Original Article

Cost–Benefit Analysis of Home Blood Pressure Monitoring in Hypertension Diagnosis and Treatment

An Insurer Perspective

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Abstract**—**Home blood pressure (BP) monitoring has been shown to be more effective than clinic BP monitoring for diagnosing and treating hypertension. However, reimbursement of home BP monitoring is uncommon in the United States because of a lack of evidence that it is cost beneficial for insurers. We develop a decision-analytic model, which we use to conduct a cost–benefit analysis from the perspective of the insurer. Model inputs are derived from the 2008 to 2011 claims data of a private health insurer in the United States, from 2009 to 2010 National Health and the Nutrition Examination Survey data, and from published meta-analyses. The model simulates the transitions among health states from initial physician visit to hypertension diagnosis, to treatment, to hypertension-related cardiovascular diseases, and patient death or resignation from the plan. We use the model to estimate cost–benefit ratios and both short- and long-run return on investment for home BP monitoring compared with clinic BP monitoring. Our results suggest that reimbursement of home BP monitoring is cost beneficial from an insurer's perspective for diagnosing and treating hypertension. Depending on the insurance plan and age group categories considered, estimated net savings associated with the use of home BP monitoring range from $33 to $166 per member in the first year and from $415 to $1364 in the long run (10 years). Return on investment ranges from $0.85 to $3.75 per dollar invested in the first year and from $7.50 to $19.34 per dollar invested in the long run. **(*Hypertension*. 2014;63:00-00.)** • **Online Data Supplement**

Key Words: blood pressure monitoring, ambulatory ■ hypertension ■ masked hypertension ■ reimbursement ■ white coat hypertension

Hypertension is a prevalent risk factor for cardiovascular diseases (CVDs) and a primary cause of healthcare expenditures.[1–3] Accurate blood pressure (BP) measurement is a key factor in hypertension diagnosis and treatment and in preventing CVDs.[4,5] Clinic BP monitoring (CBPM), the intermittent measurement of BP during visits to a doctor, is the most common method used to diagnose hypertension but is subject to false diagnoses because of the phenomena of white coat hypertension and masked hypertension.[1,6,7]

Twenty-four–hour fully automated ambulatory BP monitoring (ABPM) is considered the noninvasive gold standard for BP measurement and has been recommended as the standard method for hypertension diagnosis in the United Kingdom.[8] However, in the United States, ABPM is considered impractical for routine diagnosis, is used infrequently, and is typically reimbursed only when used to diagnose suspected white coat hypertension.[9] The difference in ABPM adoption between the United States and United Kingdom is partly because of differences in healthcare provision and reimbursement in the 2 countries. ABPM is cost-effective from a societal perspective,[8,10] and its routine use makes economic sense within the context of the United Kingdom's national healthcare system. By contrast, in the private, pluralistic healthcare market in the United States, where beneficiaries can move among different insurance plans, a plan that pays for ABPM must be concerned that it will bear the cost of the technology this year, whereas the benefits, which may not be realized for many years, may be passed to its competitors. Therefore, despite >3 decades of published research documenting its effectiveness, because ABPM requires additional labor and capital equipment expenditures on the part of the provider and because these added costs are largely under-reimbursed or not reimbursed at all, ABPM has not been embraced in the United States as a tool for routine BP screening and management.[9]

An alternative method, self-monitoring of BP by the patient at home, approaches the accuracy of ABPM in hypertension diagnosis, is more effective than conventional CBPM in diagnosing and managing hypertension[6,7,11,12] and is prognostically superior to CBPM in predicting end-organ damage[13] and adverse cardiovascular events.[14,15] Moreover, home BP monitoring (HBPM) is easier to implement than ABPM and requires less labor and capital investment. The American Heart

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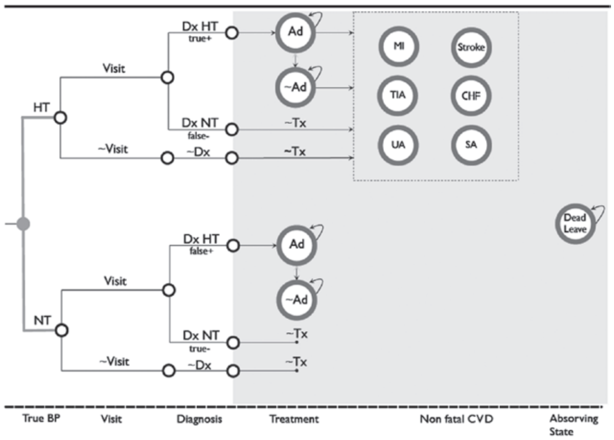

Figure. Decision analysis model for hypertension diagnosis and treatment. ~Ad indicates treatment nonadherence; Ad, treatment adherence; CHF, congestive heart failure; dead leave, dead or exit insurance plan; ~Dx, no diagnosis; Dx HT, diagnosed as hypertensive; Dx NT, diagnosed as normotensive; false+, false-positive diagnosis; false−, false-negative diagnosis; HT, hypertensive; MI, myocardial infarction; nonfatal CVD, nonfatal cardiovascular disease; NT, normotensive; SA, stable angina; true+, true positive diagnosis; true−, true negative diagnosis; ~Tx, nontreatment; TIA, transient ischemic attack; true BP, true blood pressure; UA, unstable angina; visit, physician visit; and ~visit, no physician visit.

Association, the American Society of Hypertension, and the Preventive Cardiovascular Nurses Association have called for the routine use of HBPM as an adjunct to traditional CBPM.[7] Nevertheless, most insurers do not reimburse for HBPM under the belief that it is not cost beneficial from an insurer's perspective. Lack of reimbursement in turn discourages HBPM's use. We calculated from the National Health and the Nutrition Examination Survey 2009 to 2010 that only 24% of patients with hypertension aged 20 years and over had been told by their physicians to monitor their BP at home, whereas a recent survey found that 14% of patients with hypertension do not own a home BP monitor because of its costs.[7]

Economic evaluations of HBPM have largely ignored the perspective of the private payer, and they have not disaggregated the costs and benefits of HBPM because they apply separately to diagnosis and to treatment. Lovibond et al[16] adopted a societal perspective in their comparative economic evaluation of ABPM, HBPM, and CBPM in the United Kingdom. They found that ABPM is the most cost-effective method for hypertension diagnosis and that HBPM is either indistinguishable from or, in certain scenarios among the youngest population, superior to CBPM. However, they studied HBPM only as a tool for diagnosing hypertension and did not consider its benefits in the treatment of hypertension during patient follow-up. Two other economic evaluations of HBPM in hypertension treatment[17,18] found small to no differences in the cost-effectiveness of HBPM and CBPM. Because these studies were based on randomized controlled trials, inferences about long-term savings produced by HBPM were not assessed.

In this study, we used a decision-analytic model to perform short- and long-run cost–benefit and return on investment (ROI) analyses comparing CBPM and HBPM for use in the diagnosis and treatment of hypertension from the perspective of a large private US health insurer.

Methods

Study Population

The study population consisted of members of 2 health insurance plans (a private employee plan and a Medicare Advantage plan), during the period 2008 and 2011. By the end of 2011, there were 25 478 total members in the employee plan and 8253 in the Medicare Advantage plan, with male-to-female ratios of 0.531:1 and 0.592:1, respectively. Hypertension prevalence was 6.3% among employee plan members aged 20 to 44 years, 33.5% among employee plan members aged 45 to 64 years, and 60.2% among Medicare Advantage plan members aged ≥65 years. Both insurance plans were operated by the same for-profit health maintenance organization operating in the Midwest.

Decision-Analytic Model

A decision-analytic model that combines a decision tree and a Markov model (Figure) was developed to produce cost–benefit and ROI estimates for employee plan members aged 20 to 44 and 45 to 64 years and for Medicare Advantage plan members aged ≥65 years. The model simulates a cohort of individuals as they transition stochastically among various states, from initial physician visit, to hypertension diagnosis and treatment, to the development of hypertension-related CVD states, to death or resignation from the insurance plan. Nonhypertension-related diseases are not included in the model because they are not affected by the use of HBPM. The model accounts for attrition of members from the insurance plan. It also includes treatment adherence rates, although no differences between HBPM and CBPM were assumed based on mixed evidence from the literature.[19] Transitions among states were estimated for 3-month intervals, corresponding to the typical diagnostic interval between patient visits.[20] The model estimates the dollar costs and benefits of HBPM and CBPM in both diagnosing and treating hypertension for the equivalent of 1, 3, 5, and 10 years. HBPM savings were assumed to come from both improved accuracy in diagnosing hypertension and improved treatment (better BP control) among those already diagnosed.

Data Sources and Parameters

Our primary data source was the insurer's claims from 2008 to 2011, based on the claims histories of 16 375 members with a diagnosis of essential hypertension (*International Classification of Diseases, Ninth Revision* codes 401.0, 401.1, and 401.9). The data provided were deidentified, and review was exempted from the Indiana University Institutional Review Board. Claims data were used to estimate the transition probabilities and costs of CVD events, as well as the costs of hypertension treatment for adherent and nonadherent patients. The cost of CVD episodes was estimated using all 1-year costs after the CVD event.[21] Because CBPM is the standard of care in our data, baseline transition probabilities correspond to treatment under CBPM. To obtain transition probabilities for treatment under HBPM, we adjusted baseline transition probabilities using expected HBPM-associated CVD incidence rate reductions compared with CBPM. These were calculated as the effect of HBPM on BP multiplied by the effect of BP on CVD relative risk. HBPM's effect on BP reduction was obtained from the meta-analysis of Agarwal et al.[6] The effect of BP reduction on CVD relative risk was obtained from the meta-analysis of Prospective Studies Collaboration.[22]

National Health and the Nutrition Examination Survey 2009 to 2010 survey data were used to calculate hypertension prevalence among different age groups and physician visit rates for both hypertensive and normotensive patients. Sensitivity and specificity of CBPM and HBPM were obtained from Lovibond et al.[16] Average quarterly insurance premiums for year 2012 were provided by the insurance company. All model inputs are listed in Table 1. Estimated transition probabilities are reported in the online-only Data Supplement.

HBPM Cost and Benefit Estimates

Because our analysis adopted the payer perspective, we considered only the reimbursement costs of HBPM devices plus the costs of an awareness-raising campaign to educate members about the availability of reimbursement. HBPM equipment costs were based on the retail prices (as of June 20th, 2013) of HBPM devices available through large chain drug retailers and then discounted for wholesale purchase based on information obtained from Omron (Omron Corporation, Kyoto, Japan). Following American Heart Association recommendations, we selected upper arm monitors.[7] We assumed an equipment lifetime of 5 years. Costs of the awareness-raising campaign included those associated with the transmittal of basic HBPM information and documentation to all plan members and their primary care providers. We did not include potential costs of HBPM device validation or patient training because we assume these costs are not reimbursed by the insurer.

Costs and benefits were transformed to net present values based on a 3% discount rate. Thus, all cost and benefit calculations are expressed as the value of current dollars, taking into account the diminishing value of dollars spent or saved in the future.

The expected return on money invested is an important factor for private insurers faced with reimbursement decisions. We derived ROIs, calculated as the ratio of net savings (savings minus cost) to costs, to evaluate fully the business case for HBPM reimbursement from the private market perspective.

Sensitivity Analyses

Sensitivity analyses were performed to assess the magnitude of the financial risk to be expected when HBPM is reimbursed under different scenarios. We used the bootstrap method to estimate the probability that costs would exceed net savings because of uncertainty in the effectiveness of HBPM in hypertension diagnosis and treatment. A low probability implies a low financial risk to the insurer who invests in HBPM reimbursement.

Results

Cost–Benefit Analysis

Tables 2 presents the net savings (savings minus costs) and ROIs (savings minus costs divided by costs) associated with the implementation of HBPM reimbursement. Separate tables for savings and costs are reported in the online-only Data Supplement (Tables S2 and S3 in the online-only Data Supplement, respectively). An ROI=1.00 means that $1.00 is returned for each dollar invested (a 100% return); ROI=0 means zero dollars are returned per dollar invested (a break-even investment); a negative ROI means the investment costs exceed the dollars returned (an investment loss). For the employee health plan, reimbursement of HBPM generated net savings in the first year of $33.75 per member aged 20 to 44 years (ROI=0.94) and $32.65 per member aged 45 to 64 years (ROI=0.85). These net savings remained positive through year 10, increasing to $414.81 per member aged 20 to 44 years (ROI=8.37) and $439.14 per member aged 45 to 64 years (ROI=7.50). For members of the Medicare Advantage plan aged ≥65 years, first-year net savings were $166.17 per member (ROI=3.75) and increased to $1364.27 per member (ROI=19.34) by year 10.

Table 3 decomposes short- and long-run ROIs into those associated with the use of HBPM for diagnosis only and for treatment only. The returns from an investment in HBPM vary depending on how HBPM is used and the specific age group to which it is applied. When HBPM is used only to diagnose hypertension, the ROIs show a steady increase from year 1 to year 10 and are positive for all age and insurance categories except for Medicare Advantage plan members in the first year. By contrast, when HBPM is used to monitor treatment, the ROIs are all negative for younger Employee Plan members aged 20 to 44 years (ROI=−0.87 in year 1 to ROI=−0.33 in year 10), partially negative for older Employee Plan members aged 45 to 64 years (ROI=−0.02 in year 1 to ROI=2.95 in year 10), and all positive for Medicare Advantage plan members aged ≥65 years (ROI=4.37 in year 1–18.54 in year 10). These results indicate that HBPM is generally more cost beneficial when it is used to diagnose hypertension in younger individuals and to monitor hypertension treatment in older individuals.

Sensitivity Analyses

Sensitivity analyses estimating the degree of uncertainty associated with the reimbursement of HBPM revealed a strong age-related effect. Diagnosis-related uses of HBPM were found to be insensitive to uncertainty (investment risk was low) in younger aged individuals (<65 years), whereas treatment-related uses were insensitive (investment risk was low) in older individuals (≥65 years). Complete sensitivity results are shown in the online-only Data Supplement (Table S4).

Discussion

Our findings indicate that reimbursement of HBPM by an insurance company would be expected to generate overall net savings and positive ROIs for the company in the first year and that these savings and ROIs will tend to grow larger with time. When the findings were decomposed to show the net benefits separately for diagnosis-specific and treatment-specific applications of HBPM, a strong age-related effect was revealed. For individuals aged ≥65 years, the net savings and ROIs were largest when HBPM was used to monitor hypertension treatment. For younger individuals aged <65 years, the reverse was true; net savings and ROIs were largest when HBPM was used to diagnose hypertension.

The diagnosis-related savings observed in younger individuals can be explained by noting that HBPM has better diagnostic specificity than CBPM,[16] which translates into lower costs because of fewer false-positive diagnoses and fewer people entering unnecessary lifelong treatment. This has the largest impact in younger age groups where hypertension prevalence is low. In high-prevalence populations (those aged ≥65 years), the impact of HBPM's better specificity is diluted because if most members are hypertensive, there will be more positive diagnoses that are correct in absolute terms regardless of the diagnostic method used.

Treatment-related savings were observed in older employee plan members aged 45 to 64 years and in Medicare Advantage plan members aged ≥65 years. Because the savings from improved BP control are produced by avoiding future adverse cardiovascular events, members must stay in the plan for a sufficiently long period of time to allow these events to occur. Given the relatively rapid turnover rate in most private insurance plans (in the current case ≈10 of every 100 members leave the plan each year), there is insufficient time to capture fully all the savings associated with the prevention of future adverse events in the relatively healthier younger plan members who have lower baseline CVD risks. Older plan members by contrast have higher baseline CVD risks and the average time-to-event interval is shorter. Therefore, for these individuals, even small risk reductions are able to translate into positive short-run benefits.

We adopted a payer perspective rather than a societal perspective in estimating the economic benefit of reimbursing patients for the cost of HBPM devices. Although the adoption of a more global societal perspective is meaningful in countries that have national healthcare systems where a societal benefit is synonymous with a benefit to the payer, such findings hold less sway

Table 1. Model Inputs and Sources

Parameter	Mean	95% CI		Source
Cohort settings				
Hypertension prevalence				
20–44	8.91%	7.77%	10.05%	NHANES 2009–2010
45–64	39.53%	34.84%	44.22%	NHANES 2009–2010
≥65	71.27%	67.43%	75.11%	NHANES 2009–2010
Visits (any visit)				
If HT (vH)				
20–44	86.62%	83.11%	90.13%	NHANES 2009–2010
45–64	92.86%	90.20%	95.53%	NHANES 2009–2010
65+	97.68%	96.45%	98.91%	NHANES 2009–2010
If NT (vN)	81.71%	80.12%	83.30%	NHANES 2009–2010
20–44	77.83%	75.38%	80.29%	NHANES 2009–2010
45–64	79.54%	75.66%	83.42%	NHANES 2009–2010
65+	96.69%	94.95%	98.43%	NHANES 2009–2010
Diagnosis inputs				
Sensitivity				
CBPM	85.60%	81.00%	89.20%	Lovibond et al (2011)
HBPM	85.70%	78.00%	91.00%	Lovibond et al (2011)
Specificity				
CBPM	45.90%	33.00%	59.30%	Lovibond et al (2011)
HBPM	62.40%	48.00%	75.00%	Lovibond et al (2011)
Outcome inputs				
HBPM caused change in BP reduction				
SBP, mm Hg	−2.63	−4.24	−1.02	Agarwal et al (2011)
DBP, mm Hg	−1.68	−2.58	−0.79	Agarwal et al (2011)
Quarterly premium (in US dollars)	2109.44	1830.64	2388.24	Insurance plans 2012
Cost inputs (in US dollars)				
State				
Adh (true +)	1420.91	52.22	20 281.41	Insurer's claims
~Adh (true +)	1722.93	38.01	38 936.38	Insurer's claims
MI	15 490.79	5014.04	28 560.32	Insurer's claims
UA	14 802.91	6464.09	25 586.42	Insurer's claims
SA	7252.28	602.58	16 027.12	Insurer's claims
TIA	6850.59	19.51	16 177.79	Insurer's claims
STRO	10 959.22	1342.16	22 285.24	Insurer's claims
CHF	13 105.51	7003.37	20 353.91	Insurer's claims
Adh (false +)	173.22	153.68	192.77	Insurer's claims
~Adh (false +)	173.01	164.84	181.34	Insurer's claims
Nonhyper Tx	4526.62	2074.60	6678.64	Insurer's claims

~Adh (false +) indicates treatment nonadherence among people with false-positive diagnosis; Adh (false +), treatment adherence among people with false-positive diagnosis; ~Adh (true +), treatment nonadherence among people with true positive diagnosis; Adh (true +), treatment adherence among people with true positive diagnosis; CBPM, clinic blood pressure monitoring; CHF, congestive heart failure; CI, confidence interval; DBP, diastolic blood pressure; Dx HT, diagnosed as hypertensive; Dx NT, diagnosed as normotensive; HBPM, home blood pressure monitoring; HT, hypertensive; If HT (vH), physician visit prevalence among hypertensive people; If NT (vN), physician visit prevalence among normotensive people; MI, myocardial infarction; NHANES, National Health and the Nutrition Examination Survey; nonhyper Tx, nonhypertension treatment; NT, normotensive; SA, stable angina; SBP, systolic blood pressure; STRO, stroke; TIA, transient ischemic attack; UA, unstable angina; and visits, physician visit.

Table 2. Cost–Benefit Analyses Results: ROIs by Health Plan Type and Age Group

Plan/Age Group	Investment Horizon Year 1	Year 3	Year 5	Year 10
Employee plan: 20–44 y				
Net savings (dollars)	\$33.75	\$155.11	\$245.36	\$414.81
ROI	0.94	4.34	5.52	8.37
Employee plan: 45–64 y				
Net savings (dollars)	\$32.65	\$161.79	\$255.32	\$439.14
ROI	0.85	4.20	4.98	7.50
Medicare: ≥65 y				
Net savings (dollars)	\$166.17	\$557.00	\$846.86	\$1364.27
ROI	3.75	12.59	13.83	19.34

ROIs are expressed as the ratios of net savings to costs. indicates return on investment.

in the private, multipayer, insurance market of the United States, where competition among plans and short-run ROI are primary forces driving reimbursement decisions. In a private insurance market, the decision to reimburse patients for the cost of HBPM has to make business sense to the plan. Within that context, evidence showing that such a decision is likely to generate a positive return for the plan is likely to be more persuasive. As has been argued by others, healthcare in the United States will be improved more readily by building a business case for quality that rewards payers for producing future patient benefit.[23]

This is the first study to show that an investment in HBPM yields a specific net benefit and positive ROI for the private insurer. Thus, the results reported here should have direct relevance to the reimbursement decision making of private insurance companies in the United States.

Our study has limitations: First, we accounted only for the most common hypertension-related CVDs in our simulation model. Other diseases that are correlated with BP but not included in the study, such as kidney disease[24] and depression,[25] can also generate substantial medical costs. Thus, our model generates conservative estimates of the likely savings associated with the use of HBPM. Second, our study did not consider treatment side effects[26,27] that can occur when normotensive individuals are treated for hypertension after a false-positive diagnosis. The cost of treatment side effects associated with CBPM would be expected to produce a more favorable cost–benefit ratio for HBPM relative to CBPM.[16] Third, because our study adopted an insurer's perspective, we did not include provider-related costs such as the time required for HBPM-related device validation, self-monitoring costs related to patient training, and patient–provider communication. Inclusion of these costs would increase HBPM reimbursement costs but would also increase the effectiveness of HBPM and generate additional net savings. Further research is needed to better understand how the relative value unit should be modified to compensate fully providers for patient encounters involving HBPM and what mechanisms need to be implemented to avoid under-, mis-, or overutilization of HBPM. Finally, our decision-analytic model has been populated with parameters from meta-analysis results, mostly based on randomized controlled trials. Incorporating evidence from pragmatic randomized controlled trials or observational studies would be relevant in the case of HBPM implementation, where individual's adoption may influence effectiveness. Unfortunately, the current literature is limited and does not offer enough evidence from such real-life settings.

Our study provides strong evidence supporting value-based reimbursement by demonstrating that reimbursing HBPM and promoting its use among health plan members would improve healthcare quality while simultaneously reducing both short- and long-run healthcare costs from a private insurer's perspective.

Table 3. Cost–Benefit Analyses Results: ROIs by Diagnosis and Treatment

Plan/Age Group	Investment Horizon Year 1	Year 3	Year 5	Year 10
Only diagnosis				
Employee plan: 20–44 y	0.87	4.09	6.70	11.26
Employee plan: 45–64 y	0.18	2.23	3.90	6.84
Medicare: ≥65 y	−0.36	0.81	1.82	3.75
Only treatment				
Employee plan: 20–44 y	−0.87	−0.55	−0.54	−0.33
Employee plan: 45–64 y	−0.02	1.90	1.87	2.95
Medicare: ≥65 y	4.37	14.35	13.96	18.54

ROIs are expressed as the ratios of net savings to costs. ROI indicates return on investment.

Perspectives

This economic evaluation shows for the first time that paying for home BP monitoring is cost beneficial for insurers operating in a private market. Our study provides strong evidence supporting value-based reimbursement by demonstrating that reimbursing home BP monitoring and promoting its use among health plan members would improve healthcare quality, while simultaneously reducing both short- and long-run healthcare costs from a private insurer's perspective.

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Disclosures

None.

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Novelty and Significance

What Is New?

- This is the first study to show that home blood pressure monitoring is cost beneficial from the perspective of the private insurer.
- We show that the nature of the economic benefit to the insurer varies as a function of patient age. Diagnosis-related uses of home blood pressure monitoring are most cost beneficial in younger aged individuals (<65 years), whereas treatment-related uses are most cost beneficial in older individuals (≥65 years).

What Is Relevant?

- Previous economic evaluations of home blood pressure monitoring have largely ignored the perspective of the private payer in favor of a societal perspective, which is relevant in countries such as the United Kingdom that have national single-payer insurance systems but less relevant to private insurance markets in countries such as the United States.
- By highlighting the savings that potentially could be realized by private insurers, our simulation helps support a business case for quality with respect to reimbursement decisions for home blood pressure monitoring.

Summary

We analyzed claims data from a large insurer in the United States using a decision-analytic simulation model. Our findings indicate that insurers that reimburse their enrolled members for the cost of home blood pressure monitoring devices can expect to see both a short- and long-run return on their investment. Positive returns were associated with both diagnostic- and treatment-related applications of home blood pressure monitoring and were found to vary by patient age. Future research should seek to confirm our simulated findings in prospective trials designed to evaluate the costs and benefits of home blood pressure monitoring across different age groups.

ONLINE SUPPLEMENT

Cost-Benefit Analysis of Home Blood Pressure Monitoring in Hypertension Diagnosis and Treatment: An Insurer Perspective

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Table S1 reports estimated transition probabilities between each of the model states. For example, consider the entries in the first row. The first entry (upper left corner) is 89.95. This means that an individual that is in a state of treatment non-adherence in one period has an 89.95% chance of remaining non-adherent in the next period. Moving across the first row, a non-adherent individual has a 6.42% chance of becoming adherent, a 0.11% chance of having a myocardial infarction, and a 0.25% chance of having unstable angina in the next period. Comparing the first row with the second, it can be seen that a non-adherent individual's chance of having a myocardial infarction in the next period is 0.11%, while an adherent individual's chance is only 0.03%. Model states are mutually exclusive (an individual can only be in one state at any given time), therefore, across any given row, the states sum to a probability of 100%.

Table S2 reports the incremental costs to insurers of reimbursing HBPM, and includes only the costs of HBPM devices and the costs of an awareness-raising campaign. When used only for diagnosis, devices are provided to all screened members once in the first year, which explains the unchanged cost from year 1 to year 10. When used only for treatment, devices are replaced every 5 years, during all periods in which the recipients remain in the plan or are alive.

Table S3 reports the incremental savings to insurers of reimbursing HBPM. Savings are associated with improved accuracy in diagnosing hypertension and improved treatment (better BP control). Savings are estimated from the decision analytic model. See the methods section in the manuscript for further details about savings estimation.

Table S4 shows the results of sensitivity analyses. Higher percentages indicate a greater chance that a positive return will not be realized (i.e., higher investment risk). A strong age-related effect is evident in Table S4. Focusing first on the upper half of the table, it may be seen that the expected returns are relatively insensitive to uncertainty (investment risk is low) when

HBPM is used to diagnose hypertension in younger individuals, and becomes increasingly more sensitive to uncertainty (investment risk becomes higher) as the population to which HBPM is applied becomes older. By contrast, when HBPM is used to monitor hypertension treatment (lower half of Table S4), the age effect is reversed. Uncertainty is at a maximum (investment risk is highest) when HBPM is used to monitor treatment in younger individuals aged 20-44, and is at a minimum (investment risk is lowest) when HBPM is used to monitor treatment in older individuals aged 65 and over.

S1. Transition Matrix: Calculated from the Private Insurer Claims Data

State	~Adh	Adh	MI	UA	SA	TIA	STR	CHF	Leave	Total
Employee Plan										
~Adh	89.95	6.42	0.11	0.25	0.19	0.11	0.11	0.35	2.51	100
Adh	27.02	70.69	0.03	0.12	0.08	0.04	0.05	0.08	1.9	100
MI	65.93	14.28	6.18	2.06	3.09	0	0	5.22	3.24	100
UA	73.15	10.78	2.65	5.29	2.65	0.47	0.47	2.23	2.31	100
SA	73.26	10.71	0	4.24	7.94	0	1.14	1.61	1.11	100
TIA	68.94	11.99	0	0	0.95	13.22	0	1.92	2.98	100
STR	61.92	15.21	0	2.06	0	0	14.37	1.04	5.4	100
CHF	52.61	4.16	0.45	0.68	1.13	0.24	0.48	36.24	4.01	100
Leave	0	0	0	0	0	0	0	0	100	100
Medicare Advantage Plan										
~Adh	81.61	10.51	0.37	0.34	0.47	0.38	0.56	2.64	3.12	100
Adh	19.41	77.43	0.1	0.14	0.18	0.22	0.27	1.09	1.16	100
MI	58.21	13.82	5.54	1.38	2.08	1.46	0	5.85	11.66	100
UA	68.17	11.73	2.79	3.49	2.79	0.74	0.74	7.36	2.2	100
SA	63.19	21.6	1.54	1.03	6.67	1.09	0	3.8	1.08	100
TIA	63.82	14.53	0.6	0	0.6	9.59	2.56	4.47	3.82	100
STR	52.43	14.23	0.39	0	0	2.47	17.73	4.94	7.8	100
CHF	43.65	8.05	0.71	0.5	0.28	0.53	0.83	36.79	8.67	100
Leave	0	0	0	0	0	0	0	0	100	100

~Adh: non-adherence to treatment; Adh: adherence to treatment; MI: Myocardial Infarction; UA: Unstable Angina; SA: Stable Angina; TIA: Transient Ischemic Attack; STRO: stroke; CHF: Congestive Heart Failure; Leave: death or leave plan.

S2. HBPM Costs per Member, by insurance plan and age group

	Investment horizon			
Plan/Age group	**Year 1**	**Year 3**	**Year 5**	**Year 10**
Employee plan: 20-44 y.o.				
Diagnosis and Treatment	$35.72	$35.72	$44.48	$49.55
Only Diagnosis	$35.72	$35.72	$35.72	$35.72
Only Treatment	$20.43	$20.43	$32.33	$39.27
Employee plan: 45-64 y.o.				
Diagnosis and Treatment	$38.54	$38.54	$51.28	$58.53
Only Diagnosis	$38.54	$38.54	$38.54	$38.54
Only Treatment	$26.10	$26.10	$41.00	$49.52
Medicare: ≥ 65 y.o.				
Diagnosis and Treatment	$44.26	$44.26	$61.22	$70.53
Only Diagnosis	$44.26	$44.26	$44.26	$44.26
Only Treatment	$33.91	$33.91	$52.29	$62.59

All costs are in present values, discounted at 3% rate.

S3. HBPM Savings per Member, by insurance plan and age group

	Investment horizon			
Plan/Age group	**Year 1**	**Year 3**	**Year 5**	**Year 10**
Employee plan: 20-44 y.o.				
Diagnosis and Treatment	$69.47	$190.83	$289.83	$464.37
Only Diagnosis	$66.80	$181.72	$274.96	$438.07
Only Treatment	$2.67	$9.10	$14.86	$26.27
Employee plan: 45-64 y.o.				
Diagnosis and Treatment	$71.18	$200.33	$306.61	$497.67
Only Diagnosis	$45.59	$124.54	$188.87	$302.02
Only Treatment	$25.57	$75.70	$117.60	$195.43
Medicare: ≥ 65 y.o.				
Diagnosis and Treatment	$210.42	$601.26	$908.07	$1,434.80
Only Diagnosis	$28.20	$80.29	$124.92	$210.33
Only Treatment	$182.01	$520.37	$782.24	$1,223.05

All savings in present values, discounted at 3% rate.

S4. Sensitivity Analyses Results: Probability that Costs Exceed Savings (ROI < 0)

	Investment horizon			
Plan/Age group	**Year 1**	**Year 3**	**Year 5**	**Year 10**
Uncertainty in Diagnosis				
Employee plan: 20-44 y.o.	14.30%	3.40%	2.30%	1.80%
Employee plan: 45-64 y.o.	34.50%	6.70%	4.40%	3.10%
Medicare: ≥ 65 y.o.	63.60%	41.30%	38.10%	33.70%
Uncertainty in Treatment				
Employee plan: 20-44 y.o.	100.00%	100.00%	100.00%	100.00%
Employee plan: 45-64 y.o.	58.80%	0.00%	0.00%	0.00%
Medicare: ≥ 65 y.o.	0.00%	0.00%	0.00%	0.00%

Sensitivity analyses for uncertainty in diagnosis are conducted by allowing diagnosis to be random, and keeping treatment fixed; sensitivity analyses for uncertainly in treatment are conducted by allowing treatment to be random and keeping diagnosis fixed.

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