

Cardiovascular Disease Prevention and Control: Self-Measured Blood Pressure Monitoring Interventions for Improved Blood Pressure Control - When Combined with Team-Based Care

Summary Evidence Table - Economic Review

Study	Study and Population Characteristics	Intervention & Comparison	Effectiveness	Program Costs	Healthcare Costs and Productivity Losses Averted	Economic Summary Measure
<p>Author (Year): Artinian et al. (2001)</p> <p>Design: Randomized Controlled Trial</p> <p>Economic Method: Cost-analysis</p> <p>Monetary Conversions: Reporting year 2000 and base 2014 in US\$.</p>	<p>Location: Detroit, MI</p> <p>Setting: Convenience recruit from family community center housing several other government/commu nity offices including a health clinic</p> <p>Eligibility >17 years Hypertension with or without diabetes or CVD.</p> <p>Sample Size: Home 6 Community 6</p> <p>63 screened and 26 enrolled 3 men and 23 women Age 32-93 (mean 59) African American 95%</p>	<p>This was a pilot study</p> <p>Interventions: Nurse with home BP telemonitoring (Home) Home devices set up by nurse and patient trained and given lifestyle brochure. Follow-up within 24 hours. BP readings sent every week to server and forwarded to nurse with patient receiving instant report plus lifestyle and meds counseling call from nurse. Weekly readings and report sent to GP.</p> <p>Nurse with community health center BP monitoring (Community) Similar to home monitoring except BP readings taken at</p>	<p>Analysis for 21 of 26 who had follow-up data.</p> <p>Primary outcome is change in SBP and DBP. Stratification by use/non-use of meds did not produce differences and hence analysis is for full data. Patient compliance (BP readings) with protocol was 67% in Home and 89% in Community.</p> <p>Home SBP dropped from 148.8 to 124.1 DBP 90.2 to 75.6</p> <p>Community SBP dropped from 155.2 to 142.3 DBP 89.4 to 78.2</p> <p>Usual SBP 142.4 to 143.3 DBP 91.2 to 89.1</p>	<p>\$10 incentive at baseline and \$15 at follow-up.</p> <p>Study does not provide the cost of intervention except for a conjecture about the per day cost of telemonitoring equipment</p> <p>Two African American RN nurses delivered interventions and were trained 10 hours.</p> <p>Authors state the cost of telemonitoring equipment plus training is \$1.50 per day including training in use.</p>	<p>Healthcare Cost: Health care costs averted not considered.</p> <p>Productivity: No productivity improvements considered.</p>	<p>Authors assume telemonitoring can identify White-Coat hypertension (25% prevalence in HTN pop).</p> <p>Annual treatment cost of uncomplicated HTN following JNC6 is \$1000. Hence, placing 4 HTNs on a 1 month telemonitor costs \$180 and identifies the white-coat and saves \$1000 in treatment costs</p> <p>Limitations: The cost-benefit of telemonitoring conjectured by authors may be reasonable but is not complete. Convenience recruitment Mostly women Tiny samples</p>

CVD: Self-measured Blood Pressure Interventions When Used With Team-Based Care – Economic Evidence Table

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	<p>Below Federal Poverty Level 41% Unoccupied homes 10.6%</p> <p>Time Horizon: 12 week (3 months) intervention length. Recruitment and intervention dates not provided.</p>	<p>Center 3 times a week (1-5 miles from residences). Weekly counseling meetings for lifestyle and meds. Weekly readings and report sent to GP.</p> <p>Comparison: Usual Care [n=9]</p>				
<p>Author (Year): Billups et al. (2014)</p> <p>Linked to Magid et al. (2013)</p> <p>Design: Based on RCT</p> <p>Economic Method: Modeled based on RCT</p> <p>Monetary Conversions: Reporting year 2013 and base 2014 in US\$.</p>	<p>Location: Denver-Boulder Metro, CO</p> <p>Kaiser Permanente Colorado</p> <p>Setting: MCO with 500,000 patients served in 18 primary care clinics, of which 10 participated in RCT. Each clinic has clinical pharmacist who assists the PCP with therapy.</p> <p>Sample Size: HBP: 175 Control: 173</p> <p>Characteristics: Mean age 59-60 Males 59-62% DM or CKD 46-51% Hyperlipidemia 61-68%</p>	<p>Intervention: Home blood pressure (HBP) group's BP measurements sent automatically from device via American Heart Association web-interface Heart360 to clinical pharmacy specialist to manage hypertension. Patients in HBPM given provided Omron HEM-790IT device and training. Management by email and phone. EHR system enables web-based communication between patients and providers.</p> <p>Under pre-approved collaborative arrangement,</p>	<p>Target was set at SBP/DBP <140/90 for all and <130/80 for those with diabetes.</p> <p>HBP group had significantly more e-mail (5v1) and phone (4v2) encounters.</p> <p>At 6 months, BP at goal for 54% of HBP Vs 35% in control (P <.001).</p> <p>SBP reduced 21 mmHg for HBP vs 8 mmHg for control (P <.001).</p>	<p>Intervention cost not estimated. Program cost included in healthcare cost estimate.</p> <p>Only separate estimate provided is for BP Monitor at \$60 per piece.</p> <p>Initial visit for HBP required 20 minutes of medical assistant time (at \$19.39/hr in 2009 dollars) for training on monitor and Heart360. Plus 20 minutes with pharmacist (at \$74.14/hr in 2009 dollars) for drug review and dose adjustments. Based on survey, each phone encounter with pharmacist was</p>	<p>Healthcare cost: 6 months pre and 6 months post intervention data collected.</p> <p>Claims related to hypertension included.</p> <p>Costs related to in-person encounters, email, telephone assessed based on time and salary.</p> <p>In Study 6-month Median Healthcare Cost Per Patient (HBP/Control)</p> <p>Hypertension-related Medication \$202/\$130 Out-patient \$120/\$15* Labs \$21/\$0 BP Cuff \$60/\$0</p>	<p>Summary Measure: 6-month Hypertension-related Cost per Patient HBP \$467.26 Usual \$211.02 Incremental Cost \$256.24 Incremental SBP Reduction 12.5 mmHg Cost per mmHg SBP \$20.50 Incremental persons with controlled BP \$34 Cost per incremental person with controlled BP \$1331</p> <p>Mean incremental lifetime HTN-related cost \$1965 Mean incremental life years gained 0.59</p>

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	<p>SBP/DBP (Intervention) 148.8/ 89.6 BP control 0%</p> <p>Time Horizon: Intervention length is 6 months.</p>	<p>pharmacist may initiate or alter drug therapy and order labs, and provide medication and lifestyle counseling.</p> <p>Comparison: Patients in control group advised to consult with the PCP.</p>		<p>10 minutes and 6 minutes for e-mail.</p> <p>Approximate 6-month per person program cost constructed from descriptions.</p> <p><u>One-time</u> Monitor and Web Training with medical assistant \$6.46 Initial pharmacist drug review \$24.71 BP Monitor \$60.00</p> <p><u>Variable</u> Extra 4 emails with pharmacist \$29.66 Extra 2 phone calls with pharmacist \$24.71 Total \$145.55 Annualized Cost \$200</p>	<p>Other \$0/\$0 Total \$455/\$179 Difference \$276 more</p> <p>All-cause median healthcare Medication \$622/\$475 Out-patient \$481/\$381* Labs \$122/\$113 BP Cuff \$60/\$0 Other \$0/\$0** Total \$1590/\$1283 Difference \$307 more</p> <p>* Includes e-mail, phone encounters. ** Includes hospital, ER, radiology</p> <p>Productivity Gains: No productivity effects assessed.</p>	<p>Incremental cost per life year gained \$3330.</p> <p>Comments Authors attribute positive results to clinical pharmacist, relief for physician time, home monitoring that saves clinic time, efficiency of automatic readings.</p> <p>Limitations: Not all patients may be internet proficient. Reimbursement for email and phone encounters may not be available. Patient time not accounted, as was productivity.</p>
<p>Author (Year): Bosworth et al. (2009)</p> <p>Design: RCT with 3 arms</p> <p>Economic Method: Cost Analysis</p>	<p>Location: Durham, NC</p> <p>Setting: Two Duke affiliated primary clinics</p> <p>Sample Size: 636 randomized from 2060 eligible</p>	<p>Randomized to 4 groups: Usual Care; Bi-Monthly Nurse-administered tailored telephone behavioral interv (Beh); At home self BP monitoring (Mon); Combination (Mon-Beh)</p>	<p>Intent to treat analysis.</p> <p>Recommended BP: (Systolic BP < 140 & diastolic BP < 90 mmHg [<130 and <80 mmHg for patients with diabetes])</p>	<p>Calls attended by single nurse. Patients paid \$25 at baseline and for each of 4 follow-up (\$125 total)</p> <p>Beh – Nurse completed 1682 calls, 11 per patient, mean of 16 minutes.</p>	<p>Healthcare Cost: Health care use in Duke system collected through 24 months.</p> <p>Mean outpatient encounters similar across groups; No difference in proportion hospitalized.</p>	<p>No summary economic measures reported.</p> <p>There was no difference in health care utilization across groups but there was improvement in health outcome for combination group.</p>

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<p>Monetary Conversions: Reporting year 2006 and base 2014 in US\$</p>	<p>Characteristics: Mean age-61; AfrAmer-49%; Female-66%; Low Income-19%. 73% had adequate BP control at baseline Hypertension Dx and enrollment with GP at least 12 months prior; self-reported anti-hypertensive medication; primary care provider appointment during the next 30 days; resident in area of health system.</p> <p>Time Horizon: 24 months intervention length - Dec 2005 through Jan 2008.</p>	<p>Stratified at baseline by enrollment site and health literacy.</p> <p>Interventions: Beh (n=160) Covered risk perception, hypertension education, provider relations, social support. Also adherence to recs for diet, smoking cessation/alcohol reduction, sodium intake. Mon (n=158)- Provided BP monitors, trained on use, 3 days a week readings, stamped envelopes to send logs every 2 months. Beh-Mon (n=159)</p> <p>Comparison: Usual Care (n=159)</p>	<p>Primary outcome- BP control at 24 months (and at base, 6,12,18 months)</p> <p>BP control vs usual care at 24 months: Beh:4.3% (95% CI: -4.5%, 12.9); Mon: 7.6% (95% CI: -1.9%, 17.0%); Mon-Beh: 11.0% (95% CI:1.9%, 19.8%). Note only combination had clinically significant effect.</p> <p>SBP and DBP vs Usual at 24 months: Mon: SBP:-0.6 (-3.6,2.3) DBP:-1.2 (-2.9, 0.4) Beh: SBP:+0.6 (-2.2,3.4) DBP:+0.4 (-1.1, 1.9) Mon-Beh: SBP:-3.9 (-6.9,-0.9) DBP:-2.2 (-3.82, -0.6) Other groups not significant.</p>	<p>Beh-Mon – Nurse completed 1589 calls, 10 per patient, mean of 16 minutes.</p> <p>2 Years Cost Per Person Beh \$345 Mon \$90 Beh-Mon \$416 (Sensitivity analysis cost for Beh-Mon was \$208 to \$811).</p>	<p>Mean 2 year total health cost of \$15,641 across all groups (SD=\$25,769, median=\$6698).</p> <p>Productivity: No productivity costs estimated or reported.</p>	<p>Limitations: Academic health center; 25% no 24 month data;73% controlled BP at baseline</p>

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<p>Author (Year): Bosworth et al. (2011)</p> <p>Design: RCT</p> <p>Economic Method: Average Cost</p> <p>Monetary Conversions: Reporting year 2007 and base 2014 in US\$.</p>	<p>Location: Durham, North Carolina</p> <p>Setting: Veterans Affairs Medical Center</p> <p>Size: 3 nurse-led arms, Behavioral with 148, Medication with 149, Combined with 147, and usual care with 147.</p> <p>Characteristics: Patients from VAMC primary care practices that had hypertension diagnosis, uncontrolled BP, and were on medication. Randomized to 4 arms and stratified by diabetes.</p> <p>591 included in analysis. Mean age:63-64 Male:86-96% Caucasian:44-53% Diabetes:40-44% Employed:34-35% Uncontrolled BP:35-48%</p> <p>Time Horizon:</p>	<p>Hypertension Intervention Nurse Telemedicine Study (HINTS)</p> <p>3 arms assisted by telephony and BP home-device</p> <ol style="list-style-type: none"> 1.Nurse-led behavioral [NB] (n=148) 11 tailored modules on knowledge, meds, diet, health behaviors 2. Nurse-led physician- directed medication [NM] (n=149) within decision support system. GP informed and assented. 3. Combined [C] (n=147) 4. Usual care (n=147) by general practitioner. <p>Comparison: Usual care</p> <p>Daily BP readings – assessments based on 2-week average.</p>	<p>BP Control BP Control vs. usual care at 12 Months: NB: 12.8%; NM: 12.5%; C: Not significant. BP Control vs. usual care at 18 Months: C: 7.7% (Not significant)</p> <p>Systolic at 12 months vs Usual Care 2.1, 2.4, and 4.3 mm Hg lower for NB, NM, and C groups respectively.</p> <p>Systolic at 18 months vs Usual Care 1.2 and 3.6 mm Hg lower for NM and C groups but not significant.</p> <p>Diastolic differences were not significant.</p> <p><u>Subgroup with Uncontrolled BP</u> Systolic vs Usual Care 8.3, 7.9, 14.8 mm Hg lower at 12 months for NB, NM, C.</p>	<p>Patients paid \$10 at baseline and at three 6-month GP visits.</p> <p>Poor BP control triggered 1945 nurse alerts for 389 of the 444 intervention patients. Average nurse encounter – 13.2 minutes. Alerts similar across groups.</p> <p>Program Cost Per Person (18 Months): NB:\$947 NM:\$1275 C:\$1153</p>	<p>Healthcare cost: Health care includes outpatient and inpatient care within VA system. Utilizations were similar across groups.</p> <p>Median Medical Cost (18 Months): NB:\$6910 per person NM:\$5180 per person C:Not Reported</p> <p>Productivity: Not considered or reported.</p>	<p>Summary Measure: No final economic measures provided.</p> <p>May be able to calculate cost per mm Hg.</p> <p>Limitations: Contents of the program cost not clear.</p>

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	Start in May 2006. Length 18 months. Measurements at base, 6, 12, 18 months.		8.0 mm Hg lower at 18 months for C group. Diastolic decreased at 12 and 18 months for NM and C groups.			
<p>Author (Year): Fishman et al. (2013)</p> <p>Linked to Green et al. (2008)</p> <p>Design: Based on RCT</p> <p>Economic Method: Program cost and cost-effectiveness.</p> <p>Monetary Conversions: Reporting year 2009 and base 2014 in US\$.</p>	<p>Location: Western Washington, USA.</p> <p>Setting: 10 primary care medical centers of Group Health Cooperative.</p> <p>Eligibility: Age 25 to 75 with hypertension and taking medicines. Exclude DM, CVD, and serious conditions. DBP between 90 and 109 mmHg and SBP between 140 and 199 mmHg.</p> <p>Sample Size: BPM 259 BPM+ 261 Usual 258</p> <p>Characteristics: Mean age 25 to 54 were 27 to 31%, age 55 to 64 were 41 to 44%, age 65 to 75 were 25 to 29%; Females 45 to 56%; Caucasian 79 to</p>	<p>Electronic Communications and Home Blood Pressure Monitoring to Improve Blood Pressure Control (e-BP).</p> <p>3-arm trial. All members of group health have EMR integrated into patient website.</p> <p>Home BP Monitoring (BPM) – Usual care plus home BP device, training on use of device and usual website tools to work with physician to control BP measured by device.</p> <p>Home BP Monitoring Plus Pharmacist Care (BPM+) – All features of BPM and care supervision by clinical pharmacist</p>	<p>Main outcomes were change in SBP/DBP and percentage patients achieving SBP/DBP <140/90 mmHg at 12 months.</p> <p>Percent with BP control BPM+ 56%; BPM 36%; Usual 31%.</p> <p>Reductions in BP <u>BPM+ vs BPM</u> SBP 6.0 mmHg less DBP 2.6 mmHg less <u>BPM+ vs Usual</u> SBP 8.9 mmHg less DBP 3.6 mmHg less <u>BPM vs Usual</u> SBP 2.6 mmHg less DBP No difference</p> <p># Secure Messages BPM+ 22.3; BPM 3.3; Usual 2.4.</p> <p># Phone Encounters</p>	<p>All materials and labor valued except for the EMR system. Source is project reports.</p> <p>Usual Care – Identifying eligible, informational literature, informing regarding BP.</p> <p>BPM – Usual plus sessions (1 hour) to train on device and web tools, cost of BP device. BP records entered on website. Website handled BP reports to physician by interface.</p> <p>BPM+ - Cost of BPM plus time of pharmacist in training and patient and physician contact. 3 pharmacists equally shared the panel (87 each). Pharmacist time based on logs</p>	<p>Healthcare cost from study records: Statement that there was no significant difference in inpatient, outpatient, ER. Except higher specialist visits for pharmacist arm.</p> <p>Productivity gains: No assessment performed.</p>	<p>Summary Measure: Life years gained modeled based on literature BP control produces 3.4 to 6.2 years for men and 1.6 to 4.5 years for women.</p> <p>Discounted Life Years Gained (Men/Women) Usual 0.31 (0.25) BPM 0.35 (0.29) BPM+ 0.53 (0.44)</p> <p>Cost per Life Year Gained <u>BPM vs Usual</u> was dominated – not significantly effective <u>BPM+ vs BPM</u> Men \$1850 Women \$2220</p> <p>Cost per Systolic mmHG <u>BPM vs Usual</u> \$23.76 <u>BPM+ vs BPM</u> \$65.29</p>

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	<p>86%; Less than High School 3 to 5%; SBP 151.3 to 152.2; DBP 88.9 to 89.4.</p> <p>Time Horizon: Intervention length is 12 months. Trial period June 2005 to December 2007.</p>	<p>trained in BP. Stepped medication following JNC-7. Patient-centered behavioral counseling for medication adherence and lifestyle. Pharmacist detailed initial patient plan and follow-up including drug changes and stepped protocol. Plan sent to patient and physician for input. Clinical decisions made by physician. Communications among three occurred over the web. Patient reported readings and progress toward goals.</p> <p>Omron Hem-705-CP BP device.</p> <p>Comparison: Usual Care patients provided wallet card with BP numbers, pamphlet on BP control, medication adherence and lifestyle info to control BP, website</p>	<p>BPM+ 7.5; BPM 3.8; Usual 4.0.</p> <p>No significant difference in inpatient, outpatient, ER. Modest but significantly less specialist visits for HBP+ relative to others.</p> <p>Increased life years gained modeled based on BP control.</p>	<p>was 4 hours per week in patient care and 2 hours per month in consultation with senior pharmacist.</p> <p>Cost per Patient for Usual, BPM, BPM+ Screening and produce self-management materials \$3.40, \$5.62, \$4.76 Patient training \$6.17, \$25.00, \$25.00 Protocol and training for pharmacists \$0, \$0, \$15.33 Pharmacist services \$0, \$0, \$310.63 Home BP monitor \$0, \$35.00, \$35.00 Overhead/fixed costs \$0.99, \$1.74, \$9.65 Total \$10.56, \$67.36, \$400.36</p>		<p>Cost per Diastolic mmHG <u>BPM vs Usual</u> was dominated – not significant <u>BPM+ vs BPM</u> \$114.82</p> <p>Cost per 1 pct pt increase in BP Control <u>BPM vs Usual</u> was dominated – not significant <u>BPM+ vs BPM</u> \$16.65</p> <p>Author Conclusion: BPM+ appears cost-effective relative to BPM alone based on cost per life year gained.</p> <p>Comment: Cost does not include effect on healthcare because RCT found no difference. Numerator is intervention cost alone. Group health is an integrated system other patients may need to bundle providers from different systems. Trial involved mostly</p>

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		with EMR/Lab access, appointments/refills, secure messaging with physician. Those with uncontrolled BP encouraged to talk to physician.				white patients with web access. No patient costs considered.
<p>Author (Year): Johannesson et al. (1991)</p> <p>Design: Based on cluster randomized trial with treated comparison.</p> <p>Economic Method: Cost-benefit based on willingness to pay.</p> <p>Monetary Conversions: Reporting year 1988 and base 2014 in Swedish Kroner (SEK).</p>	<p>Location: Sweden.</p> <p>Setting: 8 health centers.</p> <p>Eligibility: Age 30 to 69 on hypertension medication.</p> <p>Sample Size: Health centers were randomized into NP and U. 400 initial patients and 327 with 48-month data for economic analysis. 45 drop-offs because one center did not participate in last follow-up.</p> <p>Time Horizon: Intervention length is 24 months. Trial period 1984-1985. Follow-up during 1986-1988.</p>	<p>Intervention: Home Blood Pressure Monitoring is part of a non-pharmacological intervention (NP) with monthly nurse visits and 6-month physician visits, plus information and education about diet, exercise, and stress management. Device provided free.</p> <p>Name of device not provided.</p> <p>Drugs reduced and withdrawn after randomization for both groups following same treatment guidelines.</p> <p>Comparison: Usual care (U) with drug</p>	<p>No BP results provided</p>	<p>NP cost SEK 5300 per patient more than U during the intervention period of 1984-86.</p> <p>SEK 540 per physician visit SEK 95 per nurse visit</p>	<p>Healthcare cost: 2-year treatment cost plus patient time cost (cost of leisure) calculated for pre (1982-1984), during (1984-1986), and post (1986-1988).</p> <p>Patient time and travel cost based on response to survey at 48 months.</p> <p>2-Year Cost Per Patient Estimates 1982-1984 (1984-1986) [1986-1988]</p> <p>Drugs SEK 2132 (SEK 1080) [SEK 1100] Clinic Visits SEK 2804 (SEK 7485) [SEK 2282] Counseling SEK 0 (SEK 1802) [SEK 0] Total SEK 4936 (SEK 10367) [SEK 3382]</p>	<p>Summary Measure: Benefit defined as reduced treatment cost and cost of patient time (leisure) plus willingness to pay (WTP) additional monetary value for participating in HBPM.</p> <p>WTP based on survey was SEK 374</p> <p>Authors Estimate of Cost and Benefit* <u>Total Benefit</u> SEK 3200 (Actual payment SEK 1460 WTP SEK 370 Reduced treatment cost SEK 1380)</p> <p><u>Total Cost</u> SEK 5300 (Higher cost of HBPM intervention compared to</p>

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		treatment and HBP monitoring.			<p>Notes: Cost of device was SEK 300 and not included in treatment cost estimate. Nurse visits not included in estimates for 1982-1984 and 1986-1988 for lack of visit data.</p> <p>Productivity gains: No assessment performed.</p>	<p>conventional drug therapy) Net Benefit = - SEK 2100</p> <p>*Unclear how numbers were derived.</p> <p>Comment: Used only parts of the estimates for intervention cost and benefits (healthcare cost changes) because of non-standard methods of cost-benefit analysis and results computed by authors.</p>
<p>Author (Year): Maciejewski et al. (2014)</p> <p>Linked to Bosworth (2011)</p> <p>Design: RCT</p> <p>Economic Method: Healthcare cost.</p> <p>Monetary Conversions: Reporting year 2009 and base 2014 in US\$.</p>	<p>Location: Durham, NC.</p> <p>Setting: Clinics of Veterans Affairs Medical Center (VAMC).</p> <p>Eligibility: Patients of VAMC with hypertension, taking meds, and BP not controlled (SBP/DBP>140/90).</p> <p>Sample Size: NB 148; NM 149; C 147; U 147</p>	<p>Based on 4 arm trial Nurse-administered behavioral management (NB) Nurse-administered, physician directed, medication management with validated Clinical Decision Support (NM) Combination of NB and NM (C) Usual care (U)</p> <p>Interventions used telephone-based communication and</p>	<p>18 months after trial, SBP was reduced 5.0 mmHg for NB arm and by 5.5 mmHg for combined arm. Reduction of 3.6 for NM arm not significant.</p> <p>18 months after trial, the pct pt increment with controlled BP versus usual care was: NB 17.1; NM 20.2; C 20.4. Mostly due to deteriorating control</p>	<p>No program cost provided.</p>	<p>Healthcare cost: There was no difference across groups in probability of inpatient use, outpatient expenditures, and total expenditures. At trial end and 18 months after end. Similar finding of no difference for those with poor BP control at baseline.</p> <p>Results are reported here for total</p>	<p>Summary Measure: No summary measures reported.</p> <p>Author Conclusion: Only economic outcome is finding that there was no difference in healthcare cost, whether outpatient, inpatient, or total across arms at end of intervention and 18 months after.</p>

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	<p>Characteristics: Mean Age 63-64 Black 48% Men 92% 74-77% had >10 years of high BP history.</p> <p>Time Horizon: Intervention length is 18 months. Follow-up at 18 months. Randomized during May 2006 to July 2009.</p>	<p>used automatic telemonitored home BP devices provided free.</p> <p>Device not identified</p> <p>Comparison: Usual Care.</p>	<p>in the comparison group.</p> <p>There was no difference relative to usual care for those with controlled BP at baseline. For those with poor control at baseline, SBP was reduced relative to usual care for combined arm by 5.3 mmHg at end of trial, 5.0 at 6 months after end, 6.5 at 12 months after, and 10.0 mmHg at 18 months after. No difference for other arms after trial completion.</p>		<p>expenditures though insignificant: NB \$382 higher at end; \$3237 higher at 18 months after NM \$375 lower at end; \$977 lower at 18 months after C \$269 higher at end; \$309 higher at 18 months after</p> <p>Productivity: No assessment done.</p>	<p>Comment: Important study for assessing outcomes and expenditures 18 months after end of intervention. From payer perspective, cost did not change at and after end of trial but health outcomes improved for those with poor BP control at baseline.</p> <p>Population was veterans and results may not generalize.</p>
<p>Author (Year): Margolis et al. (2013)</p> <p>Design: RCT</p> <p>Economic Method: Intervention cost only</p> <p>Monetary Conversions: Reporting year 2010 and base 2014 in US\$.</p>	<p>Location: Minneapolis, MN</p> <p>Setting: 16 primary care clinics from HeathPartners Medical Group.</p> <p>Eligibility: Adult patients with SBP/DBP>140/90 (130/80 for diabetics) identified from health records from 16 clinics. Excluded stage 4-5 kidney disease,</p>	<p>Home Blood Pressure Telemonitoring and Case Management to Control Hypertension (HyperLink)</p> <p>Intervention (HBP) Patients in intervention clinics received BP telemonitoring devices. Pharmacist reviewed records trained patients in device use, and</p>	<p>All BP outcomes measured in clinic using same device as home BP.</p> <p>Controlled BP vs Usual Care at 6, (12), and [18] months <u>Percentage</u> 71.8 vs 45.2% (71.2 vs 52.8) [71.8 vs 57.1] <u>Incremental %</u> <u>26.6 (18.4) [14.7]</u></p>	<p>BP device and telemonitoring negotiated as per patient enrollment fee and per patient per month rate, respectively. Pharmacist log of time for each encounter plus review time.</p> <p>12-month direct program cost* \$1045 per patient. 48% was for care management</p>	<p>Healthcare Cost: No cost assessment done though short term healthcare events were recorded, most were non-CVD hospitalizations.</p> <p>Productivity: No assessment done</p>	<p>No summary measure</p> <p>Author Conclusion: BP telemonitoring and pharmacist care is safe and effective with effects sustained over 6 month f/u after end of intervention.</p> <p>Comment: Authors state program cost could be reduced from volume discounts and</p>

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	<p>coronary heart disease, or stroke past 3 months.</p> <p>Sample Size: Randomized 16 clinics, with 8 clinics each in intervention HBP (228 patients) and usual care (222 patients) matched by size and baseline BP control.</p> <p>Characteristics: Age 61.1; Female 45%; White 82%; College Degree 48%; Obesity 54%; Diabetes 19%; Kidney disease 19%; CVD 10%. SBP/DBP 148/85 mm Hg. More Hispanics in usual care and more in intervention receiving HTN care. Controlled BP 0%.</p> <p>Time Horizon: Recruitment March 09 to April 11. Intervention length was 12 months. Follow-up at 6, 12, and 18 months.</p>	<p>educated them about hypertension during in-person meeting. Home SBP/DBP threshold was 135/85 (125/75 for DM) Next 6 months, consulted every 2 weeks by phone until BP controlled and then on monthly basis. Second 6 months, consult every 2 months. Pharmacist with PCP's assent to prescribe and change therapy within parameters. Communication with PCP through EMR after each contact.</p> <p>Devices – A&D Medical 767PC.</p> <p>Comparison: Usual care that may include pharmacist referral or home BP.</p>	<p>Controlled BP at all f/u Visits 50.9% vs 21.3% (Diff.29.6)</p> <p>Reduction in SBP/DBP (Difference) 6-months 21.5/9.4 vs 10.8/3.4 (10.7/6.0) 12-months 22.5/9.3 vs 12.9/4.3 (9.7/5.1) 18 months 21.3/9.3 vs 14.7/6.4 (6.6/3.0)</p> <p>Change in # HTN Drug Classes 1.6 to 2.2 in HBP and 1.4 to 1.6 in Usual.</p> <p>Device use was almost 100% in 12 months and 71% at 18 months in HBP. Little change from baseline in home BP for usual. Self-reported medication adherence improved in HBP and decreased in usual care.</p>	<p>52% for telemonitoring. Authors state the telemonitoring was discounted and the undiscounted estimate would be \$1350 per patient.</p> <p>*All HBP patients used pharmacists with mean of 11.4 visits at 34.2 minutes each.217 out of 228 used telemonitoring with mean 9.8 months. Excludes patient time, labs, drugs, and nonstudy encounters.</p>		<p>decreasing contacts with patients who demonstrate BP control. Authors plan to analyze longer term outcomes on healthcare cost and indirect costs associated with HyperLink.</p>

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<p>Author (Year): Palmas et al. (2010)</p> <p>Linked to Shea et al. (2006) and Shea et al. (2009)</p> <p>Design: Based on RCT</p> <p>Economic Method: Intervention cost and healthcare cost.</p> <p>Monetary Conversions: Reporting year 2006 and base 2014 in US\$.</p>	<p>Location: New York City and Upstate New York, NY</p> <p>Details in Shea (2006)</p> <p>Sample Size: Interv 844; U 821 randomized.</p> <p>Characteristics: Age 70.8-70.9; Female 62.1 to 63.5%; African American 14.5% to 15.3%; Hispanic 34.6% to 35.8%; White 48.2% to 50.6%; Years education 9.7 to 9.9; HH Income less than \$20K 74% to 76%; A1c 7.36 to 7.4; SBP 142.5 to 142.8; DBP 71 to 71.6; LDL 106.6 to 108; Do not know how to use computer 78.1% to 79.9%.</p> <p>Time Horizon: IDEATel ran from Feb 28, 00 to Feb 27, 08. Follow-up data at 5 years for each patient.</p>	<p>Informatics for Diabetes Education and Telemedicine (IDEATel)</p> <p>Objective to determine intervention effect on healthcare cost at 5 years.</p> <p>This is a 5-year follow-up to the intervention described in Shea (2006). Shea (2009) was the effectiveness evaluation</p> <p>Intervention (Interv) See Shea (2006) for details</p> <p>Comparison: See Shea (2006) for details.</p>	<p>5-Year endpoints from Shea (2009) <u>Reductions compared to Usual Care at 5 years</u> SBP 4.32 mm Hg DBP 2.64 mm Hg A1c 0.29 pct pt LDL-C 3.84 mg/dL</p>	<p>Based on actual expenditures over 6-year budgetary period divided by participant-months of intervention delivered.</p> <p><u>Patient months of intervention delivered</u> Year 1-4 17575 Year 5-6 11246 Year 1-6 28821</p> <p>Software and hardware upgrades occur in Year 5.</p> <p><u>Per Patient Per Month Cost Year 1-4 (Year 5-6) [Year 1-6]</u> Telemonitoring* \$332 (\$399) [\$358] Telemedicine and bioinformatics** \$129 (\$94) [\$115] Diabetes Clinic and Case Management*** \$84 (\$152) [\$110, Study estimate is \$149] Total \$544 (\$644) [\$583, Study estimate is \$622] Cost includes patient training. *HTU units (development,</p>	<p>Healthcare Cost: Based on Medicare claims paid. Inpatient, Physician/Supplier, Outpatient, Home health, Medical equipment, Nursing Facilities, Hospice</p> <p><u>5-Year mean annual payments for all participants:</u> Intervention \$9669 vs Usual \$9040 (Not significant diff for total and all categories except medical equipment which was higher for intervention)</p> <p><u>5-Year mean annual payments for censored* [uncensored]</u> participants: Intervention \$11,292 vs Usual \$10,426 [Intervention \$7571 vs Usual \$8346] (not significant diff) *Dead or dropped out</p> <p><u>Analysis at 36, 48, 60 months.</u></p>	<p>No summary measure estimated or reported</p> <p>Author Conclusion: Sustained improvement in A1c, BP, and LDL. But, telemedicine intervention did not result in lower healthcare cost due to substitution of electronic care for outpatient visits or averted inpatient care.</p> <p>Telemedicine intervention was expensive. Equipment and methods were innovative at the time without vendors absorbing cost of development before bringing to market. May be able to implement at lower cost with new cell-phone enabled technologies and computers owned by the patients. Further reduction in cost is possible if intervention may be carried out by</p>

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				deployment, maintenance, upgrade) Data servers Security modules ADA web portal Telephone, ISP, and VPN WAN connections, data transfer, and maintenance **Hardware, software, and training for telemedicine ***DM case management teams at 2 hubs (2 nurses, ½ nutritionist, part-time endocrinologist)	Similar patterns as for 5-year period analysis and no significant difference between intervention and usual care. Productivity: No assessment done	existing personnel and infrastructure.
<p>Author (Year): Reed et al. (2010)</p> <p>Linked to Bosworth et al. (2009)</p> <p>Design: RCT</p> <p>Economic Method: Cost-effectiveness</p> <p>Monetary Conversions: Reporting year 2008 and base 2014 in US\$.</p>	<p>Location: Durham, NC.</p> <p>Setting: 2 primary clinics in large academic health setting.</p> <p>Eligibility: Adults with hypertension from 2 primary care clinics.</p> <p>Sample Size: N-160; H-158; C-159; Usual-159</p>	<p>Take Control of Your BP (TCYB)</p> <p>3 intervention arms.</p> <p>Nurse-led tailored behavioral (N) – 12 bimonthly telephone encounters. Questions and education module software driven at each call. Modules included medication, diet, and knowledge.</p> <p>Home BP monitoring (H) – 10 minute training and free</p>	<p>Usual care systolic BP unchanged. Change in mm Hg compared to usual care: For. H reduced by 0.6 For N increased by 0.6 For C decreased by 3.9</p>	<p><u>Program Cost per Participant (24 Months):</u> N \$345 H \$90 C \$416 Patient Time per Participant (24 Months): N \$55 H \$585 C \$741.</p> <p>Intervention N components Primarily Nurse time and Patient materials</p>	<p>Healthcare cost: From health system data on claims. Health care includes outpatient and inpatient care. Excludes medication costs. Interv. C had highest outpatient and lowest inpatient costs. Per person cost in 24 months (Interv Minus Usual Care) In-patient: N \$1020; H \$1194; C -\$201 Out-patient: N - \$110;</p>	<p>Summary Measure: Incremental cost per person over 24 months (Program Cost + Patient Time + Medical Cost): N \$1310 H \$1622 C \$1783</p> <p>Incremental program plus patient time cost for Combination: \$1157 Incremental cost per BP reduction = 1157/3.9=\$297 per mm Hg.</p>

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	<p>Characteristics: Mean age:62; Male:29-38%; Caucasian:43-56%; Diabetes:32-40%; Employed:36-45% Systolic:124-126; Diastolic:70-72.</p> <p>Time Horizon: Intervention year not provided. 24 month interv with followup every 6 months.</p>	<p>instrument to measure BP 3 times a week. Retraining if necessary.</p> <p>Combination (C)</p> <p>Device: Omron HEM 773AC</p> <p>Comparison: Usual Care (U).</p>		<p>(Fixed cost was \$54404 per year for Nurse Intervention)</p> <p>Intervention H components BP Monitor and Nurse-led training Time (initial 10 minutes and 5 minutes at follow-up). No telemetry since readings mailed.</p>	<p>H -\$247; C \$828 All Care: N \$910; H \$947; C \$627</p> <p>Productivity: No assessment done</p>	<p>They use BP outcomes (reduction of 2.7/1.9 mm Hg) from the ASCOT-BPLA study to estimate incremental LY was 0.1. Hence based only on program cost, CEA=416/0.1=\$416 0/LY. Assuming 12 year intervention sustained, and per year cost of \$211, CEA=\$23,000/LY If patient time is added to program cost, CEA=1157/0.1=\$11,570/LY If sustained over 12 years and discounted by 3%, CEA=\$64,000/LY</p> <p>Comment: Patient time costs are non-trivial.</p> <p>Medication costs not included</p>
<p>Author (Year): Shea et al. (2006)</p> <p>Design: RCT</p>	<p>Location: New York City and Upstate New York, NY</p> <p>Setting: Primary care clinics with hubs at Columbia</p>	<p>Informatics for Diabetes Education and Telemedicine (IDEATel)</p>	<p>Endpoints were BP, A1c, and LDL-C. Baseline and follow-up measurements taken at hubs or medical centers or at home by nurse for</p>	<p>Total cost of devices per patient \$3425 \$3000 HTU \$225 BP monitor \$75 BP cables</p>	<p>Healthcare Cost: Formal analysis and report forthcoming. Study observed higher Medicare claims in</p>	<p>No summary measure estimated or reported</p>

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<p>Economic Method: Partial intervention cost only</p> <p>Monetary Conversions: Reporting year 2002 and base 2014 in US\$.</p>	<p>University and upstate SUNY, Syracuse.</p> <p>Eligibility: Age=>55 years; on Medicare; diagnosed with DM and on treatment; resident in medically underserved area in New York State; English or Spanish fluent. Exclude severe impairment or comorbid disease.</p> <p>Sample Size: Interv 844; U 821 randomized. Analyzed Inter 700 and U 717 after loss to f/u.</p> <p>Characteristics: Age 55-64 11.9% to 12.1%</p> <p>Age 75 and above 27.9% to 29%</p> <p>African American 14.5% to 15.3%</p> <p>Hispanic 34.6% to 35.8%</p>	<p>Intervention Telemedicine with telemonitoring and case management. Home Telemedicine Units (HTU) installed in homes. Web-enabled computer to phone line. Capabilities: videoconferencing with trained nurse case managers; remote monitoring and upload of glucose and BP to patient records; web access to patient clinical data and messaging with nurse case managers; educational website developed by ADA. Nurses trained in telemedicine and diabetes care. Patients trained in use of HTUs. Treatments used Veterans Health Administration software-based guidelines for diabetes management (May '00). Change in management suggested by nurse,</p>	<p>those unable to travel. Devices used were different from those used at home.</p> <p>Those with follow-up data <u>A1c:</u> Intervention 7.35 to 6.97, Usual 7.42 to 7.17, Difference -0.18 <u>SBP:</u> Intervention 142.13 to 137.40, Usual 141.75 to 140.62, Difference -3.42 <u>DBP:</u> Intervention 71.42 to 68.44, Usual 70.91 to 70.05, Difference -1.94 <u>LDL:</u> Intervention 106.40 to 95.69, Usual 107.97 to 105.92, Difference -9.50</p> <p>With baseline values assumed for those without follow-up data (Difference) A1c -0.12 SBP -2.86 DBP -1.54 LDL -7.40</p>	<p>\$110 glucometer and cable</p> <p>Authors state a full analysis of intervention cost is forthcoming.</p>	<p>intervention versus usual care.</p> <p>Productivity: No assessment done</p>	<p>Author Conclusion: BP, A1c, and LDL reduced by largescale intervention within underserved population with low SES.</p> <p>Comment: Spillover effects possible because cluster randomization resulted in physicians treating both intervention and control patients.</p> <p>Assessment of differential drop-outs in intervention group revealed patients found the HTU bulky. PCPs preferred interacting with case manager nurses through traditional modes rather than web interface. Trial produced positive results despite poor computer literacy.</p>

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	<p>White 48.2% to 50.6%</p> <p>Less than High School 54.1% to 55.7%</p> <p>Unemployed 93.4% to 94%</p> <p>Household Income less than \$20K 71.4% to 72.5%</p> <p>Diabetes 100% A1c 7.36 to 7.4 SBP 142.5 to 142.8 DBP 71 to 71.6 LDL 106.6 to 108</p> <p>Do not know how to use computer 78.1% to 79.9%.</p> <p>Time Horizon: Randomized Dec 00 to Oct 02. Follow-up at 12 months completed Oct 31, 03.</p>	<p>reviewed by diebetologist and faxed, emailed, mailed, or phoned to Primary Care Provider (PCP). PCP in full control of treatment.</p> <p>Devices – Home Telemedicine Unit (HTU) from American telecare, Inc. Eden Prairie, MN. One Touch Sure Step glucose monitor from LifeScan, Inc, Milpitas, CA. UA-767 BP monitor from A&D Medical, Milpitas, CA.</p> <p>Comparison: Usual care (U) by Primary Care Providers who received diabetes care guidelines in mail. No input from telemedicine or study personnel.</p>				
<p>Author (Year): Wang et al. (2012)</p> <p>Linked to Boswoth et al. (20011)</p> <p>Design: RCT</p>	<p>Location: Durham, NC</p> <p>Setting: Primary care in Veterans Administration system.</p>	<p>Hypertension Intervention Nurse Telemedicine Study (HINTS) See Bosworth (2009) and Bosworth (2011) for details</p>	<p>SMBP SBP/DBP control threshold set at <135/85 and 135/80 for DM patients.</p> <p>BP Control</p>	<p>18-month intervention cost per patient NB \$947 NM \$1275 C \$1153 (Includes start-up (laptop) \$4378; BP</p>	<p>18-month per patient healthcare cost* based on VA claims (versus usual care)** Inpatient NB \$781 NM \$1620 C \$273</p>	<p>18-month Incremental Total Cost* per patient (versus usual care) with HTN-related drugs NB \$1463 NM \$2016</p>

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<p>Economic Method: Based on RCT data. Net benefit.</p> <p>Monetary Conversions: Reporting year 2007 and base 2014 in US\$.</p>	<p>Eligibility: Patients from VAMC primary care practices that had hypertension Dx, uncontrolled BP, and were on medication. Randomized to 4 arms and stratified by diabetes.</p> <p>Sample Size: 3 nurse-led arms: Behavioral with 148, Medication with 149, Combined with 147, and usual care with 147.</p> <p>Characteristics: Mean age 64; African American 50%; Male 92%. 59% had BP controlled at baseline.</p> <p>Time Horizon: Assessed the effects at 18 month follow-up</p>	<p>Objective of present study to estimate the intervention cost and effect on healthcare cost for the 3 arms: NB – Nurse-led behavioral NM – Nurse led-medication treatment C - Combined U – Usual care</p> <p>Self-measured BP included in all intervention arms. 10 minutes of training. Nurse triggered if 2-week readings not in control.</p> <p>Comparison: Usual care</p>	<p>BP Control vs. usual care at 12 Months: NB:12.8%; NM:12.5%;C:8.3% (Not significant) BP Control vs. usual care at 18 Months: C:7.7% (Not significant)</p> <p>Subgroup Analysis: Those with uncontrolled BP at baseline in arm C showed significant improvements at 6, 12, and, 18 months, and focus on them may have been appropriate.</p>	<p>device and telemedicine transmission device* \$559.61 per patient; pill container \$2.17; Nurse time; Physician time for NB and C arms)</p> <p>Labor composed of 1.9 Nurse RN FTE and physician time for NM and C arms.</p> <p>* Note this is a sophisticated device. Authors conduct sensitivity with a \$50 home BP monitor also.</p>	<p>Outpatient NB -\$289 NM -\$963 C -\$1126 Drugs NB \$24 NM \$84 C \$21 Total Health NB \$516 NM \$741 C -\$832 * Drugs are HTN-related only and other components are all-health. ER and labs are included in other outpatient.</p> <p>**Comment: None of the differences for components of healthcare cost were significant.</p> <p>Productivity: No assessment done</p>	<p>C \$321</p> <p>Reported by Authors (Adjusted)**: NB \$2113 NM \$2125 C \$681 * None were significant. ** All drugs</p> <p>Author Conclusion: Intervention cost is non-trivial and may be reduced in large-scale implementation. Also may target patients with uncontrolled BP</p> <p>Comment: The reason for insignificant difference in healthcare cost may be due to inclusion of all-cause utilization. The cost of device is quite high.</p>

Abbreviations

ABP, ambulatory blood pressure
BP, blood pressure
CEA, cost-effectiveness analysis
CHD, chronic heart disease
CKD, chronic kidney disease

CV, cardiovascular
CVD, cardiovascular disease
DBP, diastolic blood pressure
DM, diabetes mellitus
GP, general practitioner

HTN, hypertension
HTU, home telemedicine unit
JNC, Joint National Committee
MI, myocardial infarction
PCP, primary care practice

QoL, quality of life
SBP, systolic blood pressure
SES, socioeconomic status