Cost-Effectiveness of Recommendations From the Surgeon General's Call-to-Action to Control Hypertension

Gabriel S. Tajeu,[1] Stavros Tsipas,[2,*] Michael Rakotz,[2,*] and Gregory Wozniak[2,*]

In response to high prevalence of hypertension and suboptimal rates of blood pressure (BP) control in the United States, the Surgeon General released a Call-to-Action to Control Hypertension (Call-to-Action) in the fall of 2020 to address the negative consequences of uncontrolled BP. In addition to morbidity and mortality associated with hypertension, hypertension has an annual cost to the US healthcare system of \$71 billion. The Call-to-Action makes recommendations for improving BP control, and the purpose of this review was to summarize the literature on the cost-effectiveness of these strategies. We identified a number of studies that demonstrate the cost saving or cost-effectiveness of recommendations in the Call-to-Action including strategies to promote access to and availability of physical activity opportunities and healthy food options within communities, advance the use of standardized treatment approaches and guideline-recommended care, to promote the use of healthcare teams to manage hypertension, and to empower and equip patients to use self-measured BP monitoring and medication adherence strategies. While the current review identified numerous cost-effective methods to achieve the Surgeon General's recommendations for improving BP control, future work should determine the cost-effectiveness of the 2017 American College of Cardiology and American Heart Association Hypertension guidelines, interventions to lower therapeutic inertia, and optimal team-based care strategies, among other areas of research. Economic evaluation studies should also be prioritized to generate more comprehensive data on how to provide efficient and high value care to improve BP control.

Keywords: blood pressure; blood pressure control; Call-to-Action; cost-effectiveness; hypertension; Surgeon General.

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Hypertension, defined as systolic blood pressure (SBP) ≥130 mm Hg or diastolic BP (DBP) ≥80 mm Hg,[1] is a leading cause of morbidity and mortality in the United States and affects nearly half of US adults.[1–4] Antihypertensive medication and lifestyle changes (i.e., diet and exercise) have been shown to lower BP and improve BP control among adults with hypertension.[1,5] Compared with individuals with uncontrolled BP, those with controlled BP have a lower risk of cardiovascular disease (CVD) events and all-cause mortality.[1,6] However, despite the effectiveness of antihypertensive medication and lifestyle changes, research indicates a large proportion of individuals in the United States have uncontrolled BP,[7–9] and the United States has seen a decline in BP control rates from 2013–2014 to 2017–2018.[9] During this timeframe, the age-adjusted proportion of adults with controlled BP, defined using previous clinical guidelines as SBP ≥140 mm Hg or DBP ≥90 mm Hg among adults taking antihypertensive medication, declined from 53.8% to 43.7%.[9] BP control declined across race, ethnicity, and age groups over that same period. In response to the high prevalence of hypertension and suboptimal rates of BP control in the United States, the Surgeon General released a Call-to-Action to Control Hypertension (Call-to-Action) to address the negative consequences of uncontrolled BP.[10]

In addition to the morbidity and mortality associated with hypertension, hypertension is associated with substantial healthcare costs.[11] In 2016, hypertension cost the US healthcare system \$71 billion and the total cost of CVD was \$320 billion.[11] Clinically effective and cost-effective strategies exist to improve BP control, and the Call-to-Action recommends that we "recognize the substantial economic costs of uncontrolled hypertension."[10] The purpose of this review is to summarize the literature on the cost-effectiveness of strategies to improve BP control outlined in the Call-to-Action.

ECONOMIC BENEFITS OF BP CONTROL

Nearly 4 out of 5 adults with hypertension will need antihypertensive medication to get to BP control.[12] The medication classes most commonly used for BP control include thiazide diuretics, calcium channel blockers, angiotensin-converting enzyme inhibitors, beta-blockers, and angiotensin receptor blockers.[13] These medications are widely used, with over 700 million prescriptions filled annually in

Correspondence: Gabriel S. Tajeu (gabriel.tajeu@temple.edu).
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[1]Department of Health Services Administration and Policy, Temple University, Philadelphia, Pennsylvania, USA; [2]American Medical Association, Chicago, Illinois, USA.
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2017 in the United States. While aggregate patient spending is substantial at ~$5 billion per year, generic medication usage exceeds 95% and the average annual patient expenditure for a year of therapy per medication class is $50.[14] This expenditure has been found to be cost-effective across multiple antihypertensive medication classes.[15] A 2017 systematic review of studies conducted between 1990 and 2016 found that when compared with no treatment, the incremental cost-effectiveness ratio (ICER) per quality-adjusted life year (QALY) is ~$20,000 (2015 US $).[15] Additional research on the cost-effectiveness of antihypertensive medication compared with no treatment report that treatment is cost saving for black and white adults, particularly for black women where treatment saved $10,249 using a lifetime time horizon.[16] Between medication classes, angiotensin receptor blockers had greater cost-effectiveness than other medication classes such as calcium channel blockers, with ICER/QALY of ~$13,000, though this relationship did not hold across all studies in a systematic review.[15] Combination therapies with a calcium channel blocker and angiotensin receptor blocker were found to be more cost-effective than a monotherapy using the same component medications.

COST-EFFECTIVENESS OF MAJOR INTERVENTIONS TO CONTROL BP

Several recent BP lowering interventions are effective and cost-effective.[17–23] The Systolic Blood Pressure Intervention Trial (SPRINT) randomized participants to a target SBP goal of 120 vs. 140 mm Hg.[17] Intensive BP treatment in SPRINT lowered risk for CVD and all-cause mortality by 25% and 27%, respectively.[17] While SPRINT enrolled high-risk adults with hypertension and without diabetes, a large percentage of US adults would meet the eligibility criteria. For instance, among adults ≥50 years of age and SBP ≥130 mm Hg, 40.2% would meet the SPRINT eligibility criteria.[24] Even though the SPRINT intervention required high levels of clinical monitoring and resources (i.e., more frequent office visits, laboratory tests, greater medication use) compared with standard treatment, several studies have determined SPRINT is cost-effective.[18,19] Using a Markov cohort model with a lifetime time horizon, Richman *et al.* determined that intensive BP management among adults who met SPRINT eligibility criteria would have a cost-effectiveness ratio of $23,777 per QALY gained.[19] Bress *et al.* report a higher cost-effectiveness ratio of $46,546 for SPRINT, partially due to a more conservative assumption of a reduction in treatment effect over time in their microsimulation model.[18]

The Los Angeles Barbershop Blood Pressure Study (LABBPS) intervention focused on addressing BP control among black men.[22,23] This innovative intervention utilized black barbershops as the location for a study which randomized barbershops to either clinical pharmacist delivered BP management through prescribing drug therapy (intervention) or barbers alone providing education on lifestyle modification or primary care importance (control). Over the year study period, the pharmacist-led BP intervention lowered BP by 20.8 mm Hg compared with the control group.[23] Additionally, compared with 11% of participants in the control arm, 68% of intervention arm participants achieved BP control, defined as SBP <130 mm Hg and DBP <80 mm Hg.[22,23] Recent articles have assessed the cost-effectiveness of LABBPS and the cost-effectiveness of scaling the intervention.[20,21] Utilizing a discrete event simulation, over a 10-year horizon, the LABBPS intervention was cost-effective.[20] In the base case scenario, the intervention had a mean cost of $49,820 per QALY, but if drug costs were based on generic prices, the cost-effectiveness improved to $24,240 per QALY gained.[20] Additionally, if this intervention could be scaled to the entire US population of black men, there would be an estimated 40% reduction in CVD events and a cost savings of $208 per person over 10 years.[21] Black adults are more likely to have uncontrolled BP compared with whites,[1] therefore this intervention represents an important step toward the possibility of not only lowering costs but also increasing health equity.

STRATEGIES TO PROMOTE ACCESS TO AND AVAILABILITY OF PHYSICAL ACTIVITY OPPORTUNITIES AND HEALTHY FOOD OPTIONS WITHIN COMMUNITIES

Limited data are available to assess the cost-effectiveness of improving physical activity and/or healthy diet in BP control. However, a systematic review reported on 4 lifestyle interventions for hypertension.[25–29] These studies suggest that targeting physical activity and diet interventions are likely to be cost-effective. Among these studies, which evaluated educational interventions for lifestyle modification, all led by nonphysician health professionals, lifestyle education were generally cost-effective.[25] A study of an employer-sponsored and Internet-based diet and exercise program was found to be cost saving, with a $999 per person net savings.[26] A randomized controlled trial of a 24-month behavioral intervention to improve BP conducted over the telephone yielded a cost-effectiveness ratio of $42,457 per life year for normal-weight women, $43,567 for overweight men, $58,560 for overweight women, and $87,300 for normal-weight men.[27] While this intervention included health behaviors including diet, exercise, smoking, and alcohol use, it also counseled patients on other behaviors including medication adherence. The dietary approaches to stop hypertension diet could also be utilized to lower BP cost-effectively.[30,31] This diet emphasizes fruits, vegetables, low-fat dairy products, whole grains, poultry, fish, and nuts. It only recommends a small amount of red meat, sweets, and sugar-sweetened beverages, and low levels of total and saturated fat and cholesterol. This diet can lower BP substantially, particularly when adults consume low levels of salt.[31] Australian researchers reported a cost-effectiveness ratio of AUS $12,000 per disability-adjusted life year gained for the dietary approaches to stop hypertension diet (Table 1).[30] In addition to general diet and exercise interventions, a simulated BP reduction from decreasing salt intake among US adults to the recommended 2,300 mg a day level could result in savings of $18 billion in healthcare costs.[32]

STRATEGIES TO ADVANCE THE USE OF STANDARDIZED TREATMENT APPROACHES AND GUIDELINE-RECOMMENDED CARE

Utilizing standardized treatment approaches based on guideline-recommended care can improve BP control rates.[33,34] For instance, a large health system in Southern California implemented a hypertension control program which included an evidence-based treatment protocol to standardize treatment.[33] This program resulted in improvements in BP control rates from 43.6% to 80.4% in 8 years.[33] An adapted version of this model has also shown promise in a study using 12 safety-net clinics where BP control rates increased from 68% to 74% over 24 months and 69% to 74% in 15 months in the pilot clinic and the other 11 clinics, respectively.[35] While the cost-effectiveness of these interventions has not been assessed, these interventions are likely to be cost-effective. For instance, Moran *et al.* utilized a state-transition model to assess the cost-effectiveness of treating previously untreated adults according to the 2014 hypertension guidelines.[36,37] Expanding antihypertensive medication treatment to previously untreated adults based on these guidelines was cost saving in the majority of scenarios and resulted in a decrease in the number of CVD events in all scenarios over a 10-year time horizon. The number of events avoided ranged from 6,000 to 26,000 depending on scenario and cost savings ranged from $149,000 to $1,640,000, drawing the conclusion that additional expenditures on increased efforts to treat and improve BP control based on guideline recommendations would add value to the health system.

STRATEGIES TO PROMOTE THE USE OF HEALTHCARE TEAMS TO MANAGE HYPERTENSION

Attending a primary care visit with a healthcare professional within the last year is associated with an increased likelihood of controlled BP.[9] While primary care physicians are vital to care provided to US adults, there is a shortage of these clinicians that is projected to become worse over the next decade.[38] Not only are other members of the care team, including advance practice nurses, registered nurses, pharmacists, and community health workers important to meet this demand, but literature reports that a team-based approach is effective and cost-effective.[10] Clinician and pharmacist collaboration was studied in the Collaboration Among Pharmacist and Physicians to Improve Outcomes Now (CAPTION) trial.[39] The intervention involved face-to-face visits and phone calls between pharmacists and patients consisting of topics including knowledge and barriers of hypertension as well as potential lifestyle modifications. After 9 months, 43% of participants in the intervention group had controlled BP compared with 34% in the control group at a cost of $22.55 per 1 percentage point difference in control rates for the intervention group. Another simulation study reports that including a pharmacist to improve BP management (i.e., improve their medication adherence and adjust medication regimens) among patients with persistently uncontrolled BP could result in cost savings for Medicare of approximately $900 million over 5 years.[40] Using a semi-Markov model Schultz *et al.* evaluate the clinical and economic consequences of a pharmacist-led comprehensive medication therapy management (MTM) clinic compared with no MTM clinic, from the payer perspective.[41] The results suggest that compared with no MTM clinic, the MTM clinic was cost-effective in 10-year primary prevention of stroke and CVD events in patients with hypertension.

Self-measured blood pressure (SMBP) in conjunction with team-based care (TBC) appears to be a promising, cost-effective strategy for BP control. A Community Preventive Services Task Force (CPSTF) review found that SMBP vs. usual care to be cost-effective within TBC.[42] TBC activities include primary care providers, other medical and administrative staff working together with patients to provide self-management support and improve the efficiency of care delivery. Kulchaitanaroaj developed a Markov model cohort simulation to estimate long-term costs and outcomes attributable to a physician–pharmacist collaborative intervention compared with physician management alone for treating essential hypertension.[43] The team-based intervention assessed was a physician–pharmacist collaborative interventions in community-based medical offices in the Midwest, USA. The intervention appears to be a cost-effective strategy for treating hypertension, particularly for high-risk patients. In addition to pharmacists, other healthcare team staff and community workers could help improve outcomes and be cost-effective.[25,44–46] For instance, prior studies report a cost of $9,716 to $17,670 per QALY gained by utilizing community health workers to improve BP control.[44,45]

STRATEGIES TO EMPOWER AND EQUIP PATIENTS TO USE SMBP MONITORING AND MEDICATION ADHERENCE STRATEGIES

There are numerous cost-effectiveness studies of SMBP monitoring for a variety of uses (e.g., confirming a suspected diagnosis of hypertension, initiating and titrating pharmacotherapy for treatment), scenarios (e.g., SMBP alone, with and without telemonitoring or other cointerventions), and effectiveness comparisons (i.e., vs. ambulatory BP monitoring, and vs. clinic-based BP monitoring or usual care). A CPSTF review reported results of 8 studies which provided cost-effectiveness results for SMBP alone, 8 studies for SMBP with additional support, and 8 studies for SMBP within TBC.[42] It is important to note the role of cointerventions in SMBP use. Beneficial cointerventions provided with SMBP monitoring include patient training on how to use the device, sharing BP readings with their healthcare professionals, support on medication adherence, and lifestyle counseling; and patient education for self-management, and telephone or web-based tools. The interventions often are delivered within TBC. The review found that SMBP is cost-effective vs. usual care for SMBP with additional support, and for SMBP within TBC. The median costs per QALY for SMBP with additional support, based on the assumption that a decrease of 1 mm Hg of SBP would yield 0.009 QALYs saved per year and a 1 mm Hg of SBP would yield 0.093 QALYs saved over a patient's lifetime, were $2,800 and $4,000, respectively; median cost per QALY saved for SMBP within TBC under the same assumptions was $7,500 and $10,800, respectively. However, the evidence in the studies reviewed for cost-effectiveness of SMBP interventions when used alone was mixed and inconsistent. The CPSTF review identifies several gaps in cost-effectiveness evidence, including the need for studies

Table 1. Examples of cost-saving or cost-effective interventions to improve blood pressure control

Recommended strategy from the Surgeon General's Call-to-Action to Control Hypertension	Intervention	Cost savings or cost-effectiveness
Promote access to and availability of physical activity opportunities and healthy food options within communities	Dietary approaches to stop hypertension (DASH) diet: diet emphasizes fruits, vegetables, low-fat dairy products, whole grains, poultry, fish, and nuts. Only recommends a small amount of red meat, sweets, and sugar-sweetened beverages, and low levels of total and saturated fat and cholesterol.[30]	AUS $12,000 per disability-adjusted life year among adults utilizing the DASH diet.
Advance the use of standardized treatment approaches and guideline-recommended care	Expanding antihypertensive medication treatment to previously untreated adults according to the 2014 hypertension guidelines.[36]	Expanding antihypertensive medication treatment to previously untreated adults resulted in 6,000–26,000 less CVD events and $149,000–1,640,000 in cost savings over a 10-year time horizon, depending on treatment scenario.
Promote the use of healthcare teams to manage hypertension	Utilizing pharmacists to help improve blood pressure (BP) management (i.e., improve medication adherence and adjust medication regimens) among patients with persistently uncontrolled BP.[40]	Could result in cost savings for Medicare of approximately $900 million over 5 years.
Empower and equip patients to use self-measured blood pressure (SMBP) monitoring and medication adherence strategies	SMBP with additional support vs. usual care.[42]	The median costs per quality-adjusted life year for SMBP with additional support ranged from $2,800 to $4,000.

Abbreviation: CVD, cardiovascular disease.

estimating return on investment (ROI) for SMBP-alone interventions, and studies designed to capture longer-term changes in healthcare cost driven by changes in morbidity and mortality.

In a recent study, Arrieta *et al.* address 2 evidence gaps identified in the CPSTF review: the economic value of specific uses of SMBP in order to better understand how each SMBP use contributes separately to economic benefits, and the ROI and long-term changes in morbidity and mortality associated with the stand-alone use of SMBP from the perspective of the insurer.[47] A decision-analytic simulation model was applied to estimate ROI for 3 distinct uses of SMBP compared with clinic-based BP measurement (i.e., usual care): diagnosing hypertension, selecting and titrating medications, and monitoring hypertension after treatment titration, over time, and the 3 uses bundled together. The primary economic value of SMBP from an insurance perspective comes from the first 2 uses (diagnosing hypertension and selecting and titrating medications), and as a bundle, but not from using SMBP solely for ongoing monitoring of BP control over time. If the 3 uses were bundled together, coverage of SMBP devices yielded a 1-year net present value (NPV) of $190, a 2-year NPV of $229 and a lifetime NPV of $254. The economic gains (lifetime NPV) when SMBP is used only to diagnose hypertension, across all age groups, was found to be $173 per individual, and $17 when SMBP is used only to select and titrate treatment. Investment losses of $121 per individual would be incurred when SMBP is used solely to monitor BP control over time and is negative for all age groups.

Margolis reported CVD events and costs over 5 years as part of a follow-up of Hyperlink, a cluster-randomized trial in 16 primary care clinics at HealthPartners Medical Group clinics.[47] The Hyperlink trial compared an intervention combining SMBP telemonitoring and pharmacist care management to usual care of patients with hypertension in primary care. Patients in the telemonitoring intervention group followed a protocol for frequency of SMBP measurements and telephone visits with pharmacists for 6 months until and 6 months after BP control was sustained. Pharmacists were asked to adjust antihypertensive drug therapy if <75% of readings since the last visit were at goal if the patient could tolerate additional treatment. The usual care group had hypertension care managed by their primary care physicians. Telephone visits covered SMBP measurements, medication adherence, and lifestyle modification options. The 5-year follow-up ROI was 82% and there was a NPV cost savings of about $1,241 using a primary CVD composite outcome which included myocardial infarction, stroke, heart failure, and cardiovascular death. The ROI was 119% using a secondary composite measure which included coronary revascularization costs.

Nonadherence to antihypertensive medication is common and contributes to low rates of BP control.[48,49] Prior studies have reported nonadherence rates of 54.2% among adults <65 years of age and 46.2% among adults ≥65 years of age.[50,51] Rates of antihypertensive medication nonadherence need to be addressed and could improve BP control in the United States.[10] A systematic review of community hypertension interventions reports educational programs supporting antihypertensive medication adherence (either pharmacist-led, physician-led, or team-based; n = 5) were cost-effective or cost saving.[25] Cost is a major driver of nonadherence to antihypertensive medication.[52,53] Studies report that eliminating copayment for antihypertensive medication can improve adherence.[54–56] While the cost-effectiveness of this strategy has not been tested in the general population, studies have demonstrated the cost-effectiveness among adults with diabetes taking angiotensin-converting enzyme inhibitors and for combination therapy after myocardial infarction.[55,56]

RECOMMENDATIONS AND FUTURE DIRECTIONS

Hypertension guidelines and recommendations

To date, the cost-effectiveness of the 2017 American College of Cardiology (ACC) and American Heart Association (AHA) hypertension guidelines has not been determined,[1] even though the ACC and AHA have recently recommended that cost-effectiveness assessments be used in creating treatment guidelines.[57] Given the USPSTF acknowledges that clinical, policy and coverage decisions should account for considerations beyond the evidence of clinical benefits and harms, the current USPSTF policy to not consider the costs of providing a service in their assessment of screening for hypertension in adults should be reevaluated.[58] Finally, looking outside the United States, the UK's National Institute for Health and Care Excellence guidelines include cost-effectiveness analysis results in rationale for recommendations.[59]

Therapeutic inertia and combination therapy

One of the greatest challenges to BP control is therapeutic inertia (i.e., failure to initiate or intensify therapy in patients who have not achieved BP control).[10] Using a microsimulation model, Bellows *et al.* report that the factors having the greatest impact on BP control were visit frequency, medication adherence, and provider medication intensification in response to an uncontrolled BP measurement.[60] Because clinical inertia is a barrier to BP control, interventions and cost-effectiveness analysis of interventions to reduce therapeutic inertia are needed. In addition, most patients with hypertension will need more than 1 class of medication to get to BP control.[10] The 2017 ACC/AHA hypertension guidelines recommends that adults with stage 2 hypertension and an average BP more than 20 mm Hg SBP or 10 mm Hg DBP above their BP target initiate antihypertensive drug therapy with 2 different classes of first-line agents, either as separate agents or in a fixed-dose combination.[1] There is little economic analysis of different fixed-dose single pill combination therapies included in guideline recommendations. Lastly, high BP guideline treatment recommendations explicitly take into account race and ethnicity and comorbidity status. Cost-effectiveness of fixed-dose single pill combinations should focus analysis on these population groups.

Team-based care

There is also a need for cost-effectiveness analyses comparing TBC strategies to one another rather than usual care, identify which team-based initiatives hold the highest value for different populations, and assess the cost-effectiveness of TBC intensive BP strategies in order to meet SBP goals recommended by the 2017 ACC/AHA guidelines.[46] Cost-effectiveness studies of health coaching plus home BP monitoring are also needed to help inform BP control strategies in populations with health disparities.[61]

Intervention sustainability

Additional future research is needed on cost-effectiveness and sustainability of implementation strategies for BP control and economic evaluations of long-term follow-up after trial completion.[62] Little economic benefit data are available on the long-term effects (i.e., beyond 12 months) of SMBP monitoring on BP and cost-effectiveness in preventing cardiovascular events and mortality among different patient subgroups (by age, race/ethnicity, and comorbidities), and after various antihypertensive medication prescription strategies.[63]

Given the high prevalence of hypertension among US adults and the decreasing rates of BP control, the Call-to-Action was both timely and will hopefully bring increased attention to the need for improved rates of BP control. The current review identified numerous cost-effective strategies to achieve the Surgeon General's recommendations for improving BP control in the United States. However, economic evaluation studies should also be prioritized in order to generate more comprehensive data on how to provide efficient and high value care based on the recommended strategies in the Call-to-Action.

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