80% were classified as adherent, whereas rates of <80% were classified as nonadherent.

Secondary outcome measures were as follows: (1) systolic blood pressure (SBP), (2) DBP, (3) low-density lipoprotein (LDL), and (4) hemoglobin A1c. These secondary measures were used to evaluate whether medication adherence was associated with patient outcomes.

Analysis

Nonparametric Mann–Whitney tests were used for the analysis of changes in medication adherence rates from preseminar to postseminar as a result of of skewed distributions. Chi-square tests were used to compare the percentage of patients qualifying as adherent from pre-to postseminar because adherence was a categorical variable in this analysis. For analyses of medication adherence, sample sizes were the number of prescriptions. These were consistently higher than patient sample sizes because of some patients taking multiple medications.

Comparison of pre- versus postseminar data for the four clinical markers was also performed using the Mann–Whitney test because of a small number of post-intervention patients with hyperlipidemia and DM. Means and standard deviations of SBP, DBP, LDL, and hemoglobin A1c are presented for ease of interpretation. All findings were presented in aggregate form across all patients and prescriptions. Additionally, provider feedback surveys were analyzed by comparing mean ratings for the five items.

Ethical considerations

Patients of the clinics have agreed in writing to the inclusion of their deidentified chart data in QI projects. Furthermore, the University of Massachusetts Medical School Institutional Review Board approved this QI project. The data extraction was conducted on-site at the clinic in accordance with clinic and Health Insurance Portability and Accountability Act of 1996 regulations. All data were deidentified to safeguard protected health

Table 1. Pre- and postintervention demographics

	Hypertension		Hyperlipidemia		DM Type 2	
	No. of Patients	% of Total Patients	No. of Patients	% of Total Patients	No. of Patients	% of Total Patients
Patient age						
Preperiod total	142	100.0	106	100.0	23	100.0
65–74	94	66.2	79	74.5	16	69.6
75–84	41	28.9	24	22.6	6	26.1
85+	7	4.9	3	2.8	1	4.3
Postperiod total	96	100.0	32	100.0	16	100.0
65–74	65	67.7	23	71.9	11	68.7
75–84	28	29.2	9	28.1	5	31.3
85+	3	3.1	0	0.0	0	0.0
Patient gender						
Preperiod total	142	100.0	106	100.0	23	100.0
Female	101	71.1	76	71.7	18	78.3
Male	41	28.9	30	28.3	5	21.7
Postperiod total	96	100.0	32	100.0	16	100.0
Female	68	70.8	21	65.6	11	68.8
Male	28	29.2	11	34.4	5	31.2

Note: DM = diabetes mellitus.

information. Pursuant to the Safe Harbor Method as stipulated by the US-HHS, data of patients older than 89 years were further deidentified by assigning the age of 90 years to these patients (US-HHS, 2015) to avoid easy identification. Extracts contained only the specific data required for this QI project and were stored on antivirus-protected laptops.

Results

Sample

Of 319 medical records reviewed in September 2019, patients were narrowed down based on having active medications prescribed through the clinics with refill activity within the past 12 months, as well as a record of relevant clinical biomarkers within the same period. Qualifying patients for the postseminar period required inclusion in the preseminar period as well as at least one visit, refill activity, and at least one new clinical biomarker during the 13-week postperiod. Therefore, postseminar samples were smaller than preseminar ones for both the number of patients and the number of prescriptions. For hypertension, the preseminar sample was 142 patients and decreased to 96 in the postseminar period. For hyperlipidemia, the preseminar sample of 106 decreased to 32 postseminar. For DM, the preseminar sample of 23 patients decreased to 16 postseminar.

Patient age and gender were consistent across disease conditions in both the pre- and postseminar periods (**Table 1**). The majority of patients, 66%–75%, were between 65 and 74 years. Fewer than 5% of patients were 85 years or older. Female subjects represented greater than 65% of patients across each disease state.

Pre- vs postseminar changes in adherence and clinical markers

Adherence rates. **Figure 2** depicts pre- versus postseminar adherence rates. Adherence rates were measured before the educational seminar to establish a baseline for the clinics' older adult patients with hypertension,

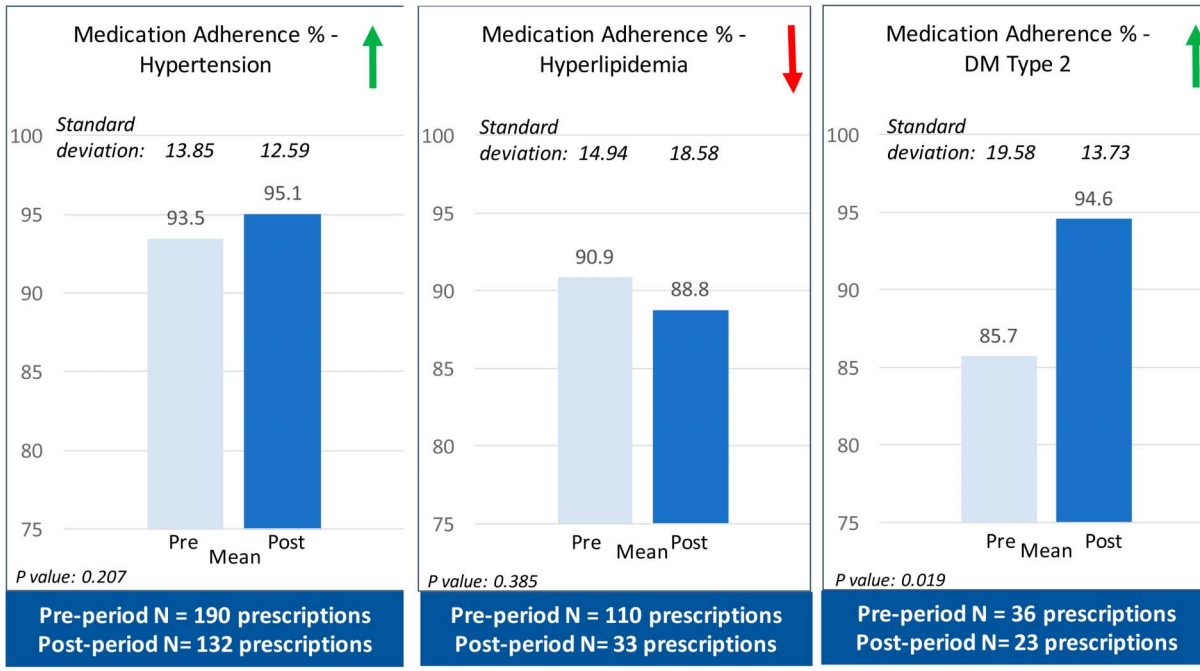

Figure 2. Pre- and postseminar medication adherence. Measured adherence rates are compared for pre- and postseminar periods separately for each condition using Mann–Whitney tests. Medication adherence rates improved among patients with DM from 85.7% in the preseminar period to 94.6% in the postseminar period and is statistically significant (p = .019). Although adherence rates improved among patients with hypertension and worsened among those with hyperlipidemia, neither result is statistically significant. DM = diabetes mellitus.

hyperlipidemia, and/or DM. Recalling that adherence is defined as taking medication as prescribed at least 80% of the time, the preseminar baseline was strong. Hypertension and hyperlipidemia mean adherence rates both exceeded 90% (93.5% and 90.9%, respectively), and DM mean adherence was 85.7%.

Adherence rates improved for hypertension patients from 93.5% preseminar (SD = 13.85) to 95.1% postseminar (SD = 12.59), although not statistically significant (p = .207). Adherence declined for hyperlipidemia patients from 90.9% preseminar (SD = 14.94) to 88.8% postseminar (SD = 18.58), also nonsignificant (p = .385). Adherence rates improved for DM patients from 85.7% preseminar (SD = 19.58) to 94.6% postseminar (SD = 13.73), and this improvement was statistically significant (p = .019).

Percentage of adherent patients. **Figure 3** depicts the percentage of patients classified as adherent both pre- and postseminar. Preseminar, 85.8% of hypertension patients had ≥80% adherence rates. This improved to 91.7% in postseminar. Among hyperlipidemia patients, 81.8% of preseminar patients were ≥80% adherent. This declined to 75.8% postseminar. Among DM patients, 72.2% of preseminar patients had ≥80% adherence rates. This improved to 87.0% postseminar. Across the three medical conditions, results were not statistically significant with p values exceeding 0.05.

Clinical markers. The clinical markers showed little change at 13-week postseminar (**Figure 4**). Among hypertension patients, mean SBP changed from 127.8 mm Hg preseminar (SD = 11.83) to 127.4 mm Hg postseminar (SD = 9.78). Mean DBP remained flat at 78.0 mm Hg pre-seminar (SD = 7.01) and 78.3 mm Hg postseminar (SD = 7.33). Among hyperlipidemia patients, mean LDL levels decreased from 93.2 mg/dl preseminar (SD = 28.22) to 92.3 mg/dl postseminar (SD = 34.41). Among DM patients, mean hemoglobin A1c levels decreased from 6.9 mg/dl preseminar (SD = 1.10) to 6.8 mg/dl postseminar (SD = 0.96). Across the three conditions, changes from preseminar to postseminar were not statistically significant.

Provider feedback. The purpose of the survey was to obtain feedback from the providers on the informativeness of the four evidence-based interventions taught in the seminar, their ease of implementation, and impact on daily practice.

On a scale of 1 (least informative) to 4 (most informative), providers ranked medication management and patient-provider interaction as the most informative topics, both scoring a mean of 2.9 out of a possible total score of 4.0. Provider consistency was ranked lower (mean = 2.3), and medication reminders was lowest (mean = 2.0). The NPs also ranked the ease of incorporating the interventions into daily practice. On a scale of 1 (least ease) to 4 (most ease), medication management was the highest-scoring intervention at a mean of 3.0 out of a possible total of 4.0. The remainder of

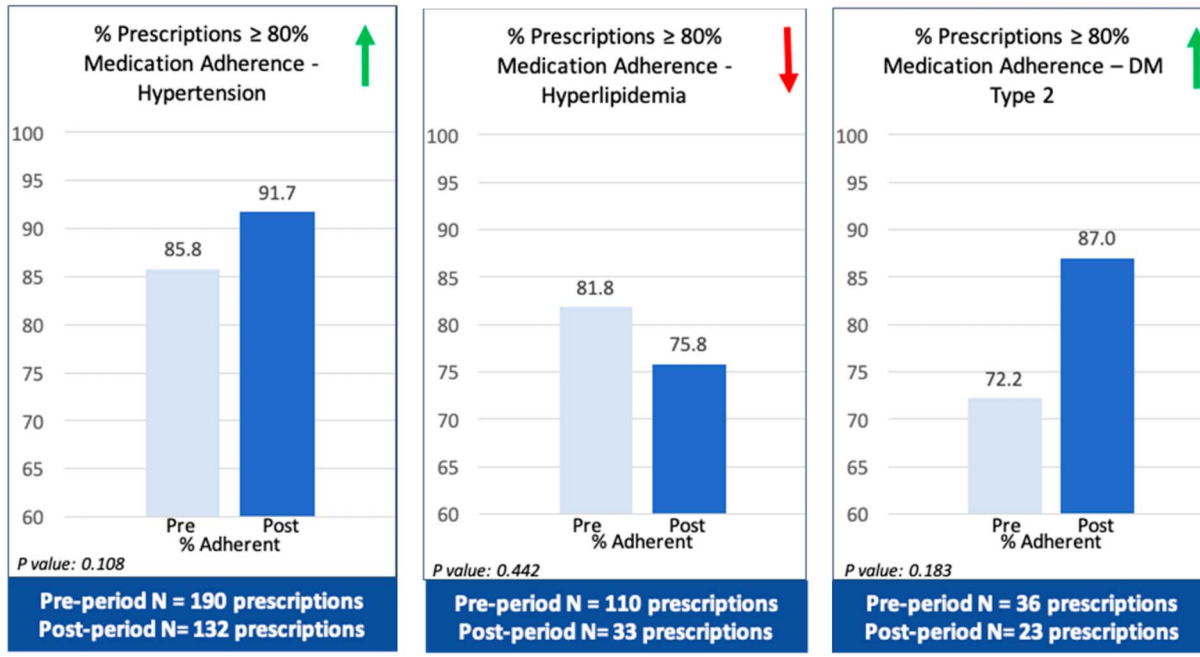

Figure 3. Pre- and postseminar percentage of patients who were adherent. Proportions of adherent patients are compared for pre- and postseminar periods separately for each disease condition using Chi-square tests. Although the percentage of total patients qualifying as adherent improved among patients with hypertension and those with DM type 2, the percentage declined among patients with hyperlipidemia. None of these results are statistically significant. DM = diabetes mellitus.

the strategies were ranked as follows: provider consistency (2.9), patient-provider interaction (2.3), and medication reminders (2.0).

A final survey question was open ended and asked NPs for input on other barriers to adherence that were not addressed during the seminar. Nurse practitioners identified insurance issues and storage of medications as additional factors impacting their patients' abilities to reach ≥80% adherence.

Discussion

Interpretation

Improvement in adherence rates from preseminar to postseminar was statistically significant for patients with DM, although hemoglobin A1c did not show statistically significant improvement after 13 weeks. In the case of hypertension, adherence rates improved without statistical significance, and clinical markers showed modest change. This may be in part due to the postseminar time frame being only 13 weeks after the seminar.

Among hyperlipidemia patients, adherence rates actually declined in the postseminar period, although the change was not statistically significant. The LDL clinical marker declined in the postseminar, but the change was minimal. With more time, adherence may change to a positive trend similar to hypertension and DM.

A meaningful change to clinical biomarkers postseminar would require (1) a postseminar clinic visit with a newly implemented provider-driven strategy to improve medication adherence, (2) improved adherence by the patient, (3) adequate time for therapeutic effect from the medications, and (4) a subsequent visit to the clinic that includes follow-up clinical markers. Continued monitoring may detect improved clinical markers after adequate time for these required events.

It is important to note that preseminar adherence rates and clinical biomarkers established a strong baseline. There are multiple factors within the practice standards at the clinics that may have contributed to this baseline. Although a 2019 study using a statistically weighted sample of 3.2 billion primary care visits from 2008 to 2015 identified the average office visit time as 21.6 minutes in 2015 (Rao, Shi, Ray, Mehortra, & Ganguli, 2019), patient visits at the clinics were either 30 or 60 minutes in duration, which allowed for more dedicated patient-facing time. These visits were also prepared by a care planner who identified opportunities and concerns for the NP before the visit such as identification of suboptimal medication adherence. Nurse practitioners were also alerted to possible suboptimal medication adherence by the EMR, which highlighted prescriptions that were past due for refill.

In addition, three additional factors have established a culture of continuous improvement for medication adherence at the clinics. As mentioned, the clinics have participated in an ACO for 5 years that includes medication adherence as a key metric. The clinics also conduct annual QI projects with medication

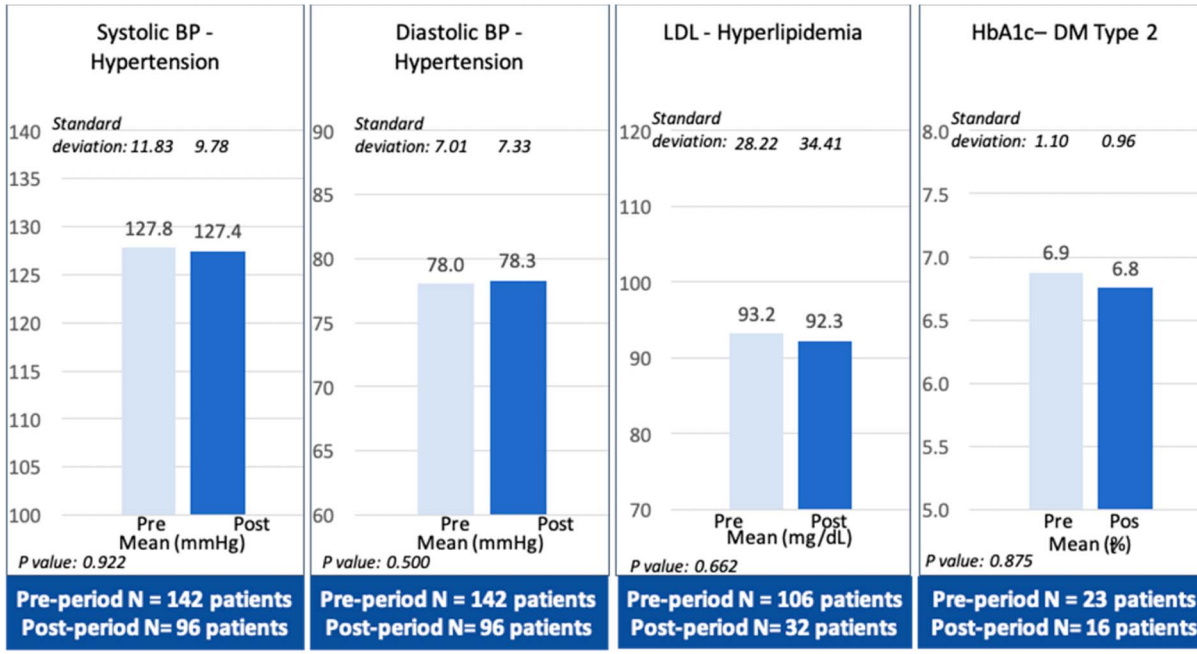

Figure 4. Pre- and postseminar clinical markers. Clinical markers are compared for pre- and postseminar periods for each condition using Mann–Whitney tests. Clinical markers improved in the cases of SBP, LDL, and HbA1c. DBP showed a slight increase from pre-to postseminar. None of these results are statistically significant. DBP = diastolic blood pressure; DM = diabetes mellitus; HbA1c = hemoglobin A1c; LDL = low-density lipoprotein; SBP = systolic blood pressure.

adherence often being a relevant component of the project. Finally, the NP-provider model at the clinics establishes emphasis on primary prevention with medication adherence being a component of that.

The clinics' patient biomarkers were at or near national clinical guidelines for hypertension, hyperlipidemia, and DM preseminar. With this strong base, postseminar improvement in clinical biomarkers may have been more modest than if preseminar biomarkers were suboptimal. This will also become more clear with monitoring over time.

Limitations

Perhaps, the greatest limitation was the measurement of medication adherence itself. It was difficult to measure adherence because of its occurrence in the patient's daily private life. Although refill requests can serve as a proxy adherence measure, this cannot account for patients who may supplement with preexisting supply, samples from another provider, pill splitting, and pill sharing across household members or friends. Although none of these practices are condoned, they are not uncommon, particularly in the face of financial barriers. The proxy adherence calculation used is a best practice throughout health care in the absence of a more accurate calculation, but its limitations must be considered.

The 13-week postseminar period was likely inadequate for capturing return office visits as well as potentially improved clinical outcomes resulting from improved adherence. Future reviews of medical records are encouraged to continue monitoring this patient cohort for changes to adherence and clinical biomarkers. Also, because of the role of the ability to pay and financial barriers to medication adherence, particularly for older adults, a literature review on financial barriers and a study of their impact at these clinics may be valuable.

Conclusion

This QI project aimed to improve medication adherence rates in two NP-managed clinics, specifically among older adult patients aged 65 years and older with hypertension, hyperlipidemia, and/or DM. Although the clinics had strong baseline adherence, a previous 4-year QI project identified variability in medication adherence over time, thus prioritizing continuous improvement to medication adherence at the clinics.

Early results were promising, particularly for patients with DM whose medication adherence improved significantly. This reinforces the growing body of knowledge reflecting strong clinical outcomes among patients treated by NPs. Sustained monitoring of this specific patient population's adherence and clinical outcomes is encouraged to measure the impact of these interventions over time.

Although the full impact of this QI project on future clinical practice is not yet determined, it has the potential to impact the way care is delivered and the health care system as a whole. The promise of early results demonstrates the positive role of the NP in medication

adherence and chronic disease management. Given the broad relevance of medication adherence, this demonstrated value can be leveraged by NPs across many patient populations. Similarly, this QI project translates to both primary care and beyond, to specialty clinics as well as in-patient settings. Provider-driven interventions to improve medication adherence may ultimately improve chronic disease management and patient quality of life while reducing complications, hospital admissions and readmissions, overall health care system expenses, and mortality rates.

Authors' contributions: *C. Kulsick was a lead author, lead project designer, and lead project interpreter. J. Votta was a lead author, lead project designer, and lead project interpreter. W. L. Wright was a lead advisor on project design and interpretation as well as an editorial guide and approver. P. White was a lead advisor on project design and interpretation as well as an editorial guide and approver. S. Strowman was a lead statistical analyst, an advisor on interpretation, and an editorial guide and approver.*

Competing interests: *The authors report no conflicts of interest.*

References

Gellad, W. F., Grenard, J. L., & Marcum, Z. A. (2011). A systematic review of barriers to medication adherence in the elderly: Looking beyond cost and regimen complexity. *The American Journal of Geriatric Pharmacotherapy*, 9, 11–23.

Lehman, A., Aslani, P., Ahmed, R., Celio, J., Gauchet, A., Bedouch, P., … Schneider, M. P. (2014). Assessing medication adherence: Options to consider. *International Journal of Clinical Pharmacy*, 36, 55–69.

Maciejewski, M. L., Hammill, B. G., Bayliss, E. A., Ding, L., Voils, C. I., Curtis, L. H., & Wang, V. (2017). Prescriber continuity and disease control of older adults. *Medical Care*, 55, 405–410.

National Community Pharmacists Association. (2013). *Medication adherence in America: A national report card*. Retrieved from https://www.ncpanet.org/pdf/reportcard/AdherenceReportCard_Abridged.pdf.

Nieuwlaat, R., Wilczynski, N., Navarro, T., Hobson, N., Jeffery, R., Keepanasseril, A., … Haynes, R. B. (2014). Interventions for enhancing medication adherence. *The Cochrane Database of Systematic Reviews*, CD000011.

Rao, A., Shi, Z., Ray, K., Mehortra, A., Ganguli, I. (2019). National trends in primary care visit use and practice capabilities, 2008-2015. *Annals of Family Medicine*, 17, 538–544.

Rui, P., & Okeyode, T. (2016). National Ambulatory Medical Care Survey: 2015 State and National Summary Tables. Retrieved from http://www.cdc.gov/nchs/ahcd/ahcd_products.htm.

Sarabi, R. E., Sadoughi, F., Orak, R. J., & Bahaadinbeigy, K. (2016). The effectiveness of mobile phone text messaging in improving medication adherence for patients with chronic diseases: A systematic review. *Iran Red Crescent Medical Journal*, 18, e25183.

Schroeder, K., Fahey, T., & Ebrahim, S. (2004). Interventions for improving adherence to treatment in patients with high blood pressure in ambulatory settings. *The Cochrane Database of Systematic Reviews*, 2, CD004804.

Tamblyn, R., Eguale, T., Huang, A., Winslade, N., & Doran, P. (2014). The incidence and determinants of primary nonadherence with prescribed medication in primary care. *Annals of Internal Medicine*, 160, 441–450.

US Department of Health and Human Services (US-HHS). (2015). *Guidance Regarding Methods for De-identification of Protected Health Information in Accordance with the Health Insurance Portability and Accountability Act (HIPAA) Privacy Rule*. Retrieved from https://www.hhs.gov/hipaa/for-professionals/privacy/special-topics/de-identification/index.html#safeharborguidance.

US Department of Health and Human Services (US-HHS), Centers for Disease Control and Prevention, National Center for Health Statistics (2017). *Health, United States, 2016: With Chartbook on Long-term Trends in Health*. Hyattsville, MD. Retrieved from https://www.cdc.gov/nchs/data/hus/hus16.pdf.

van Driel, M. L., Morledge, M. D., Ulep, R., Shaffer, J. P., Davies, P., & Deichmann, R. (2016). Interventions to improve adherence to lipid-lowering medication. *The Cochrane Database of Systematic Reviews Resource*, 12, 1–126.

Warren, J. R., Falster, M. O., Tran, B., & Jorm, L. (2015). Association of continuity of primary care and statin adherence. *PLoS One*, 10, e0140008.

World Health Organization. (2003). *Adherence to long term therapies: Evidence for action*. Retrieved from http://www.who.int/chp/knowledge/publications/adherence_full_report.pdf.

World Health Organization. (2018). *Noncommunicable diseases*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

Wright, W. L., Bachmann, J. P., Murphy, N., Gifford, L., Strowman, S., & White, P. (2019). Evaluating quality metrics of patients with type 2 diabetes managed by nurse practitioners in two family nurse practitioner-owned clinics. *Journal of the American Association of Nurse Practitioners*, 31, 413–419.

Yap, A., Thirumoorthy, T., & Kwan, Y. H. (2016). Systematic review of the barriers affecting medication adherence in older adults. *Geriatrics & Gerontology International*, 16, 1093–1101.