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Pharmacist Intervention for Blood Pressure Control: Medication Intensification and Adherence

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Abstract

Objective—To describe medication adherence and medication intensification in a physician-pharmacist collaborative management (PPCM) model compared to usual care.

Design—Prospective, cluster, randomized study in 32 primary care offices from 15 states. The primary outcomes were medication adherence and anti-hypertensive medication changes during the first nine months of the intervention. The nine month visit was completed by 539 patients, 345 of which received the intervention.

Results—There was no significant difference between intervention and usual care patients in regards to medication adherence at 9 months. Intervention patients received significantly more medication changes (4.9 vs.1.1; p=0.0003) and had significantly increased use of diuretics and aldosterone antagonists when compared to usual care (p=0.01).

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Conclusions—The PPCM model increased medication intensification, however no significant change in medication adherence was detected. PPCM models will need to develop non-adherence identification and intervention methods to further improve the potency of the care team.

Keywords

Medication intensification; Adherence; Hypertension; Pharmacist; Collaboration; Team-based care

INTRODUCTION

Hypertension has been diagnosed in 1 of every 3 American adults.[1] Fortunately, advancements in disease awareness and the advent of newer anti-hypertensive agents have led to increased BP control rates.[2] An evaluation from the National Health and Nutrition Examination Survey (NHANES) found that blood pressure (BP) control increased from 27% in 1988–1994 to 50% in 2007–2008.[3] Although these results show a major improvement, BP is still uncontrolled in 50% of the US population with hypertension.[1,3]

Although the reasons that BP control rates remain suboptimal are complex and multifactorial, the lack of adequate adherence to prescribed medication regimens appears to play an important role. Adherence to pharmacotherapy averages only 50% for chronic illnesses.[4] Further, low medication adherence increases risk for adverse cardiovascular (CV) events (e.g. heart failure, myocardial infarction, stroke).[5–8] For example, in a study of outpatients with established coronary heart disease, non-adherent patients, defined as following prescribed medication directions less than 75% of the time, were found to be 2.3 more likely to have a CV event when compared to their adherent counterparts.[8] Patients from minority populations have higher than average rates of non-adherence and CV events,[9,10] making them an important priority for treatment improvement efforts. Accountability for medication adherence is shared by patients, clinicians, their health care team, and the health care system as a whole.[11] The World Health Organization has stated that “increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments”.[4]

Poor patient adherence and limited access to care are well cited causes for poor BP control.[12] However, most uncontrolled hypertensive patients have access to health care and have been found to have frequent contact with physicians.[13] Additionally, BP can remain poorly controlled despite up to six physician visits per year.[14,15] Oliveria et al. found that patient factors (e.g. adherence) were not the most common reason for inadequate BP control.[15] The primary barrier was related to physicians who seemed satisfied with BP values that were not at recommended goals. Practitioner clinical inertia is a significant factor in poor control rates. Medication intensification has proven effective in controlling hypertension, regardless of poor medication adherence.[16]

Team-based care that includes the patient, primary care provider, and other health care professionals has been recommended as a strategy to improve BP control.[17] One of these care models, the physician-pharmacist collaborative management (PPCM) model, is a process by which pharmacists work directly with patients’ primary care physicians to

optimize therapy and supply patient education. The PPCM model has been shown to increase overall BP control and decrease mean BP when compared to usual care models.[18,19] Studies have found that improved BP control following PPCM resulted from improved medication adherence and regimen intensification.[20,21] However, specific mechanisms for improved BP control with PPCM have not been well described based on randomized, multi-centered effectiveness trials that included large minority populations.[22,23]

The "Collaboration Among Pharmacist and Physicians to Improve Outcomes Now" (CAPTION) trial, was an effectiveness study to implement PPCM for patients with uncontrolled hypertension. All medical offices had clinical pharmacists embedded in the office who were encouraged to provide proven aspects of the PPCM model to improve BP control. The objective of this study was to describe medication adherence and medication intensification in the PPCM intervention compared to usual care.

METHODS

The background study design, baseline data, and main results from the CAPTION trial have previously been reported.[24–26] Briefly, CAPTION was a 5-year, prospective, cluster-randomized multi-center clinical trial in 32 medical offices from 15 states in the U.S. Offices were stratified based on the structure of pharmacy services and percent minority patients.[24,27] Offices were then randomized to one of three arms: usual BP care, a 9-month BP intervention, or a 24-month BP intervention. The two intervention arms were designed to be identical the first 9 months so the a-priori analysis plan was to combine the two intervention arms at 9 months and compare them to the usual care.

The primary outcomes of the present sub-study were planned *a priori* and included medication adherence and anti-hypertensive medication changes during the first nine months of the intervention.

Physician & Pharmacist Training

All offices had clinical pharmacists on staff (mean 1.9).[28] Most pharmacists had a Pharm.D. degree (96%) and a postdoctoral residency or fellowship (78%), and covered clinic hours an average of 75% of the time. Seventy percent of offices had clinical pharmacy services for over 5 years.[28]

Providers in offices randomized to the BP intervention arms received training in three main areas: 1) dissemination of JNC-7, ALLHAT papers and treatment aids,[18,22] 2) strategies to overcome clinical inertia and patient barriers to achieving BP control, and 3) suggested methods of communication and collaboration between physicians and pharmacists. Regional training programs for one pharmacist and one physician investigator from each medical office were conducted. The regional training sessions were led by a physician/pharmacist team from one community-based Family Medicine program that successfully implemented the intervention model in a previous study.[5] These individuals addressed important issues for study offices, encouraged physicians to improve participation, instilled confidence and enthusiasm in in team members and addressed common barriers to treatment implementation and BP control and how they can be overcome. The training sessions discussed strategies to

effectively implement the PPCM intervention and focused on strategies found to be most effective to overcome clinical inertia, adverse drug reactions and poor medication adherence.

Patient Recruitment

The Institutional Review Board (IRB) for each office approved this study. Patients were included if they: 1) were English or Spanish speaking males or females, over 18 years of age with a diagnosis of hypertension, 2) had uncontrolled BP defined as ≥ 140 mm Hg SBP or ≥ 90 mm Hg DBP for patients with uncomplicated hypertension; or ≥ 130 mm Hg SBP or ≥ 80 mm Hg DBP for patients with diabetes or chronic kidney disease, and 3) received care from one of the participating clinics. In addition, for the purpose of this paper to address medication adherence, only those patients with at least one anti-hypertensive medication at baseline were included in the present analysis.

Patients were excluded if they had 1) current signs of hypertensive emergency (acute angina, stroke, or renal failure); 2) severe HTN (systolic BP >200 or diastolic BP > 114 mm Hg); 3) history of MI, stroke, or unstable angina in the prior 6 months; 4) systolic dysfunction with a LV ejection fraction < 35% documented by echocardiography, nuclear medicine study, or ventriculography; 5) renal insufficiency, defined by a glomerular filtration rate less than 20 ml/min or previously documented proteinuria > 1 gram per day; 6) significant hepatic disease, including prior diagnoses of cirrhosis, Hepatitis B or C infection, or laboratory abnormalities (serum ALT or AST > 2 times control or total bilirubin > 1.5 mg/dl) in the prior 6 months; 7) pregnancy; 8) diagnoses of pulmonary hypertension or sleep apnea (unless treated by continuous positive pressure ventilation); 9) poor prognosis with a life expectancy estimated less than 2 years; 10) residence in a nursing home or diagnosis of dementia; and 11) inability to give informed consent or impaired cognitive function (defined as ≥ 3 errors on the 10-item Pfeiffer Portable Mental Status Questionnaire, administered during study intake).

Data Collection

Research nurses employed in each office enrolled patients and collected all study data. Research nurses measured height, weight, pulse, and evaluated medication adherence using validated instruments.[26, 30] All research nurses were certified on proper BP measurement technique using an automated Omron HEM 907-XL device.[31] BP was measured three times in the sitting position after appropriate rest, and the second and third readings were averaged. If the second and third readings varied by more than 4mmHg (systolic or diastolic) a fourth measurement occurred and an average was taken of the two closest readings. If the BP did not meet the inclusion criteria, the nurse informed the patient's physician, and the patient was not enrolled.

Research nurses collected detailed histories from the medical record and patient surveys about: 1) the duration of HTN; 2) presence of other cardiovascular risk factors; 3) symptoms and adverse drug reactions; 4) medication adherence; 5) socio-demographics; 6) co-morbidities; and 7) current medications.

Medication adherence was measured using a six question survey (Appendix 1). This survey was previously validated in patients with hypertension[29] and was adapted from the work of Choo[32] and Morisky.[33] Previous research found that patients who endorsed at least two of the six questions were significantly more likely to have uncontrolled BP.[29] Therefore, CAPTION patients were classified as adherent or non-adherent with anti-hypertensive therapy based on whether they endorsed ≥ 2 of the 6 items. For items 2–4, patient responses of ≥ 1 days constituted endorsement.

PPCM Intervention

Once a patient in the intervention arm signed written informed consent, the pharmacist was encouraged, but not required, to perform a structured interview including: 1) medication history of all prescription, non-prescription, and herbal therapies; 2) an assessment of patient knowledge of BP medications, purpose of each medication, goals of therapy, medication dosages and timing, and potential medication side effects; 3) potential contraindications to specific pharmacologic agents; and 4) adherence and monitoring issues (e.g., side effects, patient self-efficacy) (Appendix 2). However, the clinical pharmacists were free to modify how they provided the intervention based on how it could be best integrated into their other duties.

Pharmacists were encouraged to assess medication knowledge and adherence and then educate patients on hypertension and the importance of following pharmacotherapy directions. Pharmacists also provided patients with written lifestyle educational materials and a wallet card listing all medications and doses, and contact phone numbers for the pharmacist with BP goals. When a patient was identified with memory problems or unintentional non-adherence, the pharmacist was encouraged to supply adherence aids (medication logs or weekly medication boxes).

Care plans with treatment recommendations and goal BP were created by the pharmacist for the physician and served as the source document for the pharmacist's recommendations (Appendix 2). The care plan could make specific recommendations to intensify medication dosages and add antihypertensive medications in an effort to achieve BP control. Care plans were presented directly to the physician unless the physician preferred written or electronic communication. If the physician agreed with the care plan, or if the care plan was modified by the physician, the pharmacist implemented the finalized plan. The suggested PPCM model included structured face-to-face visits with the patient at baseline, 1, 2, 4, 6 and 8 months and a telephone call at 2 weeks and additional visits if BP remained uncontrolled. However, as this was an effectiveness study, pharmacists were asked to use discretion for patient management and were free to modify or reduce this frequency, especially if they felt patients were well-controlled.

Analysis

The primary hypothesis for this study was that medication adherence and medication intensification would be greater in the intervention arm compared to the control arm. Medication intensification was defined as the number of changes to the medication regimen between baseline and 9 months. This included adding or removing medications as well as

increasing or decreasing dose. To assess how medication adherence and medication intensification might have led to improved BPs in the PPCM intervention group, several sequential analyses were carried out.

Medication adherence and medication intensification were examined to see if they were significantly influenced by the intervention. Categorical medication adherence, was analyzed using a generalized estimating equation (GEE) to compare the proportions across groups while accounting for the correlation within a center. The change in medication adherence from baseline to 9 months was also analyzed using a Fisher's exact test.

Medication intensification was analyzed using a generalized linear regression model to compare the means across groups while accounting for the correlation within a center. The 9 month distribution of medications was also compared across groups using a Fisher's exact test.

Following these analyses medication adherence and medication intensification were examined to see whether they were associated with BP. This was done using a linear mixed effects to estimate the mean difference in BP in the case of medication adherence for those who were adherent relative to those who were not, and in the case of medication intensification for those with a one unit increase in medication intensification. The model adjusted for age and baseline BP. The model also incorporated offices as random effects and assumed that random error terms were nested within subject. The office random effects were assumed to be normally distributed and have a compound symmetric covariance structure and the within subject random errors were assumed to have a first order auto-regressive [AR(1)] covariance structure. A Kenward-Rogers adjustment was used to account for the clusters.

The above modeling yielded significant results in the case of medication adherence so it was reasonable to test if adjusting for medication adherence in the main model, described in the publication of the main study results, affected the impact of the PPCM intervention on BP outcomes.[26]

RESULTS

The baseline demographic data and the main study results have previously been published.[25,26] Research nurses enrolled 625 patients from March 2010 to June 2013. The present study included 539 of these patients, who completed a 9 month visit (86.2%). Minorities were well represented (n=284; 52.7%) (Table 1). A large number of patients had household incomes below $25,000 per year (48.1%) and had either Medicaid (13.9%) or self-pay as their pay source (10.9%). Baseline BP was comparable across all study arms. Notably, 246 (45.6%) had diabetes or chronic kidney disease and therefore a lower BP goal. Stratification and randomization of offices did not prevent some differences in participant characteristics by arm; however, study arms were fairly well balanced (Table 2). In the first 9 months, intervention patients visited with the pharmacist an average of 5.2 and 4.5 times in offices randomized to the 9-month intervention and 24-month intervention arms, respectively. Physician's acceptance rates ranged from 97.7 to 100% depending on type of

medication-related recommendation (Table 3). The “regimen change” category was for recommendations made with the same medication and dosage strength (e.g. once daily changed to twice daily).

As previously reported, the difference in mean BP (systolic/diastolic) between PPCM and usual care was −6.1/−2.9 mm Hg ($p<0.001$ and $p=0.003$, respectively) at 9 months.[28] BP control, defined by JNC-7, was 43% in the intervention arms and 34% in the usual care arm at 9-months (adjusted odds ratio 1.57 [95% CI 0.99–2.50], $p=0.052$).

Antihypertensive Medication Adherence

Almost four-fifths (79.6%) of all enrolled patients were classified as adherent at baseline (Table 2). At 9 months, 19 (5.5%) of intervention patients were non-adherent compared to 17 (8.8%) of usual care patients. There was no significant difference between the proportion of intervention and usual care patients who were non-adherent at baseline and then achieved good adherence at 9 months; 48 (13.9%) and 16 (8.2%), respectively (Table 4). There was a trend for better BP control at 9 months in patients who were adherent (n=236, 43.46%) compared to those who were not adherent (10, 27.78%) ($p=0.0950$).

Antihypertensive Medication Intensification

There was an average of 4.9 BP medication changes over 9 months for intervention patients, with 3.2 of those changes being dose increases or added medications. In the same period, patients in the usual care arm averaged 1.1 BP medication changes ($p=0.0003$), with 0.7 of those changes being dose increases or medications added ($p=0.0002$) (Table 5).

Significant differences were found in the types of medication changes observed in the two arms during the intervention (Table 6). Patients who received the pharmacist intervention had significantly increased use of diuretics and aldosterone antagonists (spironolactone) when compared to usual care. However, when BP was adjusted for medication intensification, there was no significant effect on systolic BP reduction ($p=0.53$) or diastolic BP reduction ($p=0.43$).

DISCUSSION

The CAPTION study showed that PPCM can significantly improve mean BP. These results demonstrated that the pharmacists involved in the intervention not only added medications and/or increased dosages, but also removed other medications and decreased dosages. Furthermore, trends in medication changes were seen; with diuretics and aldosterone antagonists used significantly more in the intervention arms than usual care. These medication-use trends followed current national guidelines, evidence-based practices, and confirm the results of previous PPCM studies.[20,34] Specifically, the increased use of diuretics, dosage increases, and antihypertensive medications being initiated have been observed in other studies.[20,34] These findings are important because of the large number of minorities and those with lower socioeconomic status in CAPTION. Based on our results, providers in primary care offices who choose to implement PPCM should include clinical pharmacists who are embedded in the office, include the pharmacist as an integral team member, and utilize pharmacists for pharmacotherapy decisions and patient education.

Antihypertensive medication adherence was not significantly impacted by PPCM intervention in this study. Non-adherence was much lower at baseline (16.3%) than the estimated national adherence rates[1] but was consistent with other studies.[18,22] Patients who were non-adherent at baseline and were treated in intervention clinics were slightly more likely to become adherent at 9 months, but these findings were not statistically significant. The high rate of medication adherence could be due to social desirability bias, as research nurses asked patients to verbally answer adherence questions. Additionally, the modified scale used may have over-estimated antihypertensive medication adherence. We suspect that, due to the use of self-report, we were unable to fully account for the impact of PPCM on antihypertensive medication adherence. Other methods to measure adherence such as pharmacy refill records or pill counts, were not possible in this study. Regardless, the high baseline adherence could have created a "ceiling effect" on adherence improvement as seen in another study that used both pill counts and self-report.[22]

Previous studies have found that medication intensification improved BP, without improved medication adherence.[35–37] Some studies have found no relationship or an inverse relationship with improving medication adherence and BP improvement.[36,37] In our study, BP control was 43% in the PPCM arms and 34% with usual care ($p = 0.052$) suggesting that the intervention could have been more potent. The non-significant impact on BP control, compared with significant mean BP reductions, most likely was due to provider, pharmacist and/or physician, acceptance when BP was near goal.[26] Nonetheless, considering that other studies have shown the importance of medication adherence for proper BP control, it may have played a factor in improved BP levels in this study, as well, but simply couldn't be detected due to measurement limitations.[16,38] The PPCM model will need to incorporate additional strategies to identify non-adherence and then use targeted interventions to continue to improve the efficiency and effectiveness of this team care model.

While medication intensification was significantly different in the PPCM arms compared to usual care, medication intensification did not predict systolic BP reduction. We suspect this was related to intervention patients with the most difficult to control BP needing more medication intensification, yet having achieved less reduction in BP. Thus, even though medication intensification was the likely reason for the better mean BP in the intervention arms, the overall treatment effect was diluted in those patients with difficult to control BP who had to have more medication intensification. Additionally, a recent meta-analysis of randomized controlled trials with pharmacist BP interventions concluded that, while pharmacist interventions reduced BP, the reason pharmacists were effective was unclear.[39] Thus, the gap in our knowledge includes the specific mechanisms by which team-based care are effective, which strategies will optimize clinical pharmacy services and how the PPCM model potency can be further increased, especially related to optimal strategies to identify and resolve nonadherence to medications.

The CAPTION trial showed a systolic BP drop of 6.1mmHg when pharmacists were part of the care team. Based on the Hypertension Detection and Follow-up Program, this BP reduction would reduce stroke mortality by 23%.[40] More research is needed to determine if successful PPCM models can reduce stroke and other cardiovascular morbidity and mortality.

This study has limitations. First, there were some imbalances in demographics between arms. Most noticeably, usual care patients had higher rates of insurance coverage. Second, social desirability bias may have contributed to the high rates of self-reported medication adherence. This bias could have been limited if adherence was measured differently. Additionally, the possible "ceiling effect" of the high adherence rates and/or limitations associated with the self-report measure of medication adherence may have adversely affected our ability to show difference between arms. Also, 13.8% of patients enrolled at baseline did not complete the 9 month visit and where not included in this analysis. However, sensitivity analyses for missing data was completed and found no change in outcome.[26] Finally, this analysis does not consider other possible variables that could have contributed to BP improvement, such as education and lifestyle recommendations.

CONCLUSION

The PPCM model led to medication intensification, however no significant change in medication adherence was detected. Medication changes (i.e. additions, removals, increased and decreased dosages) were all significantly higher with the intervention when compared to usual care. Diuretics and aldosterone antagonists were used significantly more in the PPCM model. These findings demonstrate that clinical pharmacists increased medication intensification. However, PPCM models will need to develop non-adherence identification and intervention methods to further improve the potency of the care team.

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Appendix 1

Questions Used to Asses Antihypertensive Medication Adherence

Question	Response
Some people have difficulty in taking blood pressure medication as prescribed. Do you have difficulty with this?	Yes/No
How many days in the past week did you forget to take your blood pressure medication?	___ days*
How many days in the past week did you not take your medication on purpose?	___ days*
How many days in the past week did you add an extra pill?	___ days*
In the last 6 months, did you ever take less medicine because you felt you needed less?	Yes/No
In the last 6 months, if you felt worse when you took the medicine, did you ever stop taking it?	Yes/No

* Patients were considered answer “yes” to these questions if >0 days

Appendix 2

Pharmacist Encounter Form

6. BLOOD PRESSURE PHARMACIST ENCOUNTER
Subject ID: __ __ - __ __ __
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CAPTION
Collaboration Among Pharmacists and Physicians To Improve Outcomes Now

Subject Name: ______________________________ (For site use only; do not enter into database.)

A. PHARMACIST ENCOUNTER

1. Encounter Date: _ _/_ _/_ _ _ _ (mm/dd/yyyy)

2. Contact Type:
   - ○ Initial
   - ○ Follow-up
   - ○ Phone Communication

3. Pharmacist Code: ___________

4. Antihypertensive Medications (list ONLY blood pressure medications that are documented as current in the medical record):

a. Medication	b. Unit Strength	c. Dose	d. Frequency	e. PRN	f. Patient Report on Adherence
____________ Code: _ _ _ _				☐	O Patient taking as prescribed O Patient taking but at a different dose or frequency O Patient not taking now
____________ Code: _ _ _ _				☐	O Patient taking as prescribed O Patient taking but at a different dose or frequency O Patient not taking now
____________ Code: _ _ _ _				☐	O Patient taking as prescribed O Patient taking but at a different dose or frequency O Patient not taking now
____________ Code: _ _ _ _				☐	O Patient taking as prescribed O Patient taking but at a different dose or frequency O Patient not taking now
____________ Code: _ _ _ _				☐	O Patient taking as prescribed O Patient taking but at a different dose or frequency O Patient not taking now

6. BLOOD PRESSURE PHARMACIST ENCOUNTER
Subject ID: __ __ - __ __ __
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CAPTION
Collaboration Among Pharmacists and Physicians To Improve Outcomes Now

5. Blood Pressure Measurements

	1. Systolic BP (mm Hg)	2. Diastolic BP (mm Hg)
a. First BP measurement	___ ___ ___	___ ___ ___
b. Second BP measurement	___ ___ ___	___ ___ ___
c. Third BP measurement (optional)	___ ___ ___	___ ___ ___

6. Average Blood Pressure (Removed from paper and eCRF)

7. Goal Blood Pressure
   a. Goal Systolic Pressure: < __ __ __
   b. Goal Diastolic Pressure: < __ __ __

8. Is the patient's current blood pressure controlled?
   ○ Yes
   ○ No

9. Recommended lifestyle change options (check all that apply):
   ☐ a. ↓ weight
   ☐ b. DASH plan
   ☐ c. ↓ sodium
   ☐ d. Other diet recommendation
   ☐ e. ↑ activity
   ☐ f. ↓ smoking
   ☐ g. Other
      g.1 Specify: _____
   ☐ h. No lifestyle changes recommended

10. ↑ BP medication compliance recommended
   ○ Yes
   ○ No

6. BLOOD PRESSURE PHARMACIST ENCOUNTER
Subject ID: __ __ - __ __ __
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CAPTION
Collaboration Among Pharmacists and Physicians To Improve Outcomes Now

11. New Plan/Recommendations
- ○ Continue current regimen
- ○ Recommend change to plan (List changes to plan in Item A.12)

12. Recommended Change to Plan:

a. Medication	b. Change Type	c. Unit Strength	d. Dose	e. Frequency	f. PRN	g. Comments	h. Physician Decision
________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐		O Accept O Reject O Modify
________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐		O Accept O Reject O Modify
________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐		O Accept O Reject O Modify
________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐		O Accept O Reject O Modify
________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐		O Accept O Reject O Modify

6. BLOOD PRESSURE PHARMACIST ENCOUNTER
Subject ID: __ __ - __ __ __
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CAPTION
Collaboration Among Pharmacists and Physicians To Improve Outcomes Now

13. Planned Follow-up with Pharmacist (check all that apply):

☐ a. 1 week ☐ b. 2 weeks ☐ c. 4 weeks ☐ d. 6 weeks ☐ e. 8 weeks ☐ f. 3 months

☐ g. Other time frame
g.1 Specify:______________________

☐ h. Patient declined to re-schedule ☐ i. Pharmacist intervention completed

14. Final Plan (Complete only if changed from the pharmacist recommended plan):

a. Medication	b. Change Type	c. Unit Strength	d. Dose	e. Frequency	f. PRN
______________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐
______________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐
______________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐
______________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐
______________ Code: __ __ __ __	O Start New Drug O Discontinue Drug O Increase Dose O Decrease Dose O Regimen Change (same dose)				☐

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Table 1

Subject Demographics

Variable	Intervention (N=345) N (Pct.)	Control (N=194) N (Pct.)	Total (N=539) N (Pct.)	p-value
Gender				
Male	136 (39.4%)	82 (42.3%)	218 (40.4%)	0.6703
Female	209 (60.6%)	112 (57.7%)	321 (59.6%)	
Race/Ethnicity				
Non-Hispanic Caucasian	152 (44.1%)	96 (49.5%)	248 (46.0%)	0.6345
Minority	187 (54.2%)	97 (50.0%)	284 (52.7%)	
Declined to answer/missing	6 (1.7%)	1 (0.5%)	7 (1.3%)	
Education				
<= 12 Years	188 (54.5%)	92 (47.4%)	280 (51.9%)	0.4877
> 12 Years	157 (45.5%)	100 (51.5%)	257 (47.7%)	
Missing	0 (0.0%)	2 (1.0%)	2 (0.4%)	
Marital status				
Married	169 (49.0%)	100 (51.5%)	269 (49.9%)	0.0598
Not married	176 (51.0%)	94 (48.5%)	270 (50.1%)	
Insurance coverage				
Medicare	89 (25.8%)	78 (40.2%)	167 (31.0%)	< 0.0001
Private and Other	156 (45.2%)	82 (42.3%)	238 (44.2%)	
Medicaid	50 (14.5%)	25 (12.9%)	75 (13.9%)	
Free and None/Self-Pay	50 (14.5%)	9 (4.6%)	59 (10.9%)	
Annual income				
< $25,000	171 (49.6%)	88 (45.4%)	259 (48.1%)	0.2033
>= $25,000	174 (50.4%)	106 (54.6%)	280 (51.9%)	
Age				
Mean (SD)	58.2 (11.8)	60.3 (13.7)	59.0 (12.5)	0.1033
Min - Max	(25, 90)	(18, 91)	(18, 91)	
Weight				
Mean (SD)	97.2 (25.9)	93.3 (23.9)	95.8 (25.3)	0.1828
Min - Max	(42, 248)	(40, 188)	(40, 248)	
BMI				

Variable	Intervention (N=345) N (Pct.)	Control (N=194) N (Pct.)	Total (N=539) N (Pct.)	p-value
Mean (SD)	34.6 (8.9)	33.1 (7.7)	34.1 (8.5)	0.0768
Min - Max	(18, 83)	(16, 61)	(16, 83)	

Table 2

Baseline medical history

Variable	Intervention (N=345) N (Pct.)	Usual Care (N=194) N (Pct.)	Total (N=539) N (Pct.)	p-value
Baseline Systolic BP				
Mean (SD)	148.8 (14.4)	149.8 (15.2)	149.1 (14.7)	0.6009
Min - Max	(106, 194)	(117, 197)	(106, 197)	
Baseline Diastolic BP				
Mean (SD)	85.0 (12.0)	83.6 (12.8)	84.5 (12.3)	0.4346
Min - Max	(54, 115)	(53, 115)	(53, 115)	
Medication Adherence Score				
Adherent <= 1	274 (79.4%)	155 (79.9%)	429 (79.6%)	0.6460
Non-Adherent >= 2	57 (16.5%)	26 (13.4%)	83 (15.4%)	
Missing	14 (4.1%)	13 (6.7%)	27 (5.0%)	
Number of Antihypertensive Medications				
Mean (SD)	2.1 (1.1)	2.0 (1.1)	2.1 (1.1)	0.6674
Min - Max	(1, 6)	(1, 6)	(1, 6)	
Missing	13	10	23	
Smoking status				
Current smoker	60 (17.4%)	27 (13.9%)	87 (16.1%)	0.4491
Former smoker	112 (32.5%)	59 (30.4%)	171 (31.7%)	
Never smoker	172 (49.9%)	106 (54.6%)	278 (51.6%)	
Missing	1 (0.3%)	2 (1.0%)	3 (0.6%)	
Comorbidities				
Mean (SD)	2.2 (1.4)	2.3 (1.4)	2.2 (1.4)	0.3813
Min - Max	(0, 7)	(0, 6)	(0, 7)	
Diabetes/kidney disease				
Diabetes/kidney disease	150 (43.5%)	96 (49.5%)	246 (45.6%)	0.4579
No diabetes/kidney disease	195 (56.5%)	98 (50.5%)	293 (54.4%)	
Alcohol intake				
No alcohol intake	200 (58.0%)	112 (57.7%)	312 (57.9%)	0.9527
Any alcohol intake	144 (41.7%)	81 (41.8%)	225 (41.7%)	
Missing	1 (0.3%)	1 (0.5%)	2 (0.4%)	
Duration of high BP				

Variable	Intervention (N=345) N (Pct.)	Usual Care (N=194) N (Pct.)	Total (N=539) N (Pct.)	p-value
<= 3 years	49 (14.2%)	38 (19.6%)	87 (16.1%)	0.1257
> 3 – 10 years	123 (35.7%)	68 (35.1%)	191 (35.4%)	
> 10 years	173 (50.1%)	88 (45.4%)	261 (48.4%)	

Table 3

Types of recommendations made by intervention pharmacists and physician acceptance rate

Recommended Change	Number of Recommendations (Percent Accepted)
Start New Drug	408 (98.31%)
Discontinue Drug	264 (98.88%)
Increase Dose	302 (98.69%)
Decrease Dose	83 (97.65%)
Regimen Change	20 (100.0%)

Table 4

Antihypertensive medication adherence

Variable	Intervention (N=345)	Usual Care (N=194)	Total (N=539)	p-value
Medication Adherence Score at 9 Months				
Non-adherent	19 (5.5%)	17 (8.8%)	36 (6.7%)	0.2657
Adherent	319 (92.5%)	170 (87.6%)	489 (90.7%)	
Missing	7 (2.0%)	7 (3.6%)	14 (2.6%)	
Change in Adherence from Baseline to 9 Months				
Non-adherent to Adherent	48 (13.9%)	16 (8.2%)	64 (11.9%)	0.3645
No Change	271 (78.6%)	155 (79.9%)	426 (79.0%)	
Adherent to Non-adherent	10 (2.9%)	8 (4.1%)	18 (3.3%)	
Missing	16 (4.6 %)	15 (7.7%)	31 (5.8%)	
Change in Adherence from Baseline to 9 Months				
Mean (SD)	0.3 (1.1)	0.2 (1.0)	0.2 (1.0)	0.5501
Min - Max	(−4, 5)	(−2, 4)	(−4, 5)	
Missing	16	15	31	

Table 5

Summary of antihypertensive medication changes

Variable	Intervention (N=345)	Usual Care (N=194)	p-value
Number of Medications at 9 Months			0.4100
Mean (Std)	2.6 (1.15)	2.4 (1.20)	
(Min, Max)	(3, 6)	(2, 7)	
Medication Changes between 0–9 Months			0.0003
Mean (Std)	4.9 (5.10)	1.1 (1.56)	
(Min, Max)	(5, 36)	(1, 7)	
Medications added or doses increased 0–9 Months			0.0002
Mean (Std)	3.2 (3.22)	0.7 (1.06)	
(Min, Max)	(3, 20)	(1, 5)	
Medications removed or doses decreased 0–9 Months			0.0009
Mean (Std)	1.5 (2.16)	0.4 (0.74)	
(Min, Max)	(2, 14)	(0, 4)	

Table 6

Comparison of active antihypertensive medications at 9 months

Antihypertensive Class	Intervention (N=345)	Usual Care (N=194)	p-value
Diuretic	253 (73.3%)	121 (62.4%)	0.01
ACE Inhibitors	197 (57.1%)	105 (54.1%)	0.53
ARBs	70 (20.3%)	37 (19.1%)	0.82
DHP-CCB	134 (38.8%)	61 (31.4%)	0.09
Non DHP-CCB	21 (6.1%)	12 (6.2%)	1.00
Beta Blockers	137 (39.7%)	82 (42.3%)	0.58
Aldosterone Antagonist	28 (8.1%)	4 (2.1%)	<0.01
Direct Renin Inhibitor (Aliskiren)	1 (0.3%)	1 (0.5%)	1.00
Alpha1-Antagonists	8 (2.3%)	6 (3.1%)	0.58
Alpha2-Agonists	11 (3.2%)	5 (2.6%)	0.80
Vasodilators	3 (0.9%)	3 (1.5%)	0.67