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Adherence to Antihypertensive Therapy

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INTRODUCTION

On average, only 50% of adults adhere to chronic disease medications[1,2]; and in the case of high blood pressure (BP), lower levels of adherence are associated with worse BP control and adverse outcomes, including stroke, myocardial infarction, heart failure, and death.[3–5] Although effective medications that control BP and reduce the risk of stroke, renal, and cardiovascular disease are available, uncontrolled BP and low adherence to antihypertensive drugs persist as major public health and clinical challenges.[6,7] Research in the past decade has identified determinants of poor adherence and explored the impact of interventions to address barriers, improve adherence, and ultimately achieve BP control. Several approaches have proven successful, although no single intervention has emerged as superior in improving adherence and lowering BP across all groups. As the lower systolic BP (SBP) treatment target (<120 mm Hg) suggested by the recent Systolic Blood Pressure Intervention Trial (SPRINT) results[8,9] is integrated into clinical practice guidelines,[10] new performance standards for BP control will likely emerge and greater attention will be given to improving patient adherence to prescribed therapies in an effort to achieve BP control using the lower target.

Modest changes in adherence can lead to clinically significant reductions in BP.[11] In turn, relatively small reductions in BP are associated with improvements in mortality[12–14]: a reduction in SBP of 3 mm Hg is associated with an 8% reduction in stroke mortality and a 5% reduction in mortality from coronary heart disease.[14] Thus, efforts that lead to even modest improvements on adherence can have an appreciable effect on health outcomes at the

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population level. The purpose of this article is to provide an overview of the current status and recent developments regarding interventions to improve adherence to antihypertensive medications for primary prevention of cardiovascular events.

TYPES OF INTERVENTIONS TO IMPROVE MEDICATION ADHERENCE

Interventions to promote medication adherence may target a number of identified patient-specific barriers: asymptomatic nature of hypertension[15,16]; depression[17–21]; comorbidities[20]; low health literacy[22–24]; medication complexity, cost, and concerns[25–28]; use of alternative medicine[29–31]; poor health care system perceptions[32]; perceived discrimination[26,33]; poor communication or provider-patient interaction[33–35]; medication side effects[34,36]; forgetfulness[37,38]; inadequate social support or coping[39,40]; caring for dependents[41]; and lack of motivation for self-care.[42] Interventions that target these factors can be classified as informational, behavioral, social, or combined.[43] *Informational interventions* use didactic or interactive approaches to educate and motivate patients and to increase understanding of their condition and its treatment.[43] *Behavioral interventions* move beyond the cognitive approaches of informational interventions to influence patient behaviors by shaping, reminding, or rewarding desired behaviors, whereas *social interventions* enlist family members or others in supporting medication adherence.[43] Finally, *combined interventions*, which are becoming increasingly common, include elements of more than one informational, behavioral, or social strategy. Strategies may vary in intensity, setting (eg, individual, group), mechanism of delivery (eg, face-to-face, technology-mediated), and required personnel (eg, physician, allied health professional, or lay individual) (Table 1).

When evaluating the effectiveness of interventions to improve adherence, consideration should be given to the adherence measure used. Validated objective (eg, pharmacy fill,[44,45] electronic monitoring[46]) and subjective (eg, self-report[37,38,47–50]) measures for assessing medication-taking behavior are available (Table 2). An effect size of d = 0.2 is considered small, d = 0.5 medium, and d = 0.8 large.[51] In a recent meta-analysis assessing the impact of adherence interventions, the largest effect sizes were found among studies using objective measures of adherence, including electronic event monitoring (d = 0.621), followed by pharmacy fill measures (d = 0.299) and pill counts (d = 0.299), whereas studies using subjective, self-report measures produced smaller effect sizes (d = 0.232).[11] This may be due, in part, to objective measures being less prone to the measurement noise associated with self-report measures, thereby rendering more precise estimates of adherence and easier differentiation between low and high adherence.[52] Given that different tools assess different aspects of behavior along the adherence cascade (Fig. 1), use of both objective and self-report measures to identify at-risk patients and target patient-specific needs to improve adherence may facilitate our ability to promote adherence and increase BP control.[5]

PROMISING STRATEGIES FOR IMPROVING ADHERENCE

Meta-analyses have linked several intervention characteristics to modest improvements in antihypertensive medication adherence (Table 3). Interventions that provide behavioral rather than informational support,[53] are delivered over a longer time frame,[11,53] and include

more intervention components[11] have larger effects on adherence. With respect to health outcomes, larger intervention doses (measured by minutes per session and number of sessions) are more effective at improving BP.[55] Moreover, face-to-face versus mediated delivery of adherence interventions (eg, via mail) is associated with a larger decrease in diastolic BP (DBP), but not with a larger decrease in SBP[55]. Taken together, these findings indicate that effective interventions to promote adherence and improve BP control are likely to require ongoing, sustained focus with repeated contacts and a combination of strategies that can be tailored to patients' needs. These intervention characteristics are well-aligned with current movement toward patient-centered approaches to the management of chronic diseases. When implementing and evaluating any intervention, and particularly those that are complex and multicomponent, it is critical to attend to feasibility and implementation fidelity, as the lack of effect found in some studies of multicomponent interventions may be due to poor adherence to the intervention.[56] Challenges associated with poor adherence to multiple components of complex interventions may be addressed by providing incentives for participation, automating aspects of the intervention (eg, wireless home BP monitoring devices that communicate automatically with clinicians and automated feedback provided to patients), or changing defaults to make it easier to make healthy choices (eg, 90-day instead of 30-day prescription refills).[56]

There are specific strategies that should be considered for inclusion in an antihypertensive medication adherence intervention. Regimen simplification, through once-daily dosing, has long been known to be effective at improving medication adherence.[28] Similarly, the use of combination pills may promote medication adherence: in a single study, multivariate odds ratio (OR) for achieving proportion of days covered (PDC) ≥80% at 6-month follow-up using single amlodipine/atorvastatin combination pill versus various combinations of separate pills ranged from 1.95 to 3.10 (all $P<.0001$).[57] There is low strength evidence supporting case management as an effective strategy for promoting adherence and improving BP outcomes.[54] Finally, home BP telemonitoring[58] and habit-based interventions[55] have larger effects on health outcomes compared to other interventions, but evidence for larger effects on adherence is limited.[11,58]

Three additional promising interventions for improving medication adherence include reduction of out-of-pocket costs (Table 4), use of allied health professionals in promoting medication adherence (Table 5), and self-monitoring of BP (Table 6). Across several individual studies, reductions in patients' out-of-pocket drug costs (through reduced copayment rates[59,60] and introduction of drug insurance coverage)[61,62] were associated with significant improvements in adherence. Only 1 study, involving financial incentives equal to copayment expenditures, found no effect on adherence.[63] Evidence is limited regarding effects of reduced out-of-pocket costs on health outcomes.

Use of allied health professionals, particularly pharmacists, in interventions to improve medication adherence has proliferated in recent years. In interventions to improve BP outcomes, pharmacists deliver education about hypertension and its treatment, identify prescribing and safety issues, and/or dispense lifestyle advice.[64] Several reviews and meta-analyses demonstrate associations between pharmacist-delivered interventions and improved BP outcomes.[54,55,64–67] In fact, a recent meta-analysis found that pharmacist-delivered

interventions had the largest effect on BP outcomes, followed by those delivered by advanced practice nurses, and then physicians.[55] Although it is clear that interventions delivered by pharmacists improve BP outcomes, there is a great deal of unexplained heterogeneity in effects[67] and it is uncertain if the effect on BP outcomes is mediated by improved adherence or by some other mechanism, as effects on adherence reported across reviews and meta-analyses are inconsistent.[11,54,64,66]

Team-based collaborative care is a specific type of intervention involving allied health professionals. Multiple reviews and meta-analyses have identified improved BP outcomes associated with collaborative care models[68,69]; there is, however, limited evidence supporting adherence as the mechanism leading to improved outcomes.[11,54,68] A recent meta-analysis found that studies focusing on increasing integration of patient care across providers had a significantly *smaller* effect on adherence than interventions that did not have a focus on integration.[11] These negative findings may be due to a failure to account for differences in effectiveness between multiprofessional behavioral and informational or combined interventions. Mansoor and colleagues[69] reported that multiprofessional behavioral interventions improved adherence while multiprofessional informational or combined interventions did not. Further research is needed to identify the best model and determine if multiprofessional interventions are superior to those delivered by a single professional.[69]

Across a number of systematic reviews and meta-analyses, self-monitoring of BP leads to improvements in BP outcomes,[52,53,65,70,71] although the mechanism for this effect remains unclear. Potential mechanisms include pharmacologic (increased medication and better adherence) and nonpharmacologic (healthier lifestyle) factors.[52] The evidence for an effect of self-monitoring of BP on adherence is inconsistent,[11,53,71] but a recent meta-analysis of the effect of self-monitoring of BP found a “small but significant” effect on medication adherence.[52]

STRATEGIES WITH UNCERTAIN EFFICACY FOR IMPROVING ADHERENCE

The efficacy of other strategies to improve antihypertensive medication adherence remains uncertain. There is little evidence that, compared to other interventions, informational interventions, particularly those relying on written materials, or social support interventions are more effective at promoting antihypertensive medication adherence or improving health outcomes.[11,55] Data supporting the efficacy of particular behavioral interventions are also limited. Interventions using adherence problem-solving, decisional balance activities, and medication administration calendars are not associated with larger improvements in adherence.[11] Furthermore, adherence barrier management, rewards for adherence, and adherence goal setting are not associated with larger improvements in BP outcomes.[55] According to recent meta-analyses, when compared with other interventions, motivational interviewing, self-monitoring of medication administration/adherence, feedback about adherence, drug packaging, and efforts to improve communication between patients and providers are not associated with larger improvements in adherence and BP control.[11,55]

Although the research to date does not provide evidence that these interventions are more effective at improving adherence compared to other interventions, it is important to note that much of the research on intervention efficacy lacks methodological rigor, leading to low-quality evidence about which interventions are most effective. More high-quality studies on the effectiveness of various approaches for improving adherence and health outcomes are needed.

NEW FRONTIERS IN THE PROMOTION OF MEDICATION ADHERENCE

Technology-mediated interventions include both medical devices (eg, electronic drug monitors, pillboxes with alarms, home BP monitors, telehealth devices) and information and communication technologies (eg, computers, telephones, cell phones, e-mails, text messages), which may be used to support adherence through education and counseling, self-monitoring and feedback, or provision of reminders.[72] Research on the effectiveness of these interventions is under way. A recent review found inconsistent evidence for the effectiveness of technology-mediated interventions to promote medication adherence and improve health outcomes.[72] In contrast, a meta-analysis of Internet-based counseling demonstrated a mean reduction in SBP of 3.8 mm Hg ($P = .002$) and a mean reduction in diastolic BP (DBP) of 2.1 mm Hg ($P = .03$).[73] Another meta-analysis reported that mobile phone text messaging for adherence to medications for chronic disease led to a doubling of the odds of adherence in intervention compared with control participants (OR = 2.11, $P<.001$).[74] Notably, technology-mediated interventions are often just one component of complex, multicomponent interventions and it is difficult to isolate the effects of the technology piece.[72,73] High-quality studies with longer follow-up and objective adherence measures are needed to adequately explore the potential of technology-mediated interventions for improving adherence.

Interactive digital interventions, which include interventions accessed through a computer, smartphone, or other handheld device (eg, Web-based or computer programs, or apps for online or offline use) deserve further mention. Several characteristics of interactive digital interventions make them especially promising for the promotion of antihypertensive medication adherence. First, they are interactive, requiring input from users, which can be used to produce tailored content. Second, they can function without the need for input from a health professional, making them potentially cost-effective tools for delivering long-term, multiple-contact adherence support. Finally, once developed, these interventions are highly scalable, able to reach innumerable users for only marginal additional cost. A recent meta-analysis of interactive digital interventions demonstrated that interactive digital interventions are effective in lowering both SBP (weighted mean difference [WMD] −3.74 mm Hg, 95% confidence interval [CI] −5.28 to −2.19) and DBP (WMD −2.37 mm Hg, 95% CI −4.35 to −0.40) compared with usual care.[75] Few studies in the review included medication adherence as an outcome measure. Despite the promising results, little is known about the sustainability, long-term effectiveness, and active components of these interventions; thus, the evidence is not robust enough to warrant a policy or practice change at this time.[75] A recent content analysis of 166 medication adherence apps found that the extent to which established behavior change techniques are used in adherence apps is limited.[76] Future

research incorporating advances in behavior change theory and practice will likely guide development in this emerging area.

GAPS IN OUR KNOWLEDGE ABOUT PROMOTING MEDICATION ADHERENCE

Despite evidence supporting the efficacy of a range of promising interventions, gaps in knowledge remain. A 2014 Cochrane review of interventions to promote medication adherence suggests, “It is possible that interventions to date are not very effective because we do not understand in sufficient detail exactly what the adherence problems are.”[77] For example, unconscious, self-protective “hidden motives”[78] that render patients “immune to change” their medication-taking behavior have recently been identified and may be contributing to nonadherence to antihypertensive medications. Work is under way to fill the gaps in our understanding of these novel barriers: tools to identify individuals with hidden motives for nonadherence are being developed, and interventions to overturn nonadherence mindsets are being designed and tested. These efforts will yield insights into psychological processes underlying nonadherence and may provide a novel approach for improving adherence, BP control, and quality of life in people with hypertension.

Although it is certain that more work is needed to understand the barriers to and underlying mechanisms for adherence, there is also a need to implement and evaluate interventions that address well-established barriers to adherence. For example, a number of studies and a meta-analysis have demonstrated that low adherence to medications is associated with depression and stressful life events.[17–19,39] In one study, adjustment by depressive symptoms attenuated the association between social support and antihypertensive medication adherence.[18] Yet, with the exception of a trial that found that integrated management of hypertension and depression led to improvements in medication adherence and health outcomes,[79] few intervention trials have focused on addressing these barriers. In addition, although some work suggests that depression leads to low adherence through the mechanism of low self-efficacy,[80,81] additional research is needed to understand the mechanisms linking depression to low adherence so that targeted interventions can be developed.

In addition, work is needed to uncover sex and race differences in determinants of low adherence and effects of interventions to improve adherence. Racial and ethnic disparities in adherence rates are well-documented[82–84]; however, little is known about the root causes. Sex differences in determinants of adherence have been identified.[34] These efforts at achieving a nuanced understanding of how the relationships between adherence and its determinants are moderated by demographic and other factors will help us to tailor interventions to meet the varied needs of diverse patients. A consideration of demographic differences should be applied to intervention trials as well: a recent meta-analysis found that effect sizes of antihypertensive adherence interventions were larger for older, female, and moderate-to high-income participants, signaling the need to explore alternative interventions for younger, male, and low-income participants.[11] In general, there are major gaps in our understanding about how best to tailor interventions to meet the needs of patients with

adherence problems, different types of nonadherence (eg, intentional vs unintentional), and different preferences for delivery (eg, technology-mediated vs face-to-face).[11,85,86]

Finally, further work is needed to fully understand the link between antihypertensive medication adherence and cardiovascular outcomes. Although several studies to date have identified a significant association between adherence and cardiovascular outcomes, including myocardial infarction, heart failure, stroke, and death,[5] further work is needed to explore an association between adherence and other outcomes, such as diastolic dysfunction, a condition in which abnormalities in mechanical function of the heart are present during diastole. Hypertension may lead to diastolic dysfunction even in the absence of systolic dysfunction.[87] Diastolic heart failure accounts for approximately 40% to 60% of patients with chronic heart failure; the prognosis for these patients may be similar to that of patients with systolic heart failure.[88] Appropriate treatment of hypertension together with high patient medication adherence may be key to preventing onset of diastolic dysfunction and other cardiovascular diseases.

SUMMARY

Adherence to antihypertensive medication remains a key modifiable factor in the management of hypertension, an important, preventable risk factor for cardiovascular disease and death.[89] Timely attention in clinical and research settings to identifying and addressing barriers to low medication adherence and uncontrolled BP for the general population may interrupt the costly cycle of this chronic disease and prevent the declines in quality of life associated with the consequences of uncontrolled hypertension.

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KEY POINTS

- Relatively modest changes in adherence can lead to clinically significant improvements in BP control and reductions in cardiovascular events.
- Interventions associated with improved adherence tend to use ongoing, sustained focus, repeated contacts, and multiple strategies for addressing medication-taking behaviors.
- Promising strategies to improve antihypertensive medication adherence include regimen simplification, reduction of out-of-pocket costs, use of allied health professionals in delivering interventions (including team-based collaborative care), and self-monitoring of BP.
- Research to understand the effects of emerging technology-mediated interventions, mechanisms underlying adherence behavior, and sex-race differences in determinants of low adherence and intervention effectiveness may enhance patient-specific approaches to improve adherence and disease control.

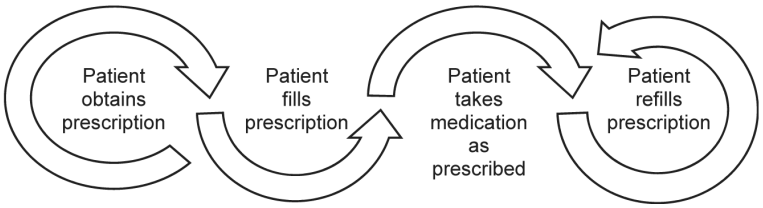

Fig. 1.
Adherence behavior cascade.

Table 1

Strategies for promoting medication adherence

Strategy	Description	Examples
Patient education	Didactic or interactive approaches to provide information and educate patients	• Face-to-face education session • Written or audiovisual education • Mailed instructional material
Social support	Enlistment of family members, friends, or other individuals to support patients in taking their medications as prescribed	• Lay health mentoring • Group support meetings • Family education
Patient motivation	Motivation of patients to take their medication as prescribed and removal of barriers that work against their motivation	• Motivational interviewing • Case management • Problem-solving • Decisional balance activities • Self-monitoring and feedback (see the next two rows)
Self-monitoring	Enlistment of patients to monitor their own BP or adherence	• Home or ambulatory BP monitoring • Home titration[90]
Feedback	Feedback to patients about their adherence or BP	• Telemonitoring of BP data • Rewards for meeting BP goals
Reminders	Reminders to patients to take their medications	• Calendars • Alarms • Pillboxes
Drug packaging	Changes in packaging of medications, intended to remind patients and/or give feedback about medication taking behavior	• Pillboxes • Blister packaging • Adherence packets
Regimen simplification	Prescription changes or changes in dosage schedule to simplify the regimen	• Combination pills • Once-daily dosing
Reduction of out-of-pocket costs	Reduction of patient out-of pocket drug costs	• Reduced medication copayments • Improved drug prescription coverage
Communication or interactions with provider	Improvements in patient-provider communication or interactions	• Communication skills training for patients and/or clinicians
Allied health providers and collaborative care	Enlistment of allied health care providers, individually or working as collaborative teams, to implement the intervention	• Pharmacist-delivered interventions • Nurse-delivered interventions • Team-based care

Abbreviation: BP, blood pressure

Table 2

Key medication adherence measures

Objective	Subjective
Pharmacy fill[6,17] • Medication Possession Ratio (MPR) • Proportion of Days Covered (PDC)[44,45] Electronic monitoring[46] Pill counts[46] Direct measurement of drug concentration in blood[46]	Morisky Medication Adherence Scale (MMAS), 4-item and 8-item versions[37,38,47] • MMAS-4 • MMAS-8 Krousel-Wood 4-item adherence tool (K-Wood-4)[48] Hill-Bone Compliance Scale[49] Medication Adherence Estimator[50]

Table 3

Comparing the effects of intervention characteristics on adherence and blood pressure

Effect on Adherence[a]	Effect on Blood Pressure[b]
Larger effect • Longer vs shorter time frame (*P*<.001) • More vs fewer intervention components (*P*<.001) • Behavioral vs informational[53] • Delivered to patients (d = 0.316) vs health care providers (d = 0.107) (*P* = .030) No difference in effect • Target adherence exclusively (d = 0.318) vs address additional health behaviors (d = 0.292) (*P* = .768) • Delivered in ambulatory care settings (d = 0.272) vs other setting (d = 0.282) (*P* = .938) • Delivered in pharmacies (d = 0.432) vs other locations (d = 0.290) (*P* = .405) • Face-to-face (d = 0.319) vs mediated delivery (d = 0.259) (*P* = .400) • Theory-based (d = 0.335) vs not theory-based (d = 0.284) (*P* = .554) • Larger intervention dose (i.e., no relationship between total minutes of intervention and effect size) (*P* = .534)	Larger effect Systolic blood pressure • Larger intervention dose (*P* = .021) • Delivered in pharmacies (d = 0.360) vs other locations (d = 0.226) (*P* = .031) • Delivered to groups (d = 0.399) vs individuals/families (d = 0.228) (*P* = .029) Diastolic blood pressure • Larger intervention dose (*P* = .027) • Face-to-face (d = 0.221) vs mediated delivery (d = 0.060) (*P*<.05) • Delivered in pharmacies (d = 0.356) vs other locations (d = 0.177) (*P* = .009) • Delivered to groups (d = 0.376) vs individuals/families (d = 0.179) (*P* = .018) No difference in effect Systolic blood pressure • Presence vs absence of behavior change theory • Face-to-face (d = 0.256) vs mediated delivery (d = 0.179) (*P*>.05) • Target patients/families vs health care providers • Delivered in ambulatory care settings vs home/community centers Diastolic blood pressure • Presence vs absence of behavior change theory • Target patients/families vs health care providers • Delivered in ambulatory care settings vs home/community centers

Where effect sizes and p-values are not listed, those data were not available from the source. No differences in effect may be due to small number of studies using these approaches.

[a] All results from Conn et al 2015,[11] unless specified.

[b] All results from Conn et al 2016.[55]

Table 4

Effectiveness of interventions to reduce out-of-pocket costs: evidence from individual studies

Study	Description of Intervention	Effect on Adherence[a]
Chernew et al,[59] 2008	Reduction of copayment rates for ACE inhibitors, ARBs, and beta-blockers	• MPR: ○ +2.6% points for ACE inhibitors/ARBs (*P*<.001) ○ +3.0% points for beta-blockers (*P*<.001)
Maciejewski et al,[60] 2010	Reduction of copayment rates	• MPR: ○ +3.4% for diuretics (*P*<.001) ○ 13.1% for ACE inhibitors (*P*<.001) ○ +2.7% for beta-blockers (*P*<.001) ○ +1.3% for calcium-channel blockers (*P*<.05)
Zhang et al,[61] 2010	Introduction of Medicare Part D coverage ($8/$20 copayments for generic/brand medications) to 3 intervention groups with following baseline conditions: **1** No coverage **2** Coverage with low quarterly drug spending cap **3** Coverage with high quarterly drug spending cap [Comparison group had benefits similar to Part D coverage at baseline.]	• MPR: ○ +13.5% points for group with no coverage at baseline (95% CI 11.5–15.5) ○ +2.6% points for group with low cap at baseline (95% CI 1.2–4.1) ○ +2.5% points for group with high cap at baseline (95% CI 1.7–3.2)
Li et al,[62] 2012	Medicare Part D coverage gap, 3 intervention groups with following baseline conditions: **1** No coverage **2** Generic-only coverage **3** Brand and generic coverage [Comparison group eligible for low-income subsidies during the gap.]	• PDC <0.8 (low adherence) ○ OR = 1.60 (95% CI 1.50–1.71) for group with no coverage at baseline ○ OR = 1.50 (95% CI 1.30–1.73) for group with generic-only coverage at baseline ○ OR = 1.00 (95% CI 0.88–1.15) for group with brand and generic coverage at baseline
Volpp et al,[63] 2014	Financial incentive equal to copayments for all antihypertensive medications, which effectively eliminated copayments	• MPR: ○ No effect (*P* = .74)

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure; CI, confidence interval; MPR, medication possession ratio; OR, odds ratio; PDC, proportion of days covered.

[a]Only Volpp et al assessed the effect of the intervention on BP outcomes; no effect was detected.

Table 5

Effectiveness of interventions involving allied health professionals (including collaborative care): summary of evidence from reviews and meta-analyses

Type of Intervention [Review/Meta-analysis]	Effects on Adherence	Effects on Blood Pressure
Nurse- and pharmacist-led care [Glynn et al,[65] 2010]	• Not assessed	• Mean difference SBP, range: −13 mm Hg to 0 mm Hg • Mean difference DBP, range: −8 mm Hg to 0 mm Hg
Pharmacist interventions [Morgado et al,[66] 2011]	• 44% of interventions increased adherence	• WMD SBP: −4.9 mm Hg, 95% CI −5.8 to −4.0 • WMD DBP: −2.6 mm Hg, 95% CI −3.5 to −1.7
Pharmacist-delivered face-to-face education; collaborative care [Viswanathan et al,[54] 2012][a]	• Pharmacist-delivered education: low strength evidence of benefit • Collaborative care: low strength evidence of no benefit	• Pharmacist-delivered education: decreased SBP and DBP (mean decrease not specified)
Multiprofessional informational, behavioral, and combined strategies [Mansoor et al,[69] 2013][a]	• Few informational or combined interventions improved adherence • All behavioral interventions improved adherence	• Most informational or combined interventions improved health outcomes, including BP • All behavioral interventions improved health outcomes, including BP
Team-based care interventions [Proia et al,[68] 2014]	• Insufficient information provided	• Median effect estimate SBP: −5.4 mm Hg, 95% CI −7.2 to −2.0 • Median effect estimate DBP: −1.8 mm Hg, 95% CI −3.2 to 0.7
Pharmacist-led interventions [Cheema et al,[64] 2014]	• OR (improved adherence) = 12.1, 95% CI 4.2–34.6	• WMD SBP: −6.1 mm Hg, 95% CI −8.4 to −3.8 • WMD DBP: −2.5 mm Hg, 95% CI −3.5 to −1.6
Pharmacist interventions [Santschi et al,[67] 2014]	• Not assessed	• WMD SBP: −7.6 mm Hg, 95% CI −9.0 to −6.3 • WMD DBP: −3.9 mm Hg, 95% CI −5.1 to −2.8
Pharmacist-delivered interventions; increased integration of care [Conn et al,[11] 2015]	• Pharmacist-delivered intervention (d = 0.356) vs not delivered by pharmacist (d = 0.277) (P = .327) • Studies that increased integration across providers (d = 0.185) vs studies without integration (d = 0.344) (P = .021)	Not assessed
Pharmacist, nurse, and physician interventionist [Conn et al,[55] 2016]	• Not assessed	• SBP ○ Pharmacist d = 0.317 (P<.001) ○ Nurse, advanced practice d = 0.298 (P = .001) ○ Physician d = 0.218 (P<.001) ○ Nurse, not advanced practice d = 0.142 (P = .089) • DBP ○ Pharmacist d = 0.235 (P<.001)

Type of Intervention [Review/Meta-analysis]	Effects on Adherence	Effects on Blood Pressure
		○ Nurse, advanced practice d = 0.224 (P = .030) ○ Physician d = 0.199 (P<.001) ○ Nurse, not advanced practice d = 0.149 (P = .101)

Abbreviations: BP, blood pressure; CI, confidence interval; DBP, diastolic blood pressure; SBP, systolic blood pressure; WMD, weighted mean difference.

[a]Specific data not reported in source

Table 6

Effectiveness of self-monitoring of blood pressure: summary of evidence from reviews and meta-analyses

Review/Meta-analysis	Effects on Adherence	Effects on Blood Pressure
Glynn et al,[65] 2010	• Not assessed	• WMD SBP: −2.5 mm Hg, 95% CI −3.7 to −1.3 • WMD DBP: −1.8 mm Hg, 95% CI −2.4 to −1.2
Bray et al,[70] 2010	• Not assessed	• WMD SBP: −3.8 mm Hg, 95% CI −5.6 to −2.0 • WMD DBP: −1.5 mm Hg, 95% CI −2.0 to −0.9
van Dalem et al,[53] 2012	• Contradictory results (2 studies)	• Mean DBP: “significant decrease” (2 studies; data not reported)
Uhlig et al,[71] 2013	• “A few studies” found effect (data not reported)	Self-monitoring only • WMD SBP, 6 mo: −3.9 mm Hg, *P*<.001 • WMD DBP, 6 mo: −2.4 mm Hg, *P*<.001 • WMD SBP, 12 mo: −1.5 mm Hg, *P*>.05 • WMD DBP, 12 mo: −0.8 mm Hg, *P*>.05 Self-monitoring + additional support • Net difference SBP, range, 12 mo: −8.9 to −2.1 mm Hg • Net difference DBP, range, 12 mo: −4.4 to 0.0 mm Hg
Fletcher et al,[52] 2015	• d = 0.21 (95% CI 0.08–0.34)	• WMD SBP: −4.1 mm Hg, 95% CI −6.7 to −1.4 • WMD DBP: −2.0 mm Hg, 95% CI −2.9 to −1.1
Conn et al,[11] 2015	• Self-monitoring (d = 0.381) vs no self-monitoring (d = 0.261) (*P* = .160)	• Not assessed
Conn et al,[55] 2016	• Not assessed	• No difference in effect (effect sizes not reported)

Abbreviations: CI, confidence interval; DBP, diastolic blood pressure; SBP, systolic blood pressure; WMD, weighted mean difference.