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Cost-effectiveness and challenges of implementing intensive blood pressure goals and team-based care

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Abstract

Purpose: Review the effectiveness, cost-effectiveness, and implementation challenges of intensive blood pressure (BP) control and team-based care initiatives.

Recent Findings: Intensive BP control is an effective and cost-effective intervention, yet implementation in routine clinical practice is challenging. Several models of team-based care for hypertension management have been shown to be more effective than usual care to control BP. Additional research is needed to determine the cost-effectiveness of team-based care models relative to one another and as they relate to implementing intensive BP goals.

Summary: As a focus of healthcare shifts to value (i.e., cost, effectiveness, and patient preferences), formal cost-effectiveness analyses will inform which team-based initiatives hold the highest value in different healthcare settings with different populations and needs. Several challenges, including clinical inertia, financial investment, and billing restrictions for pharmacist-delivered services, will need to be addressed in order to improve public health through intensive BP control and team-based care.

Keywords

cost effectiveness; patient care team; hypertension; blood pressure; pharmacists; nurses

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Introduction

Globally, high blood pressure (BP) is the leading modifiable risk factor for cardiovascular morbidity and mortality [1–3]. Of the 116 million American adults with hypertension, 53.4% are treated, and 24.7% are both treated and have controlled BP [4]. Given the widespread availability of low-cost, effective antihypertensive medications, uncontrolled BP represents a missed public health opportunity for the prevention of cardiovascular, neurologic, and renal diseases.

The 2017 American College of Cardiology/American Heart Association (ACC/AHA) BP guidelines lowered the threshold for defining hypertension and recommended a more intensive BP threshold for initiation and intensification of antihypertensive medication. Implementing and maintaining these more intensive BP goals requires significant culture shifts and investments by health systems. To achieve and maintain lower BP treatment goals, the ACC/AHA guidelines endorse comprehensive, team-based care (TBC) for hypertension management [5–7]. Furthermore, the Centers for Disease Control and Prevention recently incorporated TBC into its strategic initiatives to improve BP control [8].

Health systems are tasked with maximizing the value of healthcare services by improving quality and patient satisfaction while controlling costs [9]. In the context of hypertension management, clinicians and health systems must carefully consider the logistics of targeting intensive BP goals and, where needed, how to implement TBC programs to reach intensive BP goals. These health services must be effective and cost-effective while considering patient preferences and quality of life [10–13].

The objective of this review is to appraise the current literature regarding the effectiveness and cost-effectiveness of intensive systolic BP (SBP) goals and implementation of TBC interventions. We also discuss challenges of implementing these strategies within health systems in the US.

Cost-effectiveness analysis translates evidence from diverse sources to quantify the value of healthcare interventions

Cost-effectiveness analysis (CEA) provides a framework for payers, population health managers, governments, and clinicians to quantify the incremental health benefits, costs, and downstream consequences of an intervention relative to other options. While CEA incurs criticisms regarding uncertainty about how both cost and health outcome inputs are estimated, these analyses reveal the underlying assumptions clinicians make when considering a new therapy compared to a previous standard (e.g., how much weight to place on risk vs. benefit when initiating a medication therapy for a particular patient demographic). As such, decision-makers in the US have historically been reluctant to use CEA formally to prioritize health services [14]. However, the ACC and AHA recommend that CEAs be used in creating treatment guidelines and recently used them to make recommendations for lipid lowering treatments [15,16]. The 2018 ACC/AHA Cholesterol Management Guidelines acknowledged that proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitors, a novel antihyperlipidemic class, are low value for most patients at conventional cost-effectiveness thresholds and recommended maximally tolerated statins and ezetimibe be used first in high-risk patients [16–18].

High-quality evidence supports the cost and population health impacts of widespread achievement of standard BP goals (i.e., SBP/diastolic [DBP] <140/90 mm Hg). One analysis found that if 100% of guideline-recommended services were successfully implemented, the incremental cost per person newly-attaining BP treatment goals over two years would be $1,696 (2009 US Dollars [USD]) overall, $801 for moderate hypertension, and $850 for severe hypertension [19]. Additionally, treating to a standard SBP/DBP goal of <140/90 mm Hg is cost-saving or cost-effective in most age and sex groups [20,21].

Targeting intensive BP goals reduces CVD risk compared to standard goals

Meta-analyses of randomized trials of BP-lowering show that targeting an intensive SBP goal (i.e., lower by at least 10 mm Hg or to less than 130 mm Hg) results in a larger relative risk reduction in all-cause mortality and cardiovascular disease (CVD) events, compared to targeting standard BP goals (e.g., <140 mm Hg) [22–24]. In 2015, SPRINT (Systolic Blood Pressure Intervention Trial) demonstrated that treating to an intensive SBP target of <120 mm Hg compared to a standard target of <140 mm Hg significantly reduced all-cause mortality and CVD events among high CVD risk adults without a history of diabetes, stroke, or heart failure [25]. With and without the SPRINT results, a meta-analysis of 42 BP-lowering trials with 144,220 participants concluded that achieving an SBP of 120–124 mm Hg was associated with a significantly lower risk of CVD events compared to groups with higher achieved SBP [22]. These data prompted the 2017 ACC/AHA BP guidelines to recommend a SBP/DBP goal of <130/80 mm Hg in treated adults less than 65 years old with prior CVD or a 10-year CVD risk greater than 10%, and an SBP goal of <130 mm Hg for adults aged 65 years or older [5]. Over ten years, achieving and maintaining the 2017 ACC/AHA BP goals compared with achieving 2003 Seventh Joint National Committee Report goals or achieving 2014 Eighth Joint National Committee goals is projected to prevent 0.5 million (95% confidence interval [CI], 0.2–0.7 million) or 1.4 million (95% CI, 0.6–2.0 million) CVD events, respectively [26].

Concerns remain that the benefits of targeting intensive SBP goals as described in SPRINT and meta-analyses do not apply to all patient populations, particularly those with diabetes. The ACCORD-BP (Action to Control Cardiovascular Risk in Diabetes Blood Pressure) trial used a double 2×2 factorial design to simultaneously investigate BP, lipid, and glycemic control interventions. Participants were randomized to BP goals identical to SPRINT: <120 mm Hg or <140 mm Hg. After one year, there were no differences between the BP treatment groups for the primary composite outcome of nonfatal myocardial infarction, nonfatal stroke, or death from cardiovascular causes (hazard ratio [HR] 0.88, 95% CI 0.73 to 1.06) [27]. However, among ACCORD-BP participants in the standard glycemia treatment arm, targeting an intensive SBP did significantly reduce CVD events similar to the risk reduction observed in SPRINT (HR 0.74; 95% CI 0.55 to 1.00) [28]. In a post-hoc analysis of SPRINT, the benefits of targeting intensive SBP goals were similar among those with and without prediabetes and were not attenuated by higher serum glucose levels at baseline [29].

Cost-effectiveness of intensive vs. standard BP control

The benefits of targeting intensive SBP goals (e.g., decreased CVD events and improved survival) must be weighed against the potential harms (e.g., serious adverse events [SAE]) and implementation and maintenance costs (e.g., additional office visits, laboratory tests, personnel, and medications). Early CEAs of SPRINT data found intensive SBP goals were cost-effective (Table 1) [30,31], but these analyses assumed lifetime persistence of the benefits of intensive control or did not account for costs of treating non-cardiovascular diseases.

A model developed by the SPRINT Research Group estimated healthcare costs and quality-adjusted life years (QALY) gained from targeting intensive versus standard SBP goals in SPRINT-eligible US adults over a lifetime time horizon [32]. The model incorporated decays in medication adherence and treatment effects, a range of treatment costs and office visit frequencies, and varying baseline SAE and CVD event rates. The analysis showed targeting an intensive SBP goal was cost-effective according to accepted cost-effectiveness thresholds regardless of whether treatment benefits decayed or persisted beyond the end of SPRINT follow-up (median follow up 3.26 years) [15,33]. The incremental cost-effective ratio (ICER) was ~$47,000/QALY gained (2015 USD) for intensive goals relative to standard goals if effects decayed over time, and ~$28,000/QALY gained if treatment effects persisted over a lifetime. A scenario analysis found that the baseline risk of SAEs observed in SPRINT would need to be inflated by a factor of 2.8, or the SAE risk with the intensive treatment alone would need to be increased by a factor of 1.6, in order for the ICER to be greater than $50,000/QALY gained. Varying the number of office visits per year and medication prices did not significantly impact the results.

Opportunities and challenges

Targeting more-intensive SBP goals is effective and cost-effective in high CVD risk populations, yet applying and implementing intensive goals to the guideline-directed patient population with hypertension represents a deviation from the *status quo*. Nearly 1 in 3 US adults with treated hypertension have BP greater than previous guideline-recommended targets of <140/90 mm Hg [34]. As such, more-intensive SBP goals have not been widely adopted by clinicians, health systems, or professional societies.

Several challenges limit widespread implementation of intensive BP targets. First, in order to attain the lower SBP thresholds as demonstrated in SPRINT, clinical practice would need to mirror both the high-quality measurement of BP and treatment with medications (combinations and doses) used in SPRINT [35]. In SPRINT, BP was measured three times using an automated device (Omron HEM 907XL) at each clinic visit after a five-minute rest period [36], which typically takes 8–10 minutes [37]. For many clinics and health systems, the real and perceived constraints on space, staffing, and time limit the ability to measure and treat BP as performed under research conditions [38].

Additionally, targeting more-intensive BP goals has significant implications for medication management. Achieving lower BP may require more medications, improved adherence, higher doses, or all of these. Patients with hypertension at high risk of CVD events are likely to have multiple comorbidities and high existing medication burden, including non-antihypertensive medications [39]. Thus, medication adherence, drug interactions, and patient satisfaction and acceptance become important concerns when considering whether to add more antihypertensive medications or increase antihypertensive medication doses. When all else is equal, medication regimens that are less complex (e.g., single-pill combinations, less-frequent daily dosing) should be favored for the benefit of improved medication adherence [40–42]. The optimal doses and combinations of evidence-based antihypertensive medication classes to achieve intensive goals are unknown. It is even less clear how intensive SBP goals should be broadly applied to treatment decisions in populations that were excluded from SPRINT (e.g., age <50 years, prior diagnosis of diabetes, stroke, or heart failure).

Beyond logistics, integrating more-intensive BP goals into clinical practice will be challenging at the prescriber level. Clinical inertia, the phenomenon of not initiating or intensifying therapy at the point of care despite a BP reading that is above goal, is highly prevalent in hypertension management [43,44] and may be a key factor preventing BP control [45]. Several factors associated with the patient, provider, and system elicit clinical inertia [46], such as low health literacy, insufficient provider-patient time, or lack of protocols. Clinical inertia must be distinguished from clinical uncertainty, which may result from variability in BP measurement, poor quality data on medication adherence, or other modifiable factors. Indeed, both clinical inertia and clinical uncertainty may affect the implementation of an appropriate therapeutic regimen, reducing the likelihood of attaining intensive SBP goals.

Nonetheless, improved hypertension treatment and control rates can be achieved. Health systems like Kaiser Permanente and the Department of Veterans Affairs have successfully achieved BP control rates of 80% to standard goals among those with treated hypertension using standardized protocols and TBC [47,48]. Systematic, durable, multi-faceted interventions are needed to improve hypertension control. Using TBC has great potential to expand capacity and mitigate challenges that directly affect BP control rates.

Team-based care is more effective than usual care

TBC can be delivered with a wide variety models and more effectively lowers BP than usual care [12]. The types of TBC models studied are diverse and include non-physician provider clinic visits, utilizing non-physician providers (i.e., nurses, nurse practitioners [NP], physician assistants [PA], or pharmacists) to manage hypertension, and optimizing patient education and support personnel [12,49,50]. One recent meta-analysis of over 100 trials and 55,920 patients concluded that the most effective BP-lowering strategies use multilevel, multicomponent approaches to address barriers to hypertension control and often involve non-physician providers assessing the patients, measuring BP and laboratory values, then titrating medications [51]. Compared with usual care, TBC with non-physician medication titration resulted in a 7.1 mm Hg mean SBP reduction, and TBC with physician medication titration resulted in a 6.2 mm Hg mean SBP reduction. Similar trends were observed with DBP reductions.

Pharmacists are widely employed in TBC for hypertension management [12,49–52]. In one randomized trial of 625 patients, 43% of patients achieved BP control at nine months under pharmacist-physician collaboration, compared to 34% of those participating in usual care [53]. In another study of 450 patients, combining pharmacists with telehealth management yielded BP control rates greater than 70%, significantly more than the 45% of participants who achieved BP control via usual care [54]. Additionally, a pharmacist-led intervention in a community setting for non-Hispanic Black male patrons of barbershops with uncontrolled BP resulted in a mean SBP reduction of 21.6 mm Hg greater than usual care at six months [55]. The effects of pharmacist-provided hypertension care often persist beyond the initial intervention period [56,57]. Strong patient-pharmacist and community relationships in addition to individualized treatment plans have been considered as drivers for these successful interventions [57–59].

Nurses are also widely used for effective hypertension management in TBC models [60–62]. One meta-analysis of national and international studies that stratified results by specific nurse-led interventions found a mean decrease in SBP from baseline of 8.2 mm Hg with nurse management using treatment algorithms, and 8.9 mm Hg with nurse prescribing [62]. Another meta-analysis of 11 national and international nurse-led interventions to improve BP control in patients with diabetes demonstrated an overall 5.8 mm Hg mean decrease in SBP compared to physician-led care [63]. Nursing personnel also serve in administrative or leadership positions, liaise between the medical team and the patient, and act as crucial care coordinators in the patient care process.

Beyond pharmacist and nurse management, there are several ongoing studies to improve hypertension care using innovative TBC approaches. Notably, the RICH-LIFE (Reducing Inequities in Care of Hypertension, Lifestyle Improvement for Everyone) study will evaluate BP outcomes among underserved patients randomized to usual care compared to a comprehensive team of physicians, care managers, community health workers, pharmacists, and dietitians (). Results from this study may inform future CEA to guide value-based implementation decisions in underserved populations.

Team-based care is cost-effective relative to usual care

TBC to manage hypertension has been shown to be cost-effective in several analyses (Table 2). These studies can be broadly categorized into formal CEAs (e.g., simulation, Markov modeling) and cost analyses of observational or interventional studies. Key findings are highlighted here, as exhaustive reviews and discussions about TBC for hypertension including international studies are provided elsewhere [49,50,64].

One recent systematic review assessed 34 national and international cost-effectiveness studies of community interventions to manage patients with hypertension, most of which incorporated non-physician providers alone or in conjunction with physician-provided care [64]. Among 25 studies that implemented educational interventions for lifestyle and/or medication adherence, the median cost (2014 USD) to lower SBP by 1 mm Hg was $62 (range: $40-$114) with a median ICER of $13,986/QALY gained (range $6,683-$58,610). Importantly, the authors noted that community-based interventions for hypertension care are significantly heterogeneous in setting and outcomes studied. Most studies assessed outcomes at less than one year, and longer follow-up is needed to confidently estimate long-term ICERs. Many of the studies were not randomized or controlled, or the economic analyses did not implement uncertainty or sensitivity analyses. Regardless, the findings from this review confirm estimates from a previous systematic review of 31 TBC studies from the US and internationally, which reported a median ICER of $10,511-$15,137/QALY gained (2010 USD) and a median total implementation cost of $355 per patient [65].

Several cost analyses of pharmacist-provided care models for hypertension management have been published based on results from interventional studies [53,54,66,67]. Clinic-embedded clinical pharmacists cost $33 (2013 USD) per 1-mm Hg reduction in SBP and $70 per 1-mm Hg reduction in DBP relative to usual care [68], similar to 2008 estimates [69]. Combining pharmacist-managed hypertension care with telehealth is slightly more expensive at $139 per 1-mm Hg reduction in SBP and $265 per 1-mm Hg reduction in DBP (2012 USD) [70]. One economic evaluation found that, assuming an intervention cost of $525 per patient, a pharmacist-delivered hypertension management program could generate 5-year cost-savings in Medicare patients with treated, persistently uncontrolled BP [71]. In one formal CEA, compared to usual care, the ICER for pharmacists to manage hypertension was $26,800 (2015 USD) per QALY gained, and the intervention was broadly cost-effective for the highest risk patients (i.e., comorbid diabetes, smoking, hypercholesterolemia, or obesity) [72]. At the community pharmacist level, interventions largely focus on improving antihypertensive medication adherence, although results show both cost-savings of more than $6,000 per patient [73,74] or minimal effectiveness and cost-effectiveness compared to usual care [75,76].

For a broad range of chronic disease management, the inclusion of nurses and NPs on teams is widely considered cost-effective, especially when added to a team of other qualified healthcare professionals [77]. The most robust analyses of a nurse-administered telephone education program [78] demonstrated a lifetime ICER of $87,300 per life-year (LY) gained for normal-weight males and $43,600/LY gained for overweight males compared to usual care [79]. Including direct and indirect costs, the mean cost to deliver the intervention was $112 per patient, with a range of $61 to $259 depending on salary, number of patients managed, and types of indirect costs. In another analysis, combining an NP and community health worker to manage CVD risk factors demonstrated that for every one-mm Hg reduction in SBP and DBP, the intervention cost $101 and $209 (2010 USD), respectively, compared to usual care [80]. More economic and CEA data specific to NP-delivered hypertension care are needed to guide implementation decisions by health systems.

The variation in models for pharmacist- and nurse-delivered interventions for hypertension care hampers definitive conclusions on the cost-effectiveness of TBC. Given that TBC is effective and recommended by current clinical practice guidelines, formal CEAs that compare TBC strategies to one another rather than usual care are needed. Additionally, no CEA has assessed the cost-effectiveness of TBC strategies specifically to achieve the more-intensive SBP goals recommended by the 2017 ACC/AHA guidelines.

Opportunities and challenges preventing widespread adoption of TBC to manage hypertension

There are numerous opportunities to increase adoption of TBC in hypertension, but not without challenges. First, scopes of practice for non-physician providers (e.g., nurses and pharmacists) are managed by country or state laws, thereby dictating the degree to which non-physician providers can be integrated into clinical practice [7]. Laws differ in required physician oversight, allowable activities (e.g., medication prescribing, laboratory ordering), and protocol requirements [81]. Billing and reimbursement practices also vary, which are key institutional considerations in assessing the financial feasibility to hire a new employee. For example, pharmacists are not currently recognized as healthcare providers by Medicare in the United States, which is frequently cited by state-based programs and insurance carriers as a justification for limiting reimbursement for pharmacist-provided services [82,83]. The utilization and optimization of non-physician providers is crucial to public health. Current U.S.-based estimates project a shortage of over 40,000 primary care practitioners by 2030 [84]. There are also opportunities for including supportive healthcare personnel, such as certified nursing assistants, medical assistants, or pharmacy technicians and interns, but specific roles have yet to be delineated or evaluated formally.

In low- and middle-income countries (LMIC), integration of TBC for hypertension management is met with additional high-level systems barriers. Several competing acute healthcare, political, and social concerns may impede funding and focus for improving chronic disease management [85]. Examples include infectious diseases (e.g., malaria), armed conflict, or access to family planning services. From a funding perspective, the *status quo* of funding “vertical” interventions which target specific populations or diseases challenges the shift to fund “horizontal” interventions which focus on comprehensive, system-based solutions such as primary health care [86]. A three-round panel consultation with 141 experts from 50 LMIC identified the horizontal integration of multidisciplinary teams as a priority area to improve health care [87]. Depending on country-specific laws and regulations for healthcare professionals, utilization of diverse members of the healthcare team with strong community linkages will likely be required to develop effective and sustainable care delivery models for hypertension management in LMIC [88].

Health systems bear the cost burdens of implementing and maintaining TBC. Cost decisions are influenced by available funds, perceived or actual relative value, alignment with the organization’s mission and vision, feasibility of implementation, capacity for risk management and administrative support, and estimates for return on investment. The most effective, efficient, and feasible method for implementing TBC has yet to be determined and likely varies by practice setting, patient population, and geographic region. Given the minimal up-front costs, serious sequalae associated with uncontrolled hypertension, and effectiveness of TBC, health systems should invest in TBC with the long-term goals of improving patient outcomes and satisfaction with hypertension care.

New technology, such as smart phone apps, wearables, and Bluetooth-enabled home BP monitors may augment TBC for the management of hypertension. Technology allows for quick transmission of information, such as home BP readings, to the hypertension management team. Hypertension care can be integrated with electronic patient portals, telehealth programs, or wearable products (e.g., Fitbit™). In fact, titrating medications according to BP measurements assessed via telemonitoring has shown to be effective and cost-effective compared to usual care, particularly when combining self-monitoring with TBC interventions [89–91]. Future research could incorporate patient-reported outcomes and measure the impact of technology on patient engagement, acceptance, and satisfaction. From the patient perspective, some technology may be cost-prohibitive, which must be considered when deciding whether and how to implement certain telehealth services. Technology will undoubtedly play a crucial role to manage hypertension in patients who may not be as accessible to healthcare providers, such as those who are bedridden, live in rural areas, work during clinic hours, or struggle with access to reliable transportation.

Patient acceptance and engagement are critical to effectively manage hypertension. Patients ultimately share responsibility for their daily hypertension management including home BP monitoring, lifestyle modifications, and antihypertensive medication adherence. Unfortunately, antihypertensive medication non-adherence remains common, found in approximately 45% of treated patients, and increases with the prevalence of uncontrolled BP [92,93]. Adherence to various non-pharmacologic lifestyle modifications to reduce BP is even lower [94]. High-quality data on the effectiveness of interventions to support shared decision-making for hypertension management are lacking [95,96]. Successful strategies for sustaining patient engagement in various TBC interventions are needed.

Conclusion

Intensive therapy for SBP is an effective and cost-effective intervention to prevent complications from hypertension. Team-based care that includes non-physician providers to manage hypertension is more effective than usual care and will become increasingly important to achieve and maintain intensive SBP goals at scale. TBC strategies have been shown to be cost-effective compared to usual care. Research is needed to evaluate the efficacy and cost-effectiveness of several team-based care interventions relative to one another to achieve widespread intensive BP control targets.

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REFERENCES

1. Whelton PK. The Elusiveness of Population-Wide High Blood Pressure Control. Annu Rev Public Heal. 2015;36:109–30.

2. Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002;360:1903–13. [PubMed: 12493255]

3. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in

21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2013;380:2224–60.

4. Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, et al. Heart Disease and Stroke Statistics - 2019 Update: A Report from the American Heart Association. Circulation. 2019;139:00–00.
5. Whelton PK, Carey RM, Aronow WS, Casey DE Jr., Collins KJ, Dennison Himmelfarb C, et al. 2015 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical P. J Am Coll Cardiol. 2018;71:e127–248. [PubMed: 29146535]
6. Fisher NDL, Curfman G. Hypertension—A Public Health Challenge of Global Proportions. JAMA. 2018;320:17571759.
7. Brush JE, Handberg EM, Biga C, Birtcher KK, Bove AA, Casale PN, et al. 2015 ACC health policy statement on cardiovascular team-based care and the role of advanced practice providers. J Am Coll Cardiol. 2015;65:2118–36. [PubMed: 25975476]
8. Centers for Disease Control and Prevention. Best Practices for Cardiovascular Disease Prevention Programs: A Guide to Effective Health Care System Interventions and Community Programs Linked to Clinical Services, Promoting Team-Based Care to Improve High Blood Pressure Control [Internet]. Atlanta, GA; 2017 Available from: https://www.cdc.gov/dhdsp/pubs/guides/best-practices/team-based-care.htm
9. Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, Health, And Cost. Health Aff. 2008;27:759–69.
10. Stiefel M, Nolan K. Commentary Measuring the Triple Aim: A Call for Action. Popul Health Manag [Internet]. 2013 [cited 2019 Jun 27];16:219–20. Available from: www.liebertpub.com
11. Ory MG, Ahn S, Jiang L, Smith ML, Ritter PL, Whitelaw N, et al. Successes of a National Study of the Chronic Disease Self-Management Program. Med Care. 2013;51:992–8. [PubMed: 24113813]
12. Proia KK, Thota AB, Njie GJ, Finnie RKC, Hopkins DP, Mukhtar Q, et al. Team-Based Care and Improved Blood Pressure Control: A Community Guide Systematic Review. Am J Prev Med. 2014;47:86–99. [PubMed: 24933494]
13. Sofaer S, Firminger K. Patient Perceptions of the Quality of Health Services. Annu Rev Public Heal. 2005;26:513–59.
14. Neumann PJ. Why Don’t Americans Use Cost-Effectiveness Analysis? Am J Manag Care. 2004;10:308–12. [PubMed: 15152700]
15. Anderson JL, Heidenreich PA, Barnett PG, Creager MA, Fonarow GC, Gibbons RJ, et al. ACC/AHA statement on cost/value methodology in clinical practice guidelines and performance measures: A report of the American College of Cardiology/American Heart Association Task Force on Performance Measures and Task Force on Practice Guidelines. Circulation. 2014;129:2329–45. [PubMed: 24677315]
16. Grundy SM, Stone NJ, Bailey AL, Beam C, Birtcher KK, Blumenthal RS, et al. 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019;139:e1082–143. [PubMed: 30586774] * 2018 AHA/ACC guidelines on cholesterol management that incorporates cost-effectiveness analysis into recommendations for PCSK9 use.
17. Kazi DS, Moran AE, Coxson PG, Penko J, Ollendorf DA, Pearson SD, et al. Cost-Effectiveness of PCSK9 inhibitor therapy in patients with heterozygous familial hypercholesterolemia or atherosclerotic cardiovascular disease. JAMA. 2016;316:743–53. [PubMed: 27533159]
18. Kazi DS, Penko J, Coxson PG, Moran AE, Ollendorf DA, Tice JA, et al. Updated cost-effectiveness analysis of PCSK9 inhibitors based on the results of the FOURIER trial. JAMA - J Am Med Assoc. 2017;318:748–50.
19. Nuckols TK, Aledort JE, Adams J, Lai J, Go M-H, Keesey J, et al. Cost, Quality and Chronic Disease: Cost Implications of Improving Blood Pressure Management among U.S. Adults. Health Serv Res. 2011;46:1124–1157. [PubMed: 21306365]

20. CDC Diabetes Cost-effectiveness Group. Cost-effectiveness of intensive glycemic control, intensified hypertension control, and serum cholesterol level reduction for type 2 diabetes. JAMA. 2002;287:2542–51. [PubMed: 12020335]
21. Moran AE, Odden MC, Thanataveerat A, Tzong KY, Rasmussen PW, Guzman D, et al. Cost-Effectiveness of Hypertension Therapy According to 2014 Guidelines. N Engl J Med. 2015;372:447–55. [PubMed: 25629742]
22. Bundy JD, Li C, Stuchlik P, Bu X, Kelly TN, Mills KT, et al. Systolic Blood Pressure Reduction and Risk of Cardiovascular Disease and Mortality. JAMA Cardiol. 2017;2:775–81. [PubMed: 28564682]
23. Ettehad D, Emdin CA, Kiran A, Anderson SG, Callender T, Emberson J, et al. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. Lancet. 2016;387:957–67. [PubMed: 26724178]
24. Bangalore S, Toklu B, Gianos E, Schwartzbard A, Weintraub H, Ogedegbe G, et al. Optimal Systolic Blood Pressure Target After SPRINT: Insights from a Network Meta-Analysis of Randomized Trials. Am J Med. 2017;130:707–19. [PubMed: 28109971]
25. Wright JT Jr., Williamson J, Whelton P, Snyder J, Sink K, Roccoo M, et al. A Randomized Trial of Intensive versus Standard Blood-Pressure Control. N Engl J Med. 2015;373:2103–16. [PubMed: 26551272]
26. Bress AP, Kramer H, Khatib R, Beddhu S, Cheung AK, Hess R, et al. Potential Deaths Averted and Serious Adverse Events Incurred From Adoption of the SPRINT Intensive Blood Pressure Regimen in the United States: Projections From NHANES. Circulation. 2017;135:1617–28. [PubMed: 28193605]
27. Cushman WC, Evans GW, Byington RP, Goff DC, Grimm RH, Cutler JA, et al. Effects of Intensive Blood-Pressure Control in Type 2 Diabetes Mellitus. N Engl J Med. 2010;362:1575–85. [PubMed: 20228401]
28. Margolis KL, O'Connor PJ, Morgan TM, Buse JB, Cohen RM, Cushman WC, et al. Outcomes of Combined Cardiovascular Risk Factor Management Strategies in Type 2 Diabetes: The ACCORD Randomized Trial. Diabetes Care. 2014;37:1721–8. [PubMed: 24595629]
29. Bress AP, King JB, Kreider KE, Beddhu S, Simmons DL, Cheung AK, et al. Effect of Intensive Versus Standard Blood Pressure Treatment According to Baseline Prediabetes Status: A Post Hoc Analysis of a Randomized Trial. Diabetes Care. 2017;40:1401–8.
30. Moise N, Huang C, Rodgers A, Kohli-Lynch Ciaran N, Tzong KY, Coxson PG, et al. Comparative cost-effectiveness of conservative or intensive blood pressure treatment guidelines in adults aged 35–74 years: The cardiovascular disease policy model. Hypertension. 2016;68:88–96. [PubMed: 27181996]
31. Richman IB, Fairley M, Jørgensen ME, Schuler A, Owens DK, Goldhaber-Fiebert JD. Cost-effectiveness of Intensive Blood Pressure Management. JAMA Cardiol. 2016;1:872–9. [PubMed: 27627731]
32. Bress AP, Bellows BK, King JB, Hess R, Beddhu S, Zhang Z, et al. Cost-Effectiveness of Intensive versus Standard Blood-Pressure Control. N Engl J Med. 2017;377:745–55. [PubMed: 28834469] ** Cost-effectiveness analysis of intensive versus standard blood pressure control performed by the SPRINT Research Group.
33. Neumann PJ, Cohen JT, Weinstein MC. Updating Cost-Effectiveness - the Curious Resilience of the $50,000-per-QALY Threshold. N Engl J Med. 2014;371:796–7. [PubMed: 25162885]
34. Yoon SS, Gu Q, Nwankwo T, Wright JD, Hong Y, Burt V. Trends in Blood Pressure Among Adults With Hypertension: United States, 2003 to 2012. Hypertension. 2015;65:54–61. [PubMed: 25399687]
35. Agarwal R Implications of Blood Pressure Measurement Technique for Implementation of Systolic Blood Pressure Intervention Trial (SPRINT). J Am Heart Assoc. 2017;6:e004536. [PubMed: 28159816]
36. Johnson KC, Whelton PK, Cushman WC, Cutler JA, Evans GW, Snyder JK, et al. Blood Pressure Measurement in SPRINT (Systolic Blood Pressure Intervention Trial) SPRINT Trial. Hypertension. 2018;71:848–587. [PubMed: 29531173]

37. Drawz PE, Ix JH. BP Measurement in Clinical Practice: Time to SPRINT to Guideline-Recommended Protocols. J Am Soc Nephrol. 2018;29:383–8. [PubMed: 29051347]
38. Muntner P, Einhorn PT, Cushman WC, Whelton PK, Bello NA, Drawz PE, et al. Blood Pressure Assessment in Adults in Clinical Practice and Clinic-Based Research: JACC Scientific Expert Panel. J Am Coll Cardiol. 2019;73:317–35. [PubMed: 30678763]
39. Forman DE, Maurer MS, Boyd C, Brindis R, Salive ME, Mcfarland Horne F, et al. Multimorbidity in Older Adults With Cardiovascular Disease. J Am Coll Cardiol. 2018;71:2149–61. [PubMed: 29747836]
40. Derington CG, Gums TH, Bress AP, Herrick JS, Greene TH, Moran AE, et al. Association of Total Medication Burden With Intensive and Standard Blood Pressure Control and Clinical Outcomes: A Secondary Analysis of SPRINT. Hypertension. 2019;74:00–00 [E-pub ahead of print].
41. Bangalore S, Kamalakkannan G, Parkar S, Messerli FH. Fixed-Dose Combinations Improve Medication Compliance: A Meta-Analysis. Am J Med. 2007;120:713–9. [PubMed: 17679131]
42. Coleman CI, Limone B, Sobieraj DM, Lee S, Roberts MS, Kaur R, et al. Dosing Frequency and Medication Adherence in Chronic Disease. J Manag Care Pharm. 2012;18:527–39. [PubMed: 22971206]
43. Lebeau J-P, Cadwallader J-S, Aubin-Auger I, Mercier A, Pasquet T, Rusch E, et al. The concept and definition of therapeutic inertia in hypertension in primary care: a qualitative systematic review. BMC Fam Pract. 2014;15:130. [PubMed: 24989986]
44. Phillips LS, Branch WT, Cook CB, Doyle JP, El-Kebbi IM, Gallina DL, et al. Clinical Inertia. Ann Intern Med. 2001;135:825–34. [PubMed: 11694107]
45. Bellows BK, Ruiz-Negrón N, Bibbins-Domingo K, King JB, Pletcher MJ, Moran AE, et al. Clinic-Based Strategies to Reach United States Million Hearts 2022 Blood Pressure Control Goals. Circ Cardiovasc Qual Outcomes. 2019;12:e005624. [PubMed: 31163981]
46. O'Connor PJ, Sperl-Hillen JM, Johnson PE, Rush WA, Biltz G. Clinical Inertia and Outpatient Medical Errors. Volume 2: Henriksen K, Battles JB, Marks ES, Lewin DI, editors. Rockville, MD: Agency for Healthcare Research and Quality; 2005.
47. Jaffe MG, Lee GA, Young JD, Sidney S, Go AS. Improved Blood Pressure Control Associated With a Large-Scale Hypertension Program. JAMA. 2013;310:699–705. [PubMed: 23989679]
48. Fletcher RD, Amdur RL, Kolodner R, McManus C, Jones R, Faselis C, et al. Blood pressure control among US veterans: A large multiyear analysis of blood pressure data from the veterans administration health data repository. Circulation. 2012;125:2462–8. [PubMed: 22515976]
49. Kennelty KA, Polgreen LA, Carter BL. Team-based care with pharmacists to improve blood pressure: A review of recent literature. Curr Hypertens Rep. 2018;20:1. [PubMed: 29349522]
50. Carter BL, Bosworth HB, Green BB. The Hypertension Team: The Role of the Pharmacist, Nurse and Teamwork in Hypertension Therapy. J Clin Hypertens. 2012;14:51–65.
51. Mills KT, Obst KM, Shen W, Molina S, Zhang H-J, He H, et al. Comparative Effectiveness of Implementation Strategies for Blood Pressure Control in Hypertensive Patients: A Systematic Review and Meta-analysis. Ann Intern Med. 2018;168:110–20. [PubMed: 29277852] ** Systematic review and meta-analysis that describes the effectiveness of various strategies for improving hypertension management.
52. Dunn SP, Birtcher KK, Beavers CJ, Baker WL, Brouse SD, Page II RL, et al. The Role of the Clinical Pharmacist in the Care of Patients with Cardiovascular Disease. J Am Coll Cardiol. Elsevier; 2015;66:2129–39.
53. Carter BL, Coffey CS, Ardery G, Uribe L, Ecklund D, James P, et al. Cluster-Randomized Trial of a Physician/Pharmacist Collaborative Model to Improve Blood Pressure Control. Circ Cardiovasc Qual Outcomes. 2015;8:235–43. [PubMed: 25805647]
54. Margolis KL, Asche SE, Bergdall AR, Dehmer SP, Groen SE, Kadrmas HM, et al. Effect of Home Blood Pressure Telemonitoring and Pharmacist Management On Blood Pressure Control: The HyperLink Cluster Randomized Trial. JAMA. 2013;310:46–56. [PubMed: 23821088]
55. Victor RG, Lynch K, Li N, Blyler C, Muhammad E, Handler J, et al. A Cluster-Randomized Trial of Blood-Pressure Reduction in Black Barbershops. N Engl J Med. 2018;378:1291–301. [PubMed: 29527973] ** Cluster-randomized trial of a pharmacist-driven blood pressure management service in black barbershops.

56. Margolis KL, Asche SE, Dehmer SP, Bergdall AR, Green BB, Sperl-Hillen JM, et al. Long-term Outcomes of the Effects of Home Blood Pressure Telemonitoring and Pharmacist Management on Blood Pressure Among Adults With Uncontrolled Hypertension: Follow-up of a Cluster Randomized Clinical Trial. JAMA Netw Open. 2018;1:e181617. [PubMed: 30646139] * 24-month outcomes related to pharmacist-driven telehealth blood pressure management service.
57. Victor RG, Blyler CA, Li N, Lynch K, Moy NB, Rashid M, et al. Sustainability of Blood Pressure Reduction in Black Barbershops. Circulation. Lippincott Williams and Wilkins; 2019;139:10–9.
58. Asche SE, O'Connor PJ, Dehmer SP, Green BB, Bergdall AR, Maciosek MV, et al. Patient characteristics associated with greater blood pressure control in a randomized trial of home blood pressure telemonitoring and pharmacist management. J Am Soc Hypertens. 2016;10:873–80. [PubMed: 27720142]
59. Beran M, Asche SE, Bergdall AR, Crabtree B, Green BB, Groen SE, et al. Key components of success in a randomized trial of blood pressure telemonitoring with medication therapy management pharmacists. J Am Pharm Assoc. 2018;58:614–21.
60. Dennison Himmelfarb CR, Commodore-Mensah Y, Hill MN. Expanding the Role of Nurses to Improve Hypertension Care and Control Globally. Ann Glob Heal. 2016;82:243–53.
61. Shaw RJ, McDuffie JR, Hendrix CC, Edie A, Lindsey-Davis L, Nagi A, et al. Effects of nurse-managed protocols in the outpatient management of adults with chronic conditions: A systematic review and meta-analysis. Ann Intern Med. 2014;161:113–21. [PubMed: 25023250]
62. Clark CE, Smith LFP, Taylor RS, Campbell JL. Nurse led interventions to improve control of blood pressure in people with hypertension: systematic review and meta-analysis. BMJ. 2010;341:c3995. [PubMed: 20732968]
63. Clark CE, Smith LFP, Taylor RS, Campbell JL. Nurse-led interventions used to improve control of high blood pressure in people with diabetes: A systematic review and meta-analysis. Diabet Med. 2011;28:250–61. [PubMed: 21309833]
64. Zhang D, Wang G, Joo H. A Systematic Review of Economic Evidence on Community Hypertension Interventions. Am J Prev Med. 2017;53:S121–30. [PubMed: 29153113] ** This systematic review describes the cost-effectiveness evidence on various team-based care strategies for hypertension management in the United States and Internationally.
65. Jacob V, Chattopadhyay SK, Thota AB, Proia KK, Njie G, Hopkins DP, et al. Economics of Team-based Care in Controlling Blood Pressure: A Community Guide Systematic Review. Am J Prev Med. 2015;49:772–83. [PubMed: 26477804]
66. Carter BL, Bergus GR, Dawson JD, Farris KB, Doucette WR, Chrischilles EA, et al. A Cluster-Randomized Trial to Evaluate Physician/Pharmacist Collaboration to Improve Blood Pressure Control. J Clin Hypertens. 2008;10:260–71.
67. Carter BL, Ardery G, Dawson JD, James PA, Bergus GR, Doucette WR, et al. Physician/Pharmacist Collaboration to Improve Blood Pressure Control. Arch Intern Med. 2009;169:1996–2002. [PubMed: 19933962]
68. Polgreen LA, Han J, Carter BL, Ardery GP, Coffey CS, Chrischilles EA, et al. Cost Effectiveness of a Physician-Pharmacist Collaboration Intervention to Improve Blood Pressure Control. Hypertension. 2015;66:1145–51. [PubMed: 26527048]
69. Kulchaitanaroaj P, Brooks JM, Ardery G, Newman D, Carter BL. Incremental Costs associated with Physician and Pharmacist Collaboration to Improve Blood Pressure Control. Pharmacotherapy. 2012;32:772–80. [PubMed: 23307525]
70. Dehmer SP, Maciosek MV, Trower NK, Asche SE, Bergdall AR, Nyboer RA, et al. Economic evaluation of the home blood pressure telemonitoring and pharmacist case management to control hypertension (Hyperlink) trial. J Am Coll Clin Pharm. 2018;1:21–30. [PubMed: 30320302]
71. Overwyk KJ, Dehmer SP, Roy K, Maciosek MV, Hong Y, Baker-goering MM, et al. Modeling the Health and Budgetary Impacts of a Team-based Hypertension Care Intervention That Includes Pharmacists. Med Care. 2019;00:1–8.** Economic analysis evaluating cost thresholds for pharmacist-delivered hypertension service to be budget-neutral in Medicare populations.
72. Kulchaitanaroaj P, Brooks JM, Chaiyakunapruk N, Goedken AM, Chrischilles EA, Carter BL. Cost-utility analysis of physician-pharmacist collaborative intervention for treating hypertension compared with usual care. J Hypertens. 2017;35:178–87. [PubMed: 27684354]

73. Simpson SH, Lier DA, Majumdar SR, Tsuyuki RT, Lewanczuk RZ, Spooner R, et al. Cost-Effectiveness analysis of adding pharmacists to primary care teams to reduce cardiovascular risk in patients with Type 2 diabetes: results from a randomized controlled trial. Diabet Med. 2015;32:899–906. [PubMed: 25594919]

74. Marra C, Johnston K, Santschi V, Tsuyuki RT. Cost-effectiveness of pharmacist care for managing hypertension in Canada. Can Pharm J. 2017;150:184–97.

75. van der Laan DM, Elders PJM, Boons CCLM, Nijpels G, van Dijk L, Hugtenburg JG. Effectiveness of a Patient-Tailored, Pharmacist-Led Intervention Program to Enhance Adherence to Antihypertensive Medication: The CATI Study. Front Pharmacol. 2018;9:1–13. [PubMed: 29387012]

76. Bosmans JE, van der Laan DM, Yang Y, Elders PJM, Boons CCLM, Nijpels G, et al. The Cost-Effectiveness of an Intervention Program to Enhance Adherence to Antihypertensive Medication in Comparison With Usual Care in Community Pharmacies. Front Pharmacol. 2019;10:210. [PubMed: 30899223]

77. Bauer JC. Nurse practitioners as an underutilized resource for health reform: Evidence-based demonstrations of cost-effectiveness. Am Acad Nurse Pract. 2010;22:228–31.

78. Bosworth HB, Olsen MK, Dudley T, Orr M, Goldstein MK, Datta SK, et al. Patient education and provider decision support to control blood pressure in primary care: A cluster randomized trial. Am Heart J. 2009;157:450–6. [PubMed: 19249414]

79. Datta SK, Oddone EZ, Olsen MK, Orr M, McCant F, Gentry P, et al. Economic analysis of a tailored behavioral intervention to improve blood pressure control for primary care patients. Am Heart J. 2010;160:257–63. [PubMed: 20691830]

80. Allen JK, Dennison Himmelfarb CR, Szanton SL, Hopkins J, Frick KD. Cost-effectiveness of Nurse Practitioner/Community Health Worker Care to Reduce Cardiovascular Health Disparities. J Cardiovasc Nurs. 2014;29:308–14. [PubMed: 23635809]

81. Gadbois EA, Miller EA, Tyler D, Intrator O. Trends in State Regulation of Nurse Practitioners and Physician Assistants, 2001 to 2010. Med Care Res Rev. 2015;72:200–19. [PubMed: 25542195]

82. Nguyen E, Holmes JT. Pharmacist-provided services: Barriers to demonstrating value. J Am Pharm Assoc. 2019;59:117–20.

83. American Pharmacists Association. The pursuit of provider status [Internet]. Washington, D.C.; 2013 Available from: www.ssa.gov/OP_Home/

84. IHS Markit. 2017 Update The Complexities of Physician Supply and Demand: Projections from 2015 to 2030 [Internet]. Washington, D.C.; 2017. Available from: https://aamc-black.global.ssl.fastly.net/production/media/filer_public/a5/c3/a5c3d565-14ec-48fb-974b-99fafaeecb00/aamc_projections_update_2017.pdf

85. Bitton A, Ratcliffe HL, Veillard JH, Kress DH, Barkley S, Kimball M, et al. Primary Health Care as a Foundation for Strengthening Health Systems in Low- and Middle-Income Countries. J Gen Intern Med. 2016;32:566–71. [PubMed: 27943038]

86. Druetz T Integrated primary health care in low-and middle-income countries: a double challenge. BMC Med Ethics. 2018;19:48. [PubMed: 29945623]

87. Goodyear-Smith F, Bazemore A, Coffman M, Fortier R, Howe A, Kidd M, et al. Primary Care Research Priorities in Low- and Middle- Income Countries. Ann Fam Med. 2019;17:31–5. [PubMed: 30670392]

88. Lall D, Engel N, Devadasan N, Horstman K, Criel B. Models of care for chronic conditions in low/middle-income countries: a "best fit" framework synthesis. BMJ Glob Heal. 2018;3:e001077.

89. McManus RJ, Mant J, Franssen M, Nickless A, Schwartz C, Hodgkinson J, et al. Efficacy of self-monitored blood pressure, with or without telemonitoring, for titration of antihypertensive medication (TASMINH4): an unmasked randomised controlled trial. Lancet. 2018;391:949–59. [PubMed: 29499873]

90. Monahan M, Jowett S, Nickless A, Franssen M, Grant S, Greenfield S, et al. Cost-Effectiveness of telemonitoring and self-monitoring of blood pressure for antihypertensive titration in primary care (TASMINH4). Hypertension. 2019;73:1231–9. [PubMed: 31067190]

91. Tucker KL, Sheppard JP, Stevens R, Bosworth HB, Bove A, Bray EP, et al. Self-monitoring of blood pressure in hypertension: A systematic review and individual patient data meta-analysis. PLoS Med. 2017;14:e1002389. [PubMed: 28926573]

92. Abegaz TM, Shehab A, Gebreyohannes EA, Bhagavathula AS, Elnour AA. Nonadherence to antihypertensive drugs: A systematic review and meta-analysis. Medicine (Baltimore). Wolters Kluwer Health; 2017;96:e5641.

93. Burnier M, Egan BM. Adherence in hypertension: a review of prevalence, risk factors, impact, and management. Circ Res. 2019;124:1124–40. [PubMed: 30920917]

94. King DE, Mainous III AG, Carnemolla M, Everett CJ. Adherence to Healthy Lifestyle Habits in US Adults, 1988–2006. Am J Med. 2009;122:528–34. [PubMed: 19486715]

95. Langford AT, Williams SK, Applegate M, Ogedegbe O, Braithwaite RS. Partnerships to Improve Shared Decision Making for Patients with Hypertension – Health Equity Implications. Ethn Dis. 2019;29:97–102. [PubMed: 30906156] * This paper, in conjunction with Johnson et al, describes the importance of implementing shared decision making to maximize hypertension care and reduce health disparities.

96. Johnson RA, Huntley A, Hughes RA, Cramer H, Turner KM, Perkins B, et al. Interventions to support shared decision making for hypertension: A systematic review of controlled studies. Heal Expect. 2018;21:1191–207.* This systematic review describes the current literature on strategies to improve shared decision making with patients in hypertension care.

97. Lee P, Pham L, Oakley S, Eng K, Freydin E, Rose T, et al. Using lean thinking to improve hypertension in a community health centre: a quality improvement report. BMJ Open Qual. 2019;8:e000373.* This quality improvement paper describes the use of LEAN principles in the development of a hypertension care pathway using team-based care in an underserved setting.

98. Lee H-Y, Jun SY, Choi J-W, Kim TY. Cost Effectiveness of Intensive Blood-Pressure Control [abstract LBPS 03–01]. J Hypertens. 2016;34:e524.

99. Carter BL, Rogers M, Daly J, Zheng S, James PA. The Potency of Team-based Care Interventions for Hypertension. Arch Intern Med. 2009;169:1748–55. [PubMed: 19858431]

100. Allen JK, Dennison-Himmelfarb CR, Szanton SL, Bone L, Hill MN, Levine DM, et al. Community Outreach and Cardiovascular Health (COACH) Trial: A Randomized, Controlled Trial of Nurse Practitioner/Community Health Worker Cardiovascular Disease Risk Reduction in Urban Community Health Centers. Circ Cardiovasc Qual Outcomes. 2011;4:595–602. [PubMed: 21953407]

101. Wang V, Smith VA, Bosworth HB, Oddone EZ, Olsen MK, McCant F, et al. Economic evaluation of telephone self-management interventions for blood pressure control. Am Heart J. 2012;163:980–6. [PubMed: 22709750]

102. Bosworth HB, Powers BJ, Olsen MK, McCant F, Grubber J, Smith V, et al. Home Blood Pressure Management and Improved Blood Pressure Control: Results from a Randomized Controlled Trial. Arch Intern Med. 2011;171:1173–80. [PubMed: 21747013]

103. Hollenbeak CS, Weiner MG, Turner BJ. Cost-effectiveness of a peer and practice staff support intervention. Am J Manag Care. 2014;20:253–60. [PubMed: 24884753]

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Table 1:

Studies assessing the cost-effectiveness of intensive systolic blood pressure control

Author (Year) [Reference]	Country	Comparators	Clinical inputs	Model Description	Costs considered	Time Horizon	Perspective	Base Case ICER
Moise (2016) [30]	United States	JNC8 Guideline strategies alone* vs. Guideline-directed strategies* + "Intensive" strategy to SBP <120 mm Hg in select groups	CVD Policy Model + SPRINT	Markov model	Background health care, acute and chronic CVD, medications, monitoring, side effects	Lifetime	Payer	Men Cost-saving for both guidelines +intensive Women Cost-saving for JNC8+intensive $21,000 2016 USD per QALY gained for JNC7+intensive strategy
Richman (2016) [31]	United States	SBP <140 mm Hg vs. SBP <120 mm Hg	SPRINT	Markov model	Background medical costs, acute and chronic CVD events, medications, physician visits, adverse events	Lifetime	Not reported	$23,777 2016 USD per QALY gained
Lee (2016) [98]	Korea	SBP <140 mm Hg vs. SBP <120 mm Hg	SPRINT	"Decision model"	Medications, CVD events	Not reported	Not reported	2,513,799 Korean won (~ $2,302 2014 USD†) per QALY gained
Bress and Bellows (2017) [32]	United States	SBP <140 mm Hg vs. BP <120 mm Hg	SPRINT	Microsimulation	Medications, office visits, laboratory monitoring, acute and chronic CVD, adverse events, background non-CVD health care	Lifetime	Payer	$46,546 2017 USD per QALY gained

Abbreviations: CVD: Cardiovascular Disease; ICER: Incremental Cost-Effectiveness Ratio; JNC7: Seventh Joint National Committee; JNC8: Eighth Joint National Committee; QALY: Quality-Adjusted Life Year; SBP: Systolic Blood Pressure; SPRINT: Systolic Blood Pressure Intervention Trial; USD: United States Dollars

*Analyses were completed for JNC-7 goals and JNC-8 goals. Goals varied based on age and presence of diabetes or CKD

†In 2014, 1 US Dollar = 1,091.85 Korean won.

Table 2:

Studies assessing cost outcomes of team-based care models for hypertension management in the US (selected recent studies)

Author (Year) [Reference]	Comparators	Clinical inputs [Reference]	Model Description	Costs considered	Time Horizon or Follow-up Period	Perspective	Base Case ICER or Main Results	Notes
Pharmacist Interventions								
Polgreen (2015) [68]	Clinical pharmacist providing real-time recommendations to provider vs. usual care	CAPTION [53]	N/A	Physician time, pharmacist time, medications	9 months	"Society in general"	Intervention cost $33 (2013 USD) per 1-mm Hg reduction in SBP and $70 per 1-mm Hg reduction in DBP relative to usual care.	Did not incorporate patient preferences or utility values
Dehmer (2018) [70]	Clinical pharmacist telehealth management vs. usual care	Hyperlink [54]	N/A	Outpatient chronic management*, acute care management*, medications	12 months	Health care sector	Intervention cost $139 (2012 USD) per 1-mm Hg reduction in SBP and $265 per 1-mm Hg reduction in DBP relative to usual care	Did not incorporate patient preferences or utility values
Kulchaitanaroaj (2012) [69]	Clinical pharmacist-physician collaboration vs. usual care	Pooled two cluster randomized trials [66,99]	N/A	Provider time, pharmacist time, specialist time, laboratory tests, medications, overhead costs	6 months	Not reported	Intervention cost $36 (2008 USD) per 1-mm Hg reduction in SBP and $94 per 1-mm Hg reduction in DBP relative to usual care	Did not incorporate patient preferences or utility values
Kulchaitanaroaj (2017) [72]	Clinical pharmacist-physician collaboration vs. usual care	Pooled two cluster randomized trials [66,99]	Markov model	Provider time, pharmacist time, specialist time, acute and chronic CVD, laboratory tests, medications	Lifetime 5 years 10 years	Payer	Lifetime: $26,807.83 (2015 USD) per QALY gained 5 years: $78,547.07 per QALY gained 10 years: $39,084.65 per QALY gained	Base case assumed one-time, 6-month intervention with sustained effects for up to 2 years, then deterioration of effects thereafter
Nurse Interventions								
Datta (2010) [79]	Nurse-led behavioral intervention vs. usual care	V-STITCH [78]	Monte Carlo Simulation	Intervention costs (nurse time, supplies), variable indirect costs, resource utilization costs,	2 years	Payer	<u>Men</u> Normal weight: $87,300 per LY gained Overweight: $43,567 per LY gained <u>Women</u> Normal weight: $42,457 per LY gained Overweight: $58,560 per LY gained	Did not incorporate patient preference or utility values
Allen (2014) [80]	NP/CHW management vs. usual care	COACH [100]	N/A	NP and CHW time, laboratory tests, medications	12 months	"Health services"	Intervention cost $101 (2010 USD) per 1-mm Hg reduction in SBP and $209 per 1-mm Hg reduction in DBP relative to usual care	Did not incorporate patient preference or utility values

Author (Year) [Reference]	Comparators	Clinical inputs [Reference]	Model Description	Costs considered	Time Horizon or Follow-up Period	Perspective	Base Case ICER or Main Results	Notes
Wang (2012) [101]	Nurse-led behavioral intervention vs. nurse-led medication management vs. combined vs. usual care	HINTS [102]	N/A	Intervention costs (supplies, nurse time, physician time, home monitors), inpatient and outpatient care, medications	18 months	Payer	Mean total costs per patient: $14,441 behavioral management $14,453 medication management $13,009 combined $12,328 for usual care	Did not incorporate patient preference or utility values
Other								
Hollenbeak (2014) [103]	Telephone patient peer counseling sessions and in-office medical assistant visits vs. usual care	Randomized controlled trial	Markov model	Provider time, participant and peer compensation, acute and chronic CVD, medications	10 years	Provider	$10,866 per QALY gained (2010 USD)	Assumed yearly reinforcements of the 6-month intervention across the time horizon

Abbreviations: CAPTION: Collaboration Among Pharmacists and physicians To Improve Outcomes trial; CHW: Community Health Worker; COACH: Community Outreach and Cardiovascular Health; DBP: diastolic blood pressure HINTS: Hypertension Intervention Nurse Telemedicine Study; ICER: Incremental Cost-Effectiveness Ratio; LY: Life Year; NP: Nurse Practitioner; QALY: Quality-Adjusted Life Year; SBP: Systolic Blood Pressure; USD: United States Dollars; V-STITCH: Veterans–Study to Improve the Control of Hypertension

* Queried from insurance claims data