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

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<th>Study</th>
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<tr>
<td><strong>Author (Year): Artinian et al. (2001)</strong></td>
<td><strong>Location:</strong> Detroit, MI</td>
<td>This was a pilot study</td>
<td>Analysis for 21 of 26 who had follow-up data.</td>
<td>$10 incentive at baseline and $15 at follow-up.</td>
<td><strong>Healthcare Cost:</strong> Health care costs averted not considered.</td>
<td><strong>Authors assume telemonitoring can identify White-Coat hypertension (25% prevalence in HTN pop).</strong></td>
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<td><strong>Design:</strong> Randomized Controlled Trial</td>
<td><strong>Setting:</strong> Convenience recruit from family community center housing several other government/communtiy offices including a health clinic</td>
<td><strong>Interventions:</strong> 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.</td>
<td>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.</td>
<td><strong>Productivity:</strong> No productivity improvements considered.</td>
<td><strong>Annual treatment cost of uncomplicated HTN following JNC6 is $1000.</strong> Hence, placing 4 HTNs on a 1 month telemonitor costs $180 and identifies the white-coat and saves $1000 in treatment costs.</td>
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<td><strong>Economic Method:</strong> Cost-analysis</td>
<td><strong>Eligibility</strong> &gt;17 years Hypertension with or without diabetes or CVD.</td>
<td><strong>Home</strong> SBP dropped from 148.8 to 124.1 DBP 90.2 to 75.6</td>
<td><strong>Limitations:</strong> The cost-benefit of telemonitoring conjectured by authors may be reasonable but is not complete. Convenience recruitment Mostly women Tiny samples</td>
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<td><strong>Monetary Conversions:</strong> Reporting year 2000 and base 2014 in US$.</td>
<td><strong>Sample Size:</strong> Home 6 Community 6 63 screened and 26 enrolled 3 men and 23 women Age 32-93 (mean 59) African American 95%</td>
<td><strong>Community</strong> SBP dropped from 155.2 to 142.3 DBP 89.4 to 78.2</td>
<td><strong>Usual</strong> SBP 142.4 to 143.3 DBP 91.2 to 89.1</td>
<td><strong>Authors state the cost of telemonitoring equipment plus training is $1.50 per day including training in use.</strong></td>
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## Study and Population Characteristics

- **Below Federal Poverty Level**: 41%
- **Unoccupied homes**: 10.6%

### Time Horizon
- 12 week (3 months) intervention length.
- Recruitment and intervention dates not provided.

### Location
- Denver-Boulder Metro, CO
- Kaiser Permanente Colorado

### 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.

### Sample Size
- **HBP**: 175
- **Control**: 173

### Characteristics
- **Mean age**: 59-60
- **Males**: 59-62%
- **DM or CKD**: 46-51%
- **Hyperlipidemia**: 61-68%

## Intervention & Comparison

- **Center**: 3 times a week (1-5 miles from residences).
- **Weekly counseling meetings for lifestyle and meds. Weekly readings and report sent to GP.**

### Comparison

- **Usual Care** [n=9]

## Effectiveness

- **Target was set at SBP/DBP <140/90 for all and <130/80 for those with diabetes.**
- **HBP group had significantly more e-mail (5v1) and phone (4v2) encounters.**
- **At 6 months, BP at goal for 54% of HBP vs 35% in control (P <.001).**
- **SBP reduced 21 mmHg for HBP vs 8 mmHg for control (P <.001).**

## Program Costs

- **Intervention cost not estimated. Program cost included in healthcare cost estimate.**
- **Only separate estimate provided is for BP Monitor at $60 per piece.**
- **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 $34.**

## Healthcare Costs and Productivity Losses Averted

- **Healthcare cost: 6 months pre and 6 months post intervention data collected.**
- **Claims related to hypertension included.**
- **Costs related to in-person encounters, email, telephone assessed based on time and salary.**

### In Study 6-month Median Healthcare Cost Per Patient (HBP/Control)

- **Hypertension-related Medication**: $202/$130
- **Out-patient**: $120/$15*
- **Labs**: $21/$0
- **BP Cuff**: $60/$0

### 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**

Mean incremental lifetime HTN-related cost $1965
Mean incremental life years gained 0.59
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<td></td>
<td>SBP/DBP (Intervention) 148.8/89.6 BP control 0%</td>
<td>Pharmacist may initiate or alter drug therapy and order labs, and provide medication and lifestyle counseling. <strong>Comparison:</strong> Patients in control group advised to consult with the PCP.</td>
<td>10 minutes and 6 minutes for e-mail. <strong>Approximate 6-month per person program cost constructed from descriptions.</strong> One-time Monitor and Web Training with assistant $6.46 Initial pharmacist drug review $24.71 BP Monitor $60.00 Variable Extra 4 emails with pharmacist $29.66 Extra 2 phone calls with pharmacist $24.71 Total $145.55 Annualized Cost $200</td>
<td>Other $0/$0 Total $455/$179 <strong>Difference $276 more</strong> All-cause median healthcare Medication $622/$475 Out-patient $481/$381* Labs $122/$113 BP Cuff $60/$0 Other $0/$0** Total $1590/$1283 <strong>Difference $307 more</strong> * Includes e-mail, phone encounters. ** Includes hospital, ER, radiology</td>
<td>Incremental cost per life year gained $3330. <strong>Comments</strong> Authors attribute positive results to clinical pharmacist, relief for physician time, home monitoring that saves clinic time, efficiency of automatic readings. <strong>Limitations:</strong> Not all patients may be internet proficient. Reimbursement for email and phone encounters may not be available. Patient time not accounted, as was productivity.</td>
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**Author (Year):** Bosworth et al. (2009)  
**Design:** RCT with 3 arms  
**Economic Method:** Cost Analysis  
**Location:** Durham, NC  
**Setting:** Two Duke affiliated primary clinics  
**Sample Size:** 636 randomized from 2060 eligible  
**Randomized to 4 groups: Usual Care; Bi-Monthly Nurse-administered tailored telephone behavioral interv (Beh); At home self BP monitoring (Mon); Combination (Mon-Beh)  
**Intent to treat analysis.**  
**Recommended BP:** (Systolic BP < 140 & diastolic BP < 90 mmHg [<130 and <80 mmHg for patients with diabetes])  
**Calls attended by single nurse.**  
**Patients paid $25 at baseline and for each of 4 follow-up ($125 total) **Beh – Nurse completed 1682 calls, 11 per patient, mean of 16 minutes.**  
**Healthcare Cost:** Health care use in Duke system collected through 24 months.  
**Mean outpatient encounters similar across groups; No difference in proportion hospitalized.**  
**No summary economic measures reported.**  
**There was no difference in health care utilization across groups but there was improvement in health outcome for combination group.**
CVD: Self-measured Blood Pressure Interventions When Used With Team-Based Care – Economic Evidence Table

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<td>Monetary Conversions:</td>
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<td>Reporting year 2006 and base 2014 in US$</td>
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<td><strong>Study</strong></td>
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<td><strong>Beh</strong> (n=160)</td>
<td>Stratified at baseline by enrollment site and health literacy.</td>
<td>Primary outcome- BP control at 24 months (and at base, 6,12,18 months)</td>
<td>Beh-Mon – Nurse completed 1589 calls, 10 per patient, mean of 16 minutes.</td>
<td>Mean 2 year total health cost of $15,641 across all groups (SD=$25,769, median=$6698).</td>
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<td>Covered risk perception, hypertension education, provider relations, social support. Also adherence to recs for diet, smoking cessation/alcohol reduction, sodium intake.</td>
<td><strong>BP control vs usual care at 24 months:</strong></td>
<td><strong>2 Years Cost Per Person</strong></td>
<td><strong>Behavioral-Monitoring $416</strong></td>
<td><strong>Behavioral-Monitoring $416</strong></td>
<td><strong>Limitations:</strong></td>
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<td><strong>Mon</strong> (n=158) – Provided BP monitors, trained on use, 3 days a week readings, stamped envelopes to send logs every 2 months.</td>
<td><strong>Mon</strong> (n=158) – Provided BP monitors, trained on use, 3 days a week readings, stamped envelopes to send logs every 2 months.</td>
<td><strong>Behavioral</strong></td>
<td><strong>Behavioral-Monitoring $416</strong></td>
<td><strong>Behavioral-Monitoring $416</strong></td>
<td><strong>Academic health center; 25% no 24 month data; 73% controlled BP at baseline</strong></td>
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<td><strong>Comparison:</strong></td>
<td>Usual Care (n=159)</td>
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<td>Beh: +0.6 (-3.6, 2.3) DBP: -1.2 (-2.9, 0.4)</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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<td>Beh: +0.6 (-2.2, 3.4) DBP: +0.4 (-1.1, 1.9)</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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<td>Mon-Beh: SBP:-3.9 (-6.9, -0.9) DBP:-2.2 (-3.82, -0.6)</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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<td></td>
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<td></td>
<td>Other groups not significant.</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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<td>DBP: -2.2 (-3.82, -0.6)</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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<td>Other groups not significant.</td>
<td><strong>Behavioral-Monitoring $416</strong></td>
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**Time Horizon:**
24 months intervention length - Dec 2005 through Jan 2008.

**Interventions:**
- **Beh** (n=160)
- **Mon** (n=158)

**Comparison:**
Usual Care (n=159)

**Program Costs**
- Behavioral-Monitoring $416

**Healthcare Costs and Productivity Losses Averted**
- Mean 2 year total health cost of $15,641 across all groups (SD=$25,769, median=$6698).

**Economic Summary Measure**
- **Limitations:**
  - Academic health center; 25% no 24 month data; 73% controlled BP at baseline

**Monetary Conversions:**
- Reporting year 2006 and base 2014 in US$
### Study and Population Characteristics

**Location:** Durham, North Carolina  
**Setting:** Veterans Affairs Medical Center  
**Size:** 3 nurse-led arms, Behavioral with 148, Medication with 149, Combined with 147, and usual care with 147.  
**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.  
591 included in analysis.  
Mean age: 63-64  
Male: 86-96%  
Caucasian: 44-53%  
Diabetes: 40-44%  
Employed: 34-35%  
Uncontrolled BP: 35-48%  
**Time Horizon:**

### Intervention & Comparison

**3 arms assisted by telephony and BP home-device**  
1. Nurse-led behavioral [NB] (n=148) 11 tailored modules on knowledge, med, 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.  
**Comparison:** Usual care  
Daily BP readings – assessments based on 2-week average.

### Effectiveness

**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)  
**Systolic at 12 months vs Usual Care**  
2.1, 2.4, and 4.3 mm Hg lower for NB, NM, and C groups respectively.  
**Systolic at 18 months vs Usual Care**  
1.2 and 3.6 mm Hg lower for NM and C groups but not significant.  
Diastolic differences were not significant.  
**Subgroup with Uncontrolled BP**  
**Systolic vs Usual Care**  
8.3, 7.9, 14.8 mm Hg lower at 12 months for NB, NM, C.

### Program Costs

<table>
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<th>Healthcare Costs and Productivity Losses Averted</th>
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| Patients paid $10 at baseline and at three 6-month GP visits.  
Poor BP control triggered 1945 nurse alerts for 389 of the 444 intervention patients. Average nurse encounter – 13.2 minutes. Alerts similar across groups.  
**Program Cost Per Person (18 Months):**  
NB: $947  
NM: $1275  
C: $1153 |

### Economic Summary Measure

- **Author (Year):** Bosworth et al. (2011)  
- **Design:** RCT  
- **Economic Method:** Average Cost  
- **Monetary Conversions:** Reporting year 2007 and base 2014 in US$.  
- **Location:** Durham, North Carolina  
- **Setting:** Veterans Affairs Medical Center  
- **Size:** 3 nurse-led arms, Behavioral with 148, Medication with 149, Combined with 147, and usual care with 147.  
- **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.  
591 included in analysis.  
Mean age: 63-64  
Male: 86-96%  
Caucasian: 44-53%  
Diabetes: 40-44%  
Employed: 34-35%  
Uncontrolled BP: 35-48%  
**Time Horizon:**

**Summary Measure:** No final economic measures provided.  
May be able to calculate cost per mm Hg.  
**Limitations:** Contents of the program cost not clear.
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<tbody>
<tr>
<td>Author (Year): Fishman et al. (2013)</td>
<td>Location: Western Washington, USA.</td>
<td>Electronic Communications and Home Blood Pressure Monitoring to Improve Blood Pressure Control (e-BP). 3-arm trial. All members of group health have EMR integrated into patient website. 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. Home BP Monitoring Plus Pharmacist Care (BPM+) – All features of BPM and care supervision by clinical pharmacist.</td>
<td>Main outcomes were change in SBP/DBP and percentage patients achieving SBP/DBP &lt;140/90 mmHg at 12 months. Percent with BP control BPM+ 56%; BPM 36%; Usual 31%. Reductions in BP BPM+ vs BPM SBP 6.0 mmHg less DBP 2.6 mmHg less BPM+ vs Usual SBP 8.9 mmHg less DBP 3.6 mmHg less BPM vs Usual SBP 2.6 mmHg less DBP No difference.</td>
<td>All materials and labor valued except for the EMR system. Source is project reports.</td>
<td>Healthcare cost from study records: Statement that there was no significant difference in inpatient, outpatient, ER. Except higher specialist visits for pharmacist arm. Productivity gains: No assessment performed.</td>
<td>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.</td>
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<tr>
<td>Linked to Green et al. (2008)</td>
<td>Setting: 10 primary care medical centers of Group Health Cooperative.</td>
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<td>Discounted Life Years Gained (Men/Women) Usual 0.31 (0.25) BPM 0.35 (0.29) BPM+ 0.53 (0.44)</td>
</tr>
<tr>
<td>Design: Based on RCT</td>
<td>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.</td>
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<td>Cost per Systolic mmHg BPM vs Usual $23.76 BPM+ vs BPM $65.29</td>
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<tr>
<td>Economic Method: Program cost and cost-effectiveness.</td>
<td>Sample Size: BPM 259 BPM+ 261 Usual 258</td>
<td># Secure Messages BPM+ 22.3; BPM 3.3; Usual 2.4.</td>
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<td>Monetary Conversions: Reporting year 2009 and base 2014 in US$.</td>
<td>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</td>
<td># Phone Encounters</td>
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<td>86%; Less than High School 3 to 5%; SBP 151.3 to 152.2; DBP 88.9 to 89.4.</td>
<td>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. Omron Hem-705-CP BP device. <strong>Comparison: Usual Care</strong> patients provided wallet card with BP numbers, pamphlet on BP control, medication adherence and lifestyle info to control BP, website</td>
<td>BPM+ 7.5; BPM 3.8; Usual 4.0. No significant difference in inpatient, outpatient, ER. Modest but significantly less specialist visits for HBP+ relative to others. Increased life years gained modeled based on BP control.</td>
<td>was 4 hours per week in patient care and 2 hours per month in consultation with senior pharmacist.</td>
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<td><strong>Time Horizon:</strong> Intervention length is 12 months. Trial period June 2005 to December 2007.</td>
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<td><strong>Cost per Diastolic mmHG</strong> BPM vs Usual was dominated – not significant BPM+ vs BPM $114.82 <strong>Cost per 1 pct pt increase in BP Control</strong> BPM vs Usual was dominated – not significant BPM+ vs BPM $16.65</td>
<td><strong>Author Conclusion:</strong> BPM+ appears cost-effective relative to BPM alone based on cost per life year gained. <strong>Comment:</strong> 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</td>
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**Author (Year):** Johannesson et al. (1991)

**Design:** Based on cluster randomized trial with treated comparison.

**Economic Method:** Cost-benefit based on willingness to pay.

**Monetary Conversions:** Reporting year 1988 and base 2014 in Swedish Kroner (SEK).

**Location:** Sweden.

**Setting:** 8 health centers.

**Eligibility:** Age 30 to 69 on hypertension medication.

**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.


**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. Name of device not provided.

Drugs reduced and withdrawn after randomization for both groups following same treatment guidelines.

**Comparison:** Usual care (U) with drug.
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<td></td>
<td>treatment and HBP monitoring.</td>
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<td>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.</td>
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<td><em>Unclear how numbers were derived.</em></td>
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<td>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.</td>
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<td>Summary Measure: No summary measures reported.</td>
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<td>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.</td>
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**Author (Year):** Maciejewski et al. (2014)  
**Linked to Bosworth (2011)**  
**Design:** RCT  
**Economic Method:** Healthcare cost.  
**Monetary Conversions:** Reporting year 2009 and base 2014 in US$.  
**Location:** Durham, NC.  
**Setting:** Clinics of Veterans Affairs Medical Center (VAMC).  
**Eligibility:** Patients of VAMC with hypertension, taking meds, and BP not controlled (SBP/DBP > 140/90).  
**Sample Size:** NB 148; NM 149; C 147; U 147  
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)  
Interventions used telephone-based communication and  
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.  
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  
No program cost provided.  
**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.  
Results are reported here for total  
**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.
### Characteristics:
- Mean Age 63-64
- Black 48%
- Men 92%
- 74-77% had >10 years of high BP history.

### Time Horizon:
- Intervention length is 18 months.
- Follow-up at 18 months.
- Randomized during May 2006 to July 2009.

### Comparison: Usual Care.

### Effectiveness:
- in the comparison group.
- 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.

### Program Costs:
- **Healthcare Cost:** No cost assessment done though short term healthcare events were recorded, most were non-CVD hospitalizations.
- **Productivity:** No assessment done.

### Economic Summary Measure:
- **Author Conclusion:** BP telemonitoring and pharmacist care is safe and effective with effects sustained over 6 month f/u after end of intervention.

### Comment:
- Authors state program cost could be reduced from volume discounts and
### Study and Population Characteristics

- **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.

- **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%.

- **Time Horizon:** Recruitment March 09 to April 11. Intervention length was 12 months. Follow-up at 6, 12, and 18 months.

### Intervention & Comparison

- 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 PCPs assent to prescribe and change therapy within parameters. Communication with PCP through EMR after each contact.

- **Devices – A&D Medical 767PC.**

- **Comparison:** Usual care that may include pharmacist referral or home BP.

### Effectiveness

- **Controlled BP at all f/u Visits**
  - 50.9% vs 21.3% (Diff.29.6)

- **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)

- **Change in # HTN Drug Classes**
  - 1.6 to 2.2 in HBP and 1.4 to 1.6 in Usual.

### Program Costs

- 52% for telemonitoring. Authors state the telemonitoring was discounted and the undiscounted estimate would be $1350 per patient.

- *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.

### Economic Summary Measure

- decreasing contacts with patients who demonstrate BP control. Authors plan to analyze longer term outcomes on healthcare cost and indirect costs associated with HyperLink.
<table>
<thead>
<tr>
<th>Study</th>
<th>Study and Population Characteristics</th>
<th>Intervention &amp; Comparison</th>
<th>Effectiveness</th>
<th>Program Costs</th>
<th>Healthcare Costs and Productivity Losses Averted</th>
<th>Economic Summary Measure</th>
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</thead>
<tbody>
<tr>
<td><strong>Author (Year):</strong> Palmas et al. (2010)</td>
<td><strong>Location:</strong> New York City and Upstate New York, NY</td>
<td>Informatics for Diabetes Education and Telemedicine (IDEATel)</td>
<td>5-Year endpoints from Shea (2009) Reductions compared to Usual Care at 5 years SBP 4.32 mm Hg DBP 2.64 mm Hg A1c 0.29 pct pt LDL-C 3.84 mg/dL</td>
<td>Based on actual expenditures over 6-year budgetary period divided by participant-months of intervention delivered. Patient months of intervention delivered Year 1-4 17575 Year 5-6 11246 Year 1-6 28821 Software and hardware upgrades occur in Year 5. Per Patient Per Month Cost Year 1-4 (Year 5-6) [Year 1-6] Telemonitoring* $332 ($399) [358] Telemedicine and bioinformatics** $129 ($94) [$115] Diabetes Clinic and Case Management*** $84 ($152) [$110, Study estimate is $149] <strong>Total $544 ($644) [583, Study estimate is $622]</strong> Cost includes patient training. *HTU units (development,</td>
<td><strong>Healthcare Cost:</strong> Based on Medicare claims paid. Inpatient, Physician/Supplier, Outpatient, Home health, Medical equipment, Nursing Facilities, Hospice <strong>Healthcare Cost:</strong> Based on Medicare claims paid. Inpatient, Physician/Supplier, Outpatient, Home health, Medical equipment, Nursing Facilities, Hospice 5-Year mean annual payments for all participants: Intervention $9669 vs Usual $9040 (Not significant diff for total and all categories except medical equipment which was higher for intervention)</td>
<td>No summary measure estimated or reported</td>
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<tr>
<td>Linked to Shea et al. (2006) and Shea et al. (2009)</td>
<td><strong>Details in Shea (2006):</strong> Sample Size: Interv 844; U 821 randomized.</td>
<td>Objective to determine intervention effect on healthcare cost at 5 years.</td>
<td><strong>Author Conclusion:</strong> 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. 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</td>
<td><strong>Author Conclusion:</strong> 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. 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</td>
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<td><strong>Design:</strong> Based on RCT</td>
<td><strong>Characteristics:</strong> 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%.</td>
<td>This is a 5-year follow-up to the intervention described in Shea (2006). Shea (2009) was the effectiveness evaluation</td>
<td></td>
<td><strong>5-Year mean annual payments for censored patients:</strong> Intervention $11,292 vs Usual $10,426 [Intervention $7571 vs Usual $8346] (not significant diff) <em>Dead or dropped out</em>*</td>
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<tr>
<td><strong>Economic Method:</strong> Intervention cost and healthcare cost.</td>
<td><strong>Time Horizon:</strong> IDEATel ran from Feb 28, 00 to Feb 27, 08. Follow-up data at 5 years for each patient.</td>
<td><strong>Intervention (Interv)</strong> See Shea (2006) for details</td>
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<td>Analysis at 36, 48, 60 months.</td>
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<td>Study</td>
<td>Study and Population Characteristics</td>
<td>Intervention &amp; Comparison</td>
<td>Effectiveness</td>
<td>Program Costs</td>
<td>Healthcare Costs and Productivity Losses Averted</td>
<td>Economic Summary Measure</td>
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<td>deployment, maintenance, upgrade)</td>
<td>Similar patterns as for 5-year period analysis and no significant difference between intervention and usual care.</td>
<td>existing personnel and infrastructure.</td>
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<td>Data servers</td>
<td><strong>Productivity:</strong> No assessment done</td>
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<td>Security modules</td>
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<td>ADA web portal</td>
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<td>Telephone, ISP, and VPN</td>
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<td>WAN connections, data transfer, and maintenance</td>
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<td><strong>Hardware, software, and training for telemedicine</strong></td>
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<td>***DM case management teams at 2 hubs (2 nurses, ½ nutritionist, part-time endocrinologist)</td>
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<td>Author (Year): Reed et al. (2010)</td>
<td>Location: Durham, NC.</td>
<td>Take Control of Your BP (TCYB)</td>
<td>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</td>
<td>Program Cost per Participant (24 Months): N $345</td>
<td>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;</td>
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<td></td>
<td>Setting: 2 primary clinics in large academic health setting.</td>
<td>3 intervention arms.</td>
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<td>H $90</td>
<td>Summary Measure: Incremental cost per person over 24 months (Program Cost + Patient Time + Medical Cost): N $1310 H $1622 C $1783</td>
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<td>Eligibility: Adults with hypertension from 2 primary care clinics.</td>
<td>Nurse-led tailored behavioral (N) – 12 bimonthly telephone encounters. Questions and education module software driven at each call. Modules included medication, diet, and knowledge.</td>
<td></td>
<td>C $416</td>
<td>Incremental program plus patient time cost for Combination: $1157 Incremental cost per BP reduction = 1157/3.9=$297 per mm Hg.</td>
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<td>Sample Size: N-160; H-158; C-159; Usual-159</td>
<td>Home BP monitoring (H) – 10 minute training and free</td>
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<td>Patient Time per Participant (24 Months): N $55</td>
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<td>H $585</td>
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<td>C $741</td>
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<td>Intervention N components</td>
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<td>Primarily Nurse time and Patient materials</td>
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<td>Study and Population Characteristics</td>
<td>Intervention &amp; Comparison</td>
<td>Effectiveness</td>
<td>Program Costs</td>
<td>Healthcare Costs and Productivity Losses Averted</td>
<td>Economic Summary Measure</td>
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<td><strong>Characteristics:</strong> Mean age: 62; Male: 29-38%; Caucasian: 43-56%; Diabetes: 32-40%; Employed: 36-45% Systolic: 124-126; Diastolic: 70-72.</td>
<td>Instrument to measure BP 3 times a week. Retraining if necessary. Combination (C) <strong>Device:</strong> Omron HEM 773AC <strong>Comparison:</strong> Usual Care (U).</td>
<td>(Fixed cost was $54404 per year for Nurse Intervention) Intervention H components BP Monitor and Nurse-led training Time (initial 10 minutes and 5 minutes at follow-up). No telemetry since readings mailed.</td>
<td>H -$247; C $828 All Care: N $910; H $947; C $627</td>
<td>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=$4160/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</td>
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<td><strong>Time Horizon:</strong> Intervention year not provided. 24 month interv with followup every 6 months.</td>
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<td><strong>Comment:</strong> Patient time costs are non-trivial. Medication costs not included</td>
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<tr>
<td><strong>Author (Year):</strong> Shea et al. (2006)</td>
<td><strong>Location:</strong> New York City and Upstate New York, NY</td>
<td><strong>Setting:</strong> Primary care clinics with hubs at Columbia</td>
<td>Informatics for Diabetes Education and Telemedicine (IDEATel)</td>
<td><strong>Endpoints were BP, A1c, and LDL-C. Baseline and follow-up measurements taken at hubs or medical centers or at home by nurse for</strong></td>
<td><strong>Healthcare Cost:</strong> Formal analysis and report forthcoming. Study observed higher Medicare claims in</td>
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<td><strong>Design:</strong> RCT</td>
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<td><strong>Total cost of devices per patient</strong> $3425 $3000 HTU $225 BP monitor $75 BP cables</td>
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<td><strong>No summary measure estimated or reported</strong></td>
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<tr>
<td>Study</td>
<td>Study and Population Characteristics</td>
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<tr>
<td><strong>Economic Method:</strong> Partial intervention cost only</td>
<td>University and upstate SUNY, Syracuse.</td>
<td><strong>Intervention</strong> 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, those unable to travel. Devices used were different from those used at home.</td>
<td><strong>Those with follow-up data</strong> <strong>A1c:</strong> Intervention 7.35 to 6.97, Usual 7.42 to 7.17, Difference -0.18 <strong>SBP:</strong> Intervention 142.13 to 137.40, Usual 141.75 to 140.62, Difference -3.42 <strong>DBP:</strong> Intervention 71.42 to 68.44, Usual 70.91 to 70.05, Difference -1.94 <strong>LDL:</strong> Intervention 106.40 to 95.69, Usual 107.97 to 105.92, Difference -9.50 <strong>With baseline values assumed for those without follow-up data (Difference)</strong> A1c -0.12 SBP -2.86 DBP -1.54 LDL -7.40</td>
<td>$110 glucometer and cable Authors state a full analysis of intervention cost is forthcoming.</td>
<td>intervention versus usual care. <strong>Productivity:</strong> No assessment done</td>
<td><strong>Author Conclusion:</strong> BP, A1c, and LDL reduced by largescale intervention within underserved population with low SES. <strong>Comment:</strong> Spillover effects possible because cluster randomization resulted in physicians treating both intervention and control patients. 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.</td>
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<td>Study</td>
<td>Study and Population Characteristics</td>
<td>Intervention &amp; Comparison</td>
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<td>Program Costs</td>
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<td></td>
<td>White 48.2% to 50.6%</td>
<td>reviewed by diabetologist and faxed, emailed, mailed, or phoned to Primary Care Provider (PCP). PCP in full control of treatment.</td>
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<td>Less than High School 54.1% to 55.7%</td>
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<td>Unemployed 93.4% to 94%</td>
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<td>Household Income less than $20K 71.4% to 72.5%</td>
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<td>Diabetes 100% A1c 7.36 to 7.4</td>
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<td></td>
<td>SBP 142.5 to 142.8 DBP 71 to 71.6 LDL 106.6 to 108</td>
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<td>Do not know how to use computer 78.1% to 79.9%</td>
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<td><strong>Time Horizon:</strong> Randomized Dec 00 to Oct 02. Follow-up at 12 months completed Oct 31, 03.</td>
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<td><strong>Devices:</strong> 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&amp;D Medical, Milpitas, CA.</td>
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<td><strong>Comparison:</strong> Usual care (U) by Primary Care Providers who received diabetes care guidelines in mail. No input from telemedicine or study personnel.</td>
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<td></td>
<td><strong>Author (Year):</strong> Wang et al. (2012)</td>
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<td></td>
<td>Linked to Bosworth et al. (2011)</td>
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<td></td>
<td><strong>Setting:</strong> Primary care in Veterans Administration system.</td>
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<td></td>
<td><strong>Design:</strong> RCT</td>
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<td>Hypertension Intervention Nurse Telemedicine Study (HINTS) See Bosworth (2009) and Bosworth (2011) for details</td>
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<td>SMBP SBP/DBP control threshold set at &lt;135/85 and 135/80 for DM patients.</td>
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<td><strong>BP Control</strong></td>
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<td></td>
<td><strong>18-month intervention cost per patient</strong></td>
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<td></td>
<td>NB $947</td>
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<td>NM $1275</td>
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<td>C $1153</td>
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<td>(Includes start-up (laptop) $4378; BP</td>
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<td><strong>Inpatient</strong></td>
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<td>NB $781</td>
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<td>NM $1620</td>
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<td>C $273</td>
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<td><strong>18-month per patient healthcare cost</strong> based on VA claims (versus usual care)**</td>
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<td>NB $1463</td>
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<td>NM $2016</td>
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<td><strong>18-month Incremental Total Cost</strong> per patient (versus usual care) with HTN-related drugs</td>
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# CVD: Self-measured Blood Pressure Interventions When Used With Team-Based Care – Economic Evidence Table

## Study and Population Characteristics

**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.

**Sample Size:** 3 nurse-led arms: Behavioral with 148, Medication with 149, Combined with 147, and usual care with 147.

**Characteristics:** Mean age 64; African American 50%; Male 92%. 59% had BP controlled at baseline.

**Time Horizon:** Assessed the effects at 18 month follow-up

## Intervention & Comparison

- **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-medications treatment C - Combined U – Usual care
- **Self-measured BP** included in all intervention arms. 10 minutes of training. Nurse triggered if 2-week readings not in control.
- **Comparison:** Usual care

## Effectiveness

- **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)

## Program Costs

- **Device and telemmedicine transmission device:** $559.61 per patient; pill container $2.17; Nurse time; Physician time for NB and C arms
- **Labor composed of 1.9 Nurse RN FTE and physician time for NM and C arms.**
- **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.

## Healthcare Costs and Productivity Losses Averted

- **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.**
- **Productivity:** No assessment done

## Economic Summary Measure

- **C $321**

### 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 telemmedicine unit
- JNC, Joint National Committee
- MI, myocardial infarction
- PCP, primary care practice

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**Author Conclusion:** Intervention cost is non-trivial and may be reduced in large-scale implementation. Also may target patients with uncontrolled BP

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