

Home Blood Pressure Telemonitoring with  
Pharmacist Management in Patients with  
Uncontrolled Hypertension:  
**Long-term Effects on Cardiovascular Events**



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# Disclosures

- No conflicts of interest to disclose
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# Study Team

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# Rationale

- Although BP control has improved in the last two decades, improvement has stalled since 2010.
- Only about 50% of Americans with hypertension have BP <140/90, the proportion <130/80 is even lower.
- Hypertension remains the predominant risk factor for cardiovascular mortality
- U.S. adults with hypertension visit a physician an average of 4 times per year, and 80-90% of those with uncontrolled BP have a usual source of care, received care in the last year, and have insurance.

# Study Design

- Cluster-randomized controlled trial in 16 primary care clinics at HealthPartners Medical Group
  - Medication Therapy Management (MTM) Pharmacists work in team under collaborative practice agreements with physicians
- Adult patients with BP>140/90 confirmed in research clinic
- Primary care clinics randomly assigned to 2 groups:
  - **Usual care (UC)**
  - **Telemonitoring Intervention (TI)** combining pharmacist-led care management and home BP telemonitoring

# Telemonitoring Intervention

- Home blood pressure telemonitor
  - Transmits stored BP to cloud
  - Patient measures BP 3 days per week, a.m. and p.m. (6 readings /week)
  - Pharmacist accesses BP data remotely from clinic
- Pharmacist case management
  - Visits with patients primarily by phone
  - Adjusts antihypertensive therapy using algorithm from collaborative practice agreement with PCP
  - Emphasizes lifestyle strategies and medication adherence
- Intervention for 12 months, post-intervention observation
  - Months 0-6: One in-person intake visit, phone visits every 2-4 weeks depending on BP control
  - Months 7-12: phone visits every 2 months
  - Months 13-54: return to usual primary care without telemonitoring

# Cardiovascular Event Ascertainment

- Self-reported hospitalizations at 6, 12, 18 and 54 month visits
- EHR and claims searched for all participants
- Duplicate events removed
- All hospitalizations and relevant records from EHR/claims reviewed by physician blinded to intervention group, adjudicated for CV event(s) of interest
  - Primary composite endpoint: MI, stroke, hospitalized heart failure, CV death
  - Secondary composite endpoint: Above plus coronary revascularization

# Analytic Methods

- Generalized estimating equations with robust standard errors were used to test differences in CV incidence
- Marginal Cox models were used to estimate the hazard ratio with time to first event by treatment group



# Cost assignment

- Telemonitoring costs = manufacturers' estimate of market price at time of study (> than cost to study)
- Pharmacist management costs = cost to study
- Event costs from literature
  - MI, stroke and heart failure
    - Dehmer et al. Ann Fam Med. 2017 (Medical Expenditure Panel Survey)
    - Includes initial event costs and annual follow-up costs
  - Revascularization
    - Nagle and Smith Am J Manag Care 2004 (review)
    - Assuming 75% PCI and 25% CABG
- All costs were inflation adjusted to 2017

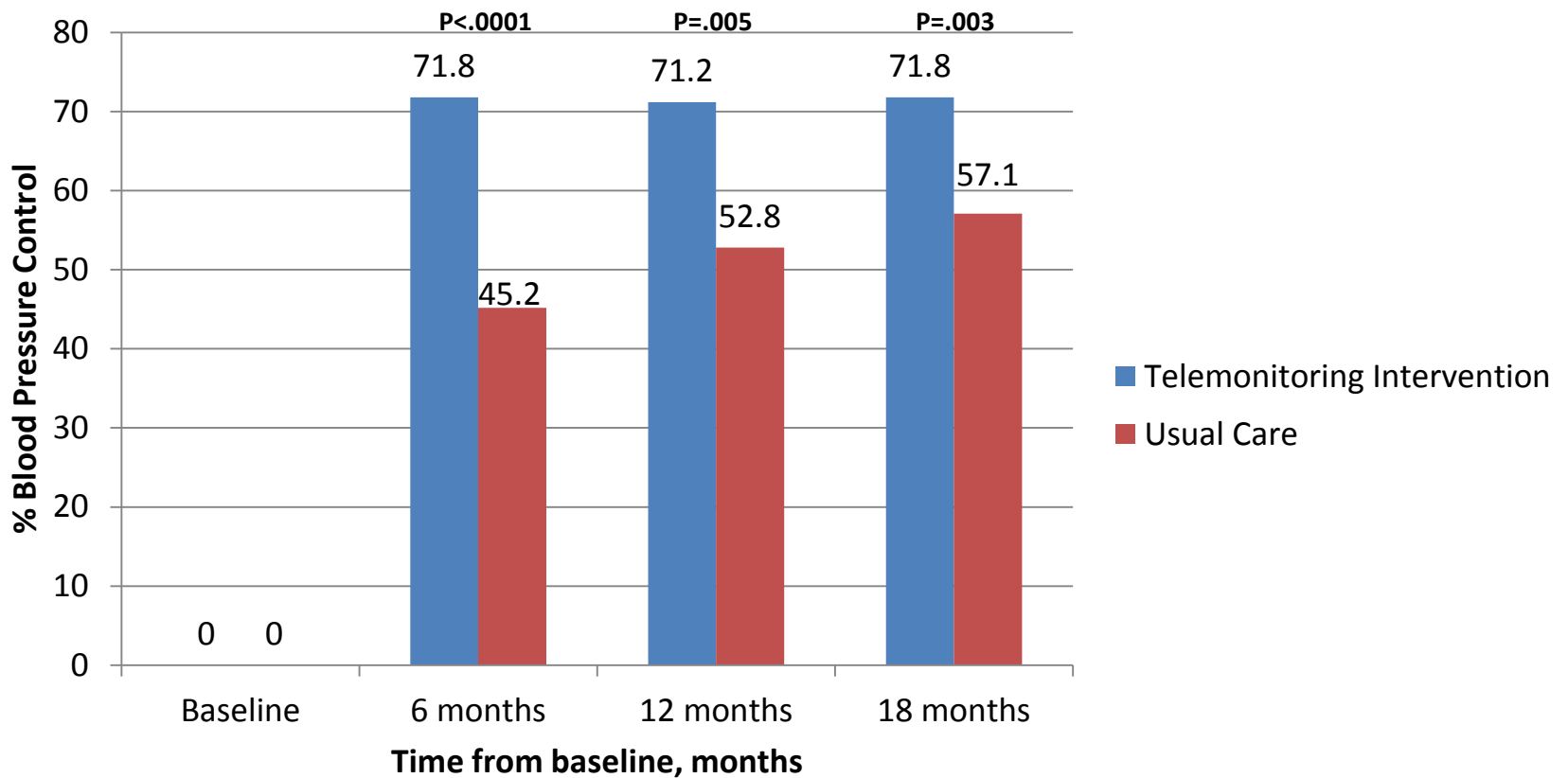
# ROI calculation

- ROI = net return / intervention costs
  - Net return = net costs \* -1
  - Net Cost = intervention costs – (UC event costs – TI event costs)

# Participant Baseline Characteristics

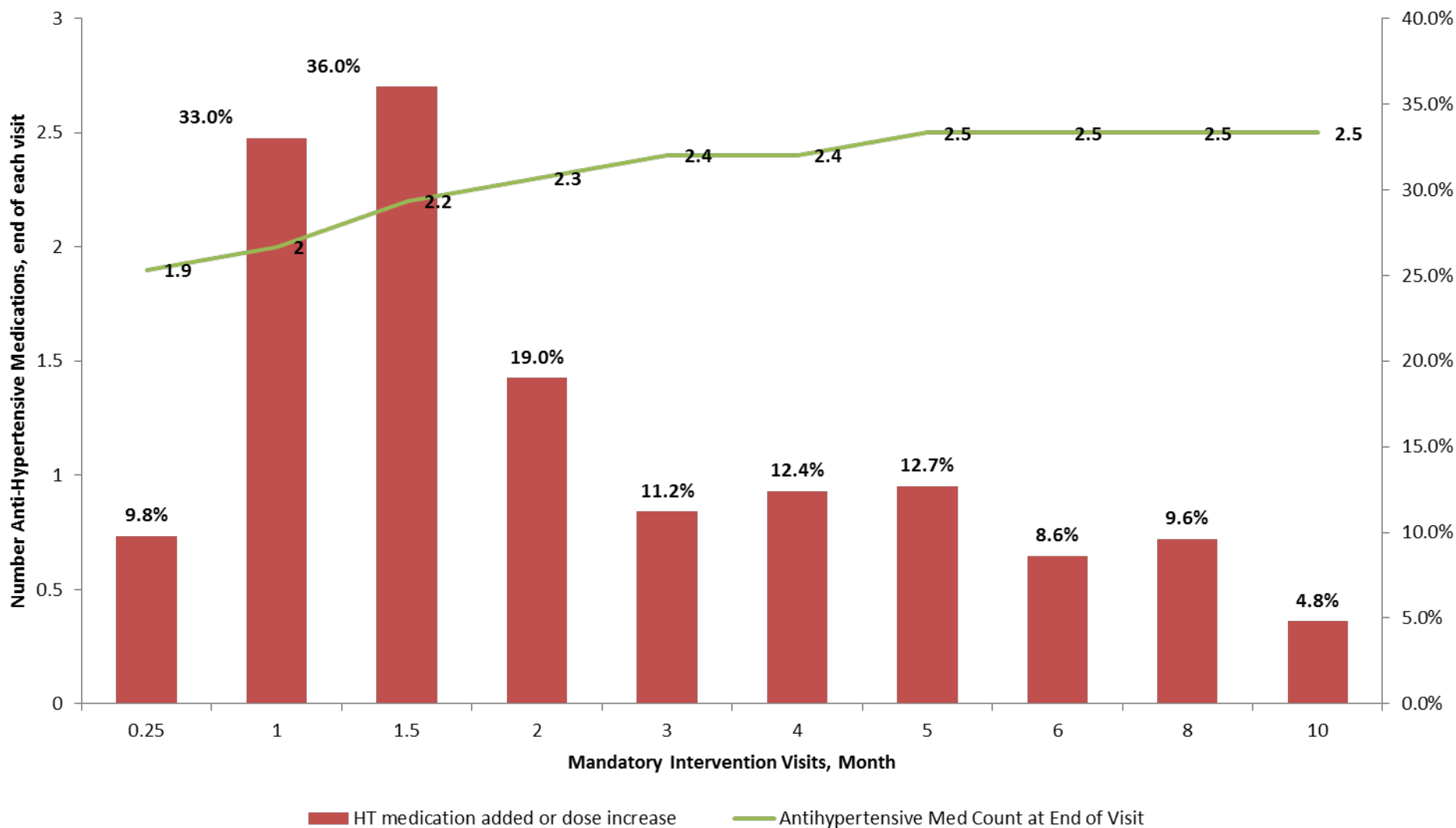
- Mean age 61 y.
- Mean BP 148/85 mm Hg
- Mean number of antihypertensive drugs 1.5
- 45% female
- 82% non-Hispanic white
- 32% with cardiovascular disease or diabetes

## % Blood Pressure Control Over Time



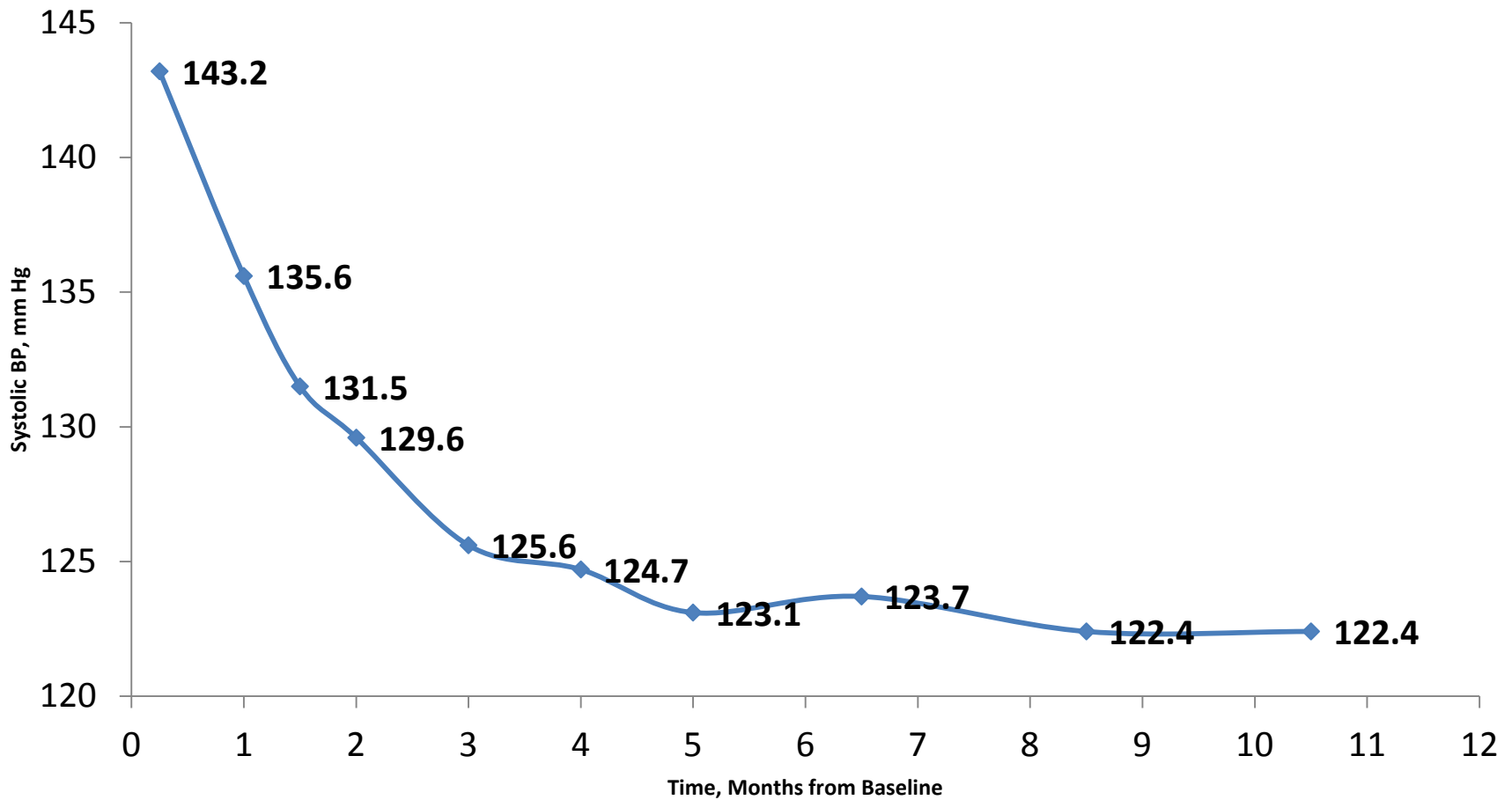
# Pharmacist Medication Adjustment

## Anti-Hypertensive Therapy Adjustment by Pharmacists, by visit

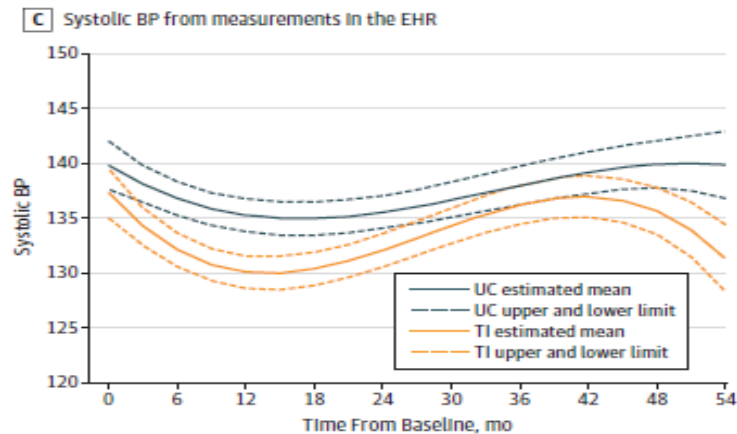
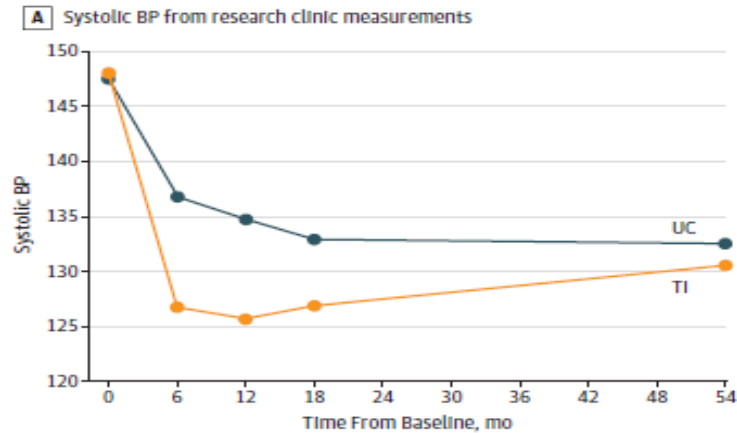


# Mean Home Systolic Blood Pressure

SBP mean



# Long-term BP Differences



# Cardiovascular Events Over 5 Years

	Intervention (n=228)		Usual Care (n=222)	
	Events	Patients (%)	Events	Patients (%)
MI	5		11	
Stroke	4		12	
Heart failure	5		3	
CV Death	1		0	
<b>Total</b>	<b>15</b>	<b>10 (4.4%)</b>	<b>26</b>	<b>19 (8.6%)</b>
Revascularization	2		10	
<b>Total</b>	<b>17</b>	<b>12 (5.3%)</b>	<b>36</b>	<b>23 (10.4%)</b>

Incidence of 1° composite outcome: OR= 0.49 (95% CI, 0.21-1.13),  $p=0.09$

Incidence of 2° composite outcome: OR= 0.48 (95% CI, 0.22-1.08),  $p=0.08$

Similar results for time-to-event analyses ( $p=0.06-0.09$ )



# Estimated CV Event Costs (5 Years)

	Intervention (n=228)		Control (n=222)	
	Events	Estimated \$	Events	Estimated \$
<b>MI</b>	5	\$273,000	11	\$593,000
<b>Stroke</b>	4	\$174,000	12	\$506,000
<b>Heart failure</b>	5*	\$249,000	3	\$253,000
<b>Revascularization</b>	2	\$62,000	10*	\$187,000
<b>Total</b>	15	\$758,000	36	\$1,538,000
		<b>Difference</b>	<b>-\$780,000</b>	

\*HF events in later years have lower follow-up costs, post-MI revascularization included in MI costs.

# ROI and Net Savings over 5 years

- ROI
  - **126%** (for every dollar spent, that dollar was recouped plus \$1.26)
  - If intervention costs were reduced by 1/3 through new technology and increased scale, the ROI would rise to **239%**
- Net savings (in 2017 \$US)
  - **\$1,908 / patient**
  - Based on \$1,511 in intervention costs offset by \$3,420 in reduced event costs, per patient
  - If intervention costs were reduced by 1/3 through new technology and increased scale, net savings would rise to **\$2,412 / patient**

# Modeled outcomes: Methods

- Long-term outcomes were predicted using the HealthPartners Institute ModelHealth™: CVD microsimulation model
- Hyperlink study population characteristics at 54 months were entered into the model and then subsequent events and costs up to 30 years post-index were simulated 1,000 times and averaged
- Assumed only legacy effects of intervention

At 54 months	Intervention (n=220)	Control (n=214)
Age, years <sup>a</sup>	64.4	64.4
Sex, n (%)	99 (45.0%)	97 (45.3%)
Systolic BP, mm Hg <sup>b</sup>	132.1	133.6
BMI, kg/m <sup>2</sup>	31.3	31.7
Current smoker, %	13 (5.9%)	18 (8.4%)
Prior MI, n (%)	11 (5.0%)	19 (8.8%)
Prior stroke, n (%)	8 (3.6%)	11 (5.1%)

<sup>a</sup> Age-adjusted for comparable risk; <sup>b</sup> From study visit or EMR

# Modeled outcomes: Results

	Difference <sup>a</sup> (Intervention – Control)		
	10 years	20 years	30 years
<b>CV events</b>	-24.8	-28.8	-29.8
<b>CV deaths</b>	-0.7	-2.9	-3.4
<b>Life years</b>	+8	+49	+82
<b>Quality-adjusted life years</b>	+25	+69	+104
<b>CV costs</b>	-\$1,216,000	-\$1,615,000	-\$1,704,000
<b>Net costs per person</b>	-\$3,822	-\$5,572	-\$5,963

<sup>a</sup> Control group model results scaled to n=220 to match intervention group

# Conclusions

- The intervention lowered BP and may have reduced CV events by 50% over 5 years even in this small study
- If the reduction in CV events is not due to chance, the telemonitoring intervention is cost-saving over 5 years
- Microsimulation modeling predicts enduring benefits in CV events, CV mortality, QALYs, and costs for over 30 years
- Similar interventions should be more widely adopted in clinical practice with costs shared by payors

# Questions?

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# Potential Intervention Adaptations

- BP monitor sends data by Bluetooth to SmartPhone
- BP data goes to EHR flowsheet
  - Can be used to meet HEDIS “Controlling High BP” numerator
- Intensive telemonitoring intervention may only be needed for 3-4 months in many patients
- Intervention could be tailored to individual needs
- Patients with recurrence of uncontrolled BP could receive “booster” intervention
- Other primary care team members can fill or support MTM pharmacist role (NP, RN, health coach, MD, etc.)
  - New CMS CPT codes for remote monitoring: 99453, 99454, 99457

# Hyperlink 3 Study Design

