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Rates, Amounts, and Determinants of Ambulatory Blood Pressure Monitoring Claim Reimbursements Among Medicare Beneficiaries

Shia T. Kent^a, Daichi Shimbo^b, Lei Huang^a, Keith M. Diaz^b, Anthony J. Viera^c, Meredith Kilgore^d, Suzanne Oparil^e, and Paul Muntner^a

Shia T. Kent: shia@uab.edu; Daichi Shimbo: ds2231@cumc.columbia.edu; Lei Huang: leihuang@uab.edu; Keith M. Diaz: kd2442@cumc.columbia.edu; Anthony J. Viera: anthony_viera@med.unc.edu; Meredith Kilgore: mkilgore@uab.edu; Suzanne Oparil: soparil@uab.edu; Paul Muntner: pmuntner@uab.edu

^aDepartment of Epidemiology, University of Alabama at Birmingham, 1665 University Blvd RPHB 220, Birmingham, AL, 35924, USA

^bCenter for Behavioral Cardiovascular Health, Department of Medicine, Columbia University Medical Center, 622 West 168th Street, New York, NY, 10032, USA

^cDepartment of Family Medicine, University of North Carolina at Chapel Hill, 590 Manning Dr, Chapel Hill, NC, 27599, USA

^dDepartment of Health Care Organization and Policy, University of Alabama at Birmingham, 1665 University Blvd RPHB 330, Birmingham, AL, USA

^eDepartment of Medicine, Vascular Biology and Hypertension Program, University of Alabama at Birmingham, 1720 2nd Avenue South, ZRB 1034, Birmingham, AL, 35924 USA

Abstract

Ambulatory blood pressure monitoring (ABPM) can be used to identify white coat hypertension and guide hypertensive treatment. We determined the percentage of ABPM claims submitted between 2007–2010 that were reimbursed. Among 1,970 Medicare beneficiaries with submitted claims, ABPM was reimbursed for 93.8% of claims that had an ICD-9 diagnosis code of 796.2 (“elevated blood pressure reading without diagnosis of hypertension”) versus 28.5% of claims without this code. Among claims without an ICD-9 diagnosis code of 796.2 listed, those for the component (e.g., recording, scanning analysis, physician review, reporting) versus full ABPM procedures and performed by institutional versus non-institutional providers were each more than two times as likely to be successfully reimbursed. Of the claims reimbursed, the median payment was \$52.01 (25–75th percentiles: \$32.95–\$64.98). In conclusion, educating providers on the

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Corresponding Author: Shia Kent, University of Alabama at Birmingham, 1700 University Blvd LHL 446, Birmingham, AL 35294, shia@uab.edu; Phone: (205) 934-7164.

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ABPM claims reimbursement process and evaluation of Medicare reimbursement may increase the appropriate use of ABPM and improve patient care.

Keywords

White Coat Hypertension; Blood Pressure Monitoring; Ambulatory; Medicare; Insurance; Health; Reimbursement

INTRODUCTION

In the United States (US), the diagnosis and management of hypertension are primarily guided by blood pressure (BP) readings obtained in the clinic setting [1, 2]. However, many persons exhibit a white coat effect, defined as having BP that is higher in the clinic versus out-of-clinic setting, or white coat hypertension (WCH), defined as having hypertension based on clinic measurements despite having non-elevated BP outside of the clinic setting [3]. WCH is estimated to be present in 15% to 25% of individuals with elevated clinic BP [4]. It is generally accepted that the risk of cardiovascular disease in patients with WCH is low compared with those whose clinic and ambulatory BPs are both elevated (i.e., sustained hypertension) [4]. Ambulatory BP monitoring (ABPM) is considered the “gold standard” for identifying WCH, and has been found to be a cost-effective method to avoid overuse of antihypertensive medications [5, 6].

In 2001, the US Centers for Medicaid and Medicare Services (CMS) approved reimbursement for ABPM for patients with suspected WCH [7]. Despite the high prevalence of WCH in individuals with elevated clinic BP, only 0.1% of Medicare beneficiaries had a claim submitted for ABPM between 2007 and 2010 (see accompanying Shimbo et al. JASH article in current issue). These findings suggest that ABPM is being underutilized in Medicare beneficiaries. Concerns about unreimbursed claims and low reimbursement amounts may be barriers to performing ABPM in Medicare beneficiaries. Identifying factors that are associated with the successful reimbursement of ABPM by CMS may encourage its more widespread use in clinical practice. We examined the percentage of Medicare ABPM claims submitted that were reimbursed and the factors associated with successful reimbursement. We also examined the amounts reimbursed to providers and the factors associated with higher reimbursement amounts.

METHODS

We conducted a study of Medicare beneficiaries using the 2006–2010 national 5% random sample from the CMS. Medicare is a US federal health insurance program administered by the CMS that covers individuals 65 years of age and older, on disability, or who have end-stage renal disease. Coverage may be chosen on a fee-for-service basis or through contracts with managed care organizations (i.e., Part C coverage also known as Medicare Advantage). Medicare data used for the current analyses were derived from the beneficiary enrollment file and fee-for-service Parts A (inpatient), B (outpatient), and D (pharmacy) claims. These data sources provide Medicare claims and assessment data linked by beneficiary across the continuum of care. We excluded Medicare beneficiaries with coverage through Part C from

the current analysis, as claims are incomplete for these individuals. CMS and the Institutional Review Board at the University of Alabama at Birmingham approved the study.

ABPM procedures were identified from 2007–2010 claims submitted through Medicare Part B. ABPM claims from 2006 were not included, allowing for a 365 day “look back” preceding the ABPM index claim that was used to define covariates, including healthcare utilization and comorbidities, for Medicare beneficiaries. Claims included those with Healthcare Common Procedure Coding System (HCPCS) codes for the “full” ABPM procedure (HCPCS code 93784) or the recording, scanning analysis, physician review, and reporting components (HCPCS codes 93786, 93788, or 93790) (Table 1). Each beneficiary’s first ABPM claim was used as his/her “index” claim. As all ABPM components may not be performed on the same date, we created an ABPM “episode” for each participant. The ABPM episode consisted of all ABPM claims submitted within a 30 day period beginning with and including the index claim (Figure 1). Reimbursement amounts are listed on ABPM claims. We categorized beneficiaries by whether or not at least one of their ABPM claims in the episode period was reimbursed, defined as a CMS payment of over \$0. Beneficiaries were required to have continuous full Medicare coverage (Medicare Parts A, B and D coverage) and to reside in the 50 US states or Washington DC for the entire 365 day look back period through the 30 day ABPM episode period. In order to have the sample represent the general population, we excluded beneficiaries who were < 65 years of age at the start of the 365 day look back period.

Covariates

A priori-selected covariates were used to characterize Medicare beneficiaries with ABPM claims. Demographics, defined using the Medicare beneficiary enrollment file, included age, gender, race/ethnicity grouped as non-Hispanic white or other, Medicare/Medicaid dual eligibility for the entire look back period as a measure of poverty, and urban/rural status as defined using Rural/Urban Commuting Area codes. Diabetes, coronary heart disease, and kidney disease were defined using claims during the look back period and previously published algorithms (Appendix 1). We also determined the number of outpatient visits for hypertension each beneficiary had during the look back period. This was defined by the number of separate days with an outpatient physician evaluation and management claim with an International Classification of Diseases, 9th revision (ICD-9) diagnosis code of 401.x (i.e. “malignant, benign or unspecified essential hypertension”). The number of antihypertensive medication classes each beneficiary filled during the look back period was identified from the Medicare Part D file. Antihypertensive medication classes were defined as listed in the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) guidelines [8] and were updated by two authors (D.S., S.O.) to include newer medications. We defined WCH by the ICD-9 diagnosis code of 796.2 (i.e. “elevated blood pressure reading without diagnosis of hypertension”). Beneficiaries were considered to have a history of WCH if an ICD-9 code of 796.2 was present on one or more claims during the look back period. A WCH diagnosis was considered to be made concurrent with a beneficiary’s ABPM claim if the diagnosis code of 796.2 was listed on the claim. We also categorized beneficiaries by whether at least one ABPM claim was submitted by a cardiologist (specialty code “06”), an institutional provider

(e.g. hospital outpatient department, rural health clinic, or dialysis center) versus by non-institutional providers (e.g. individual physician, clinical laboratory, or free-standing ambulatory surgery center)[9], and for a full procedure versus for component procedures.

Statistical Analyses

The percentage of beneficiaries with a reimbursed ABPM claim was calculated, overall and separately for beneficiaries with and without a WCH diagnosis code on their ABPM claim. Next, among those without a WCH diagnosis code on an ABPM claim, relative risks and 95% confidence intervals (CIs) for having a reimbursed ABPM claim were calculated using Poisson regression models and sandwich estimators. Relative risks were calculated for the covariates described above in unadjusted models and in a model that included all of these covariates. Among those without a WCH diagnosis code on their ABPM claims, we calculated the ten most common diagnosis codes for claims that were reimbursed and, separately, for those that were not reimbursed. We did not perform these calculations in beneficiaries with a WCH diagnosis code on their ABPM claims, since only a small percentage of these were not reimbursed.

For beneficiaries whose ABPM claims were reimbursed, we calculated the total amounts reimbursed, as well as the amounts paid for the full ABPM procedure and for each component. Differences in amounts reimbursed for full ABPM procedure claims across levels of the *a priori* selected covariates were calculated using general linear models. Models were conducted unadjusted and in a model that included all of these covariates. All analyses were conducted using SAS version 9.3 (Cary, North Carolina).

RESULTS

Between 2007 and 2010, ABPM claims were submitted for 1,970 Medicare beneficiaries. Overall, 1,347 (68.4%) of the 1,970 Medicare beneficiaries had an ABPM claim reimbursed (Table 2). A WCH diagnosis was listed on 1,202 (61.0%) of ABPM claims. Claims were reimbursed for 1,128 (93.8%) of beneficiaries with a WCH diagnosis on their ABPM claim. In contrast, claims were reimbursed for only 219 (28.5%) of beneficiaries without a WCH diagnosis on their ABPM claim. Beneficiaries were more likely to have a WCH diagnosis on their ABPM claim if they had a history of WCH, a claim for the full ABPM procedure, or an ABPM claim submitted by a cardiologist or institutional provider. Additionally, beneficiaries with a WCH diagnosis on their ABPM claim had fewer outpatient visits for hypertension and were taking fewer classes of antihypertensive medication during the look back period, were less likely to have a history of diabetes, and were more likely to have an urban residence than those who did not have a WCH diagnosis on their claim.

Table 3 shows the proportion of beneficiaries with reimbursed ABPM claims. Claims for ABPM procedure components and claims filed by institutional providers were more likely to be reimbursed. Having a history of WCH was associated with a higher likelihood of a reimbursement in the overall population, but not among those without a WCH diagnosis code on their ABPM claims. Having a rural residence was associated with a lower likelihood of reimbursement in the overall population, but with a higher likelihood of reimbursement among those without a WCH diagnosis on their ABPM claims. Table 4 shows unadjusted

and multivariable adjusted relative risks for having a reimbursed ABPM claim for participants with a WCH code on their ABPM claim. Among beneficiaries without a WCH code on their ABPM claims, those who had only ABPM procedure component claims versus a full procedure claim or a claim filed by an institutional provider were more likely to have their ABPM claim reimbursed after multivariable adjustment. Among beneficiaries without a WCH diagnosis on their ABPM claims, more than 80% had ICD-9 diagnosis codes for essential hypertension listed on both reimbursed (Supplemental Tables 1) and unreimbursed claims (Supplemental Table 2). Other diagnoses were coded on fewer than 10% of these claims.

The median amount paid for each beneficiary's ABPM claims was \$52.01 (25th, 75th percentiles: \$32.95, \$64.98) (Figure 2). Among those with only component ABPM claims, the median amount paid for a beneficiary's ABPM claims was \$30.46 (25th, 75th percentiles: \$16.87, \$44.05) compared with \$55.14 (25th, 75th percentiles: \$44.93, \$66.37) for a claim for the full procedure. Among reimbursed claims for the full ABPM procedure, those submitted with versus without a WCH diagnosis had a \$6.22 (95% CI: \$5.06, \$7.39) higher reimbursement. Rural beneficiaries had a \$5.67 (95% CI: \$4.88, \$6.47) lower reimbursement amount compared to urban beneficiaries (Supplemental Table 3). Average reimbursement amounts differed by less than \$5 across levels of the other characteristics examined. After multivariable adjustment, full ABPM procedure claims submitted with a WCH diagnosis and by institutional providers received higher reimbursements, while rural beneficiaries received lower reimbursements than urban beneficiaries.

DISCUSSION

The results of this study indicate that ABPM procedures performed in Medicare beneficiaries are likely to be reimbursed by CMS if the ICD-9 diagnosis code of 796.2 is included in the claim. We also found that almost 30% of claims without a 796.2 diagnosis code were reimbursed. Among claims without a 796.2 diagnosis code, claims for procedure components versus for the full ABPM procedure and those submitted by an institutional provider versus a non-intentional provider were more than twice as likely to be reimbursed. The median reimbursement amount for an ABPM procedure was less than \$60.

Medicare ABPM claim processing instructions define suspected WCH as having (1) at least three visits with an office BP >140/90 mm Hg, (2) at least two documented SBP/DBP measurements taken out of the office which are <140/90 mm Hg, and (3) no evidence of end-organ damage [10]. To indicate that ABPM was performed due to suspected WCH, Medicare instructs that an ABPM claim should list the ICD-9 code of 796.2 for a diagnosis of an "elevated blood pressure reading without diagnosis of hypertension". We found that over 90% of ABPM claims with the ICD-9 diagnosis code of 796.2 were reimbursed. However, in the current study, 62% of beneficiaries with this diagnosis code on their ABPM claim were taking antihypertensive medications. Additionally, adjusted models indicated that claims were reimbursed at a similar rate for beneficiaries taking and not taking antihypertensive medication. While several publications defined WCH as a condition that occurs only in untreated patients [4, 11], prior research indicates that it is also valuable to determine the presence of a white coat effect in treated patients [12–14]. Based on the

results of the current study, Medicare does not appear to mandate that the ICD-9 diagnosis code of 796.2 should be restricted to patients who are not on antihypertensive medications.

It is not clear why almost 30% of ABPM claims without an ICD-9 diagnosis code of 796.2 were reimbursed. We found that essential hypertension diagnosis codes were common on both reimbursed and unreimbursed ABPM claims without the 796.2 diagnosis code. Among beneficiaries with an ABPM claim that did not contain a WCH diagnosis code, those submitted by institutional providers were more likely to be reimbursed. This finding is consistent with results of prior studies that have shown that larger, urban healthcare providers that are part of hospital systems are more likely to have extensive documentation processes, including health information technology systems and documentation improvement programs [15–17], that may lead to the submission of more complete claims with a higher likelihood of reimbursement [18, 19]. We did not have access to the supporting documentation for ABPM claims and, therefore, could not assess whether the completeness of documentation was a determinant of success in receiving reimbursement.

Low reimbursement amounts for ABPM in Medicare beneficiaries may discourage healthcare providers from purchasing an ABPM device and performing ABPM. The mean reimbursement for an ABPM procedure in the current analysis is lower than the average of \$74 (95% CI: \$72, \$76) reported in a previous analysis of Medicare data [20]. Even this higher reimbursement amount does not approach the cost of the procedure [14]. ABPM procedures were reported to have provider costs of AU\$133 to AU\$140 (US\$125 to US\$131) in Australia [21], and £326 (US\$559) in Britain [22]. These low reimbursement amounts may discourage providers from performing ABPM. However, both the 2013 European Society of Hypertension Position Paper on ABPM and the 2011 British National Institute for Health and Clinical Excellence (NICE) hypertension management guideline synthesized the literature and concluded that ABPM provides a cost-effective approach for guiding the diagnosis of hypertension [6, 23].

Limited indications for ABPM reimbursement by Medicare may also discourage providers from performing a procedure. Suspected WCH is the only covered indication, and Medicare instructs providers that the need for repeated ABPM procedures should be “rare” [10]. However, repeated ABPM procedures carried out over time may be useful to guide the treatment of hypertension, since the white coat effect and prevalence of WCH increase with age [23–26]. Importantly, repeated ABPM measures may be used to separate true and white coat treatment-resistant hypertension, to identify the development of sustained hypertension among those with diagnosed WCH [27, 28], and to guide antihypertensive therapy to achieve target blood pressures while avoiding overtreatment [14, 23, 29]. In addition to WCH, ABPM accurately identifies masked hypertension, defined as the presence of elevated out-of-office despite non-elevated clinic BP. Masked hypertension has been shown to be associated with a cardiovascular risk similar to that of sustained hypertension [30]. ABPM also has the unique ability to identify a number of abnormal circadian BP patterns associated with increased cardiovascular risk (e.g., elevated nighttime BP, a non-dipping pattern, and an increased morning surge) [23].

Our study has several strengths. We used national data on US adults 65 years of age and older from Medicare. The national reach of Medicare provides high generalizability of our study results to older US adults. Since the size of the white coat effect may increase as patients age [24, 26], adopting the widespread use of ABPM holds even more importance among Medicare beneficiaries. Our study also has limitations. As with all claims-based analyses, our results depend on the accuracy of claims to identify comorbid conditions and pharmacy fills. In addition, given the restricted conditions for which Medicare reimburses an ABPM procedure, many providers may perform ABPM procedures without submitting a claim.

Conclusions

The vast majority of ABPM procedures for Medicare beneficiaries with suspected WCH are reimbursed if the ICD-9 diagnosis code of 796.2 is included on the claim. However, reimbursement amounts are generally below the cost of the procedure. Given low reimbursement amounts and limited indications, coverage may be insufficient to encourage the widespread use of ABPM for identifying WCH and monitoring treated hypertension. These issues may be barriers to performing ABPM in Medicare. Educating providers on CMS instructions for reimbursement of ABPM and evaluation of the reimbursement amounts for ABPM by CMS may increase its appropriate use in older US adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

ABPM	Ambulatory blood pressure monitoring
BP	Blood pressure
CI	Confidence intervals
CMS	Centers for Medicaid and Medicare Services
HCPCS	Healthcare Common Procedure Coding System
ICD-9	International Classification of Diseases, 9 th revision

JNC	Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
US	United States
WCH	White coat hypertension

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Appendix 1. Medicare claims algorithms used to define beneficiary comorbidities

History of diabetes mellitus [31]

Any one of the following:

- a. At least 1 inpatient claim with discharge ICD-9 diagnoses (any position) of 250.xx, 357.2, 362.0x, or 366.41
- b. At least 2 carrier claim, carrier line or outpatient claims with ICD-9 diagnoses (any position) of 250.xx, 357.2, 362.0x, or 366.41, linked by CLAIM_ID to an ambulatory physician evaluation and management claim, with the 2 claims occurring at least 7 days apart
- c. At least 1 prescription record for an oral antidiabetes medication or insulin fills

History of coronary heart disease [32]

Any one of the following:

- a. myocardial infarction: 1 inpatient or physician evaluation or management outpatient claims containing ICD-9 diagnoses 410.x or 412.x
- b. revascularization: 1 inpatient or outpatient claim containing ICD-9 procedure codes 00.66, 36.01–36.09 or 36.10–36.19, or CPT codes 92980–92996, 33510–33536, or 1 inpatient or outpatient claim containing ICD-9 diagnosis codes V45.81 or V45.82
- c. Other ischemic disease: 1 inpatient or physician evaluation or management outpatient claim with 411, 413, or 414 codes.

History of stroke [33]

Any one of the following:

- a. At least 1 inpatient ICD-9 diagnosis (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x
- b. At least 1 carrier claim, carrier line or outpatient claims with ICD-9 diagnoses (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x, linked by CLAIM_ID to an ambulatory physician evaluation and management claim
- c. At least 1 claim with ICD-9 diagnoses (any position) of 430.xx, 431.xx, 433.x1, 434.x1 or 436.x in other file types (home health aide, durable medical equipment, hospice, skilled nursing facility)

History of chronic kidney disease [34]

Any one of the following:

- a. at least 1 inpatient claim with discharge ICD-9 kidney disease diagnoses: 016.0, 095.4, 189.0, 189.9, 223.0, 236.91, 250.4, 271.4, 274.1, 283.11, 403.xx, 404.xx, 440.1, 442.1, 447.3, 572.4, 580.xx–588.xx, 591, 642.1, 646.2, 753.12–753.17, 753.19, 753.2, 794.4
- b. at least 2 carrier claim, carrier line or outpatient claims with kidney disease ICD-9 diagnoses above (any position), with the 2 claims occurring at least 7 days apart.

History of heart failure [32]

At least one inpatient or outpatient, or carrier line or claim (any position) linked by CLAIM_ID to an ambulatory physician evaluation and management claim with ICD-9 diagnoses of 398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, or 428.9

Highlights

- Only 68% of Medicare claims for ambulatory blood pressure are reimbursed.
- Claims are likely to be reimbursed if the ICD-9 diagnosis code 796.2 is included.
- Less than 30% of claims without a 796.2 diagnosis code were reimbursed.
- The median reimbursement amount for an ABPM procedure was \$52.01.

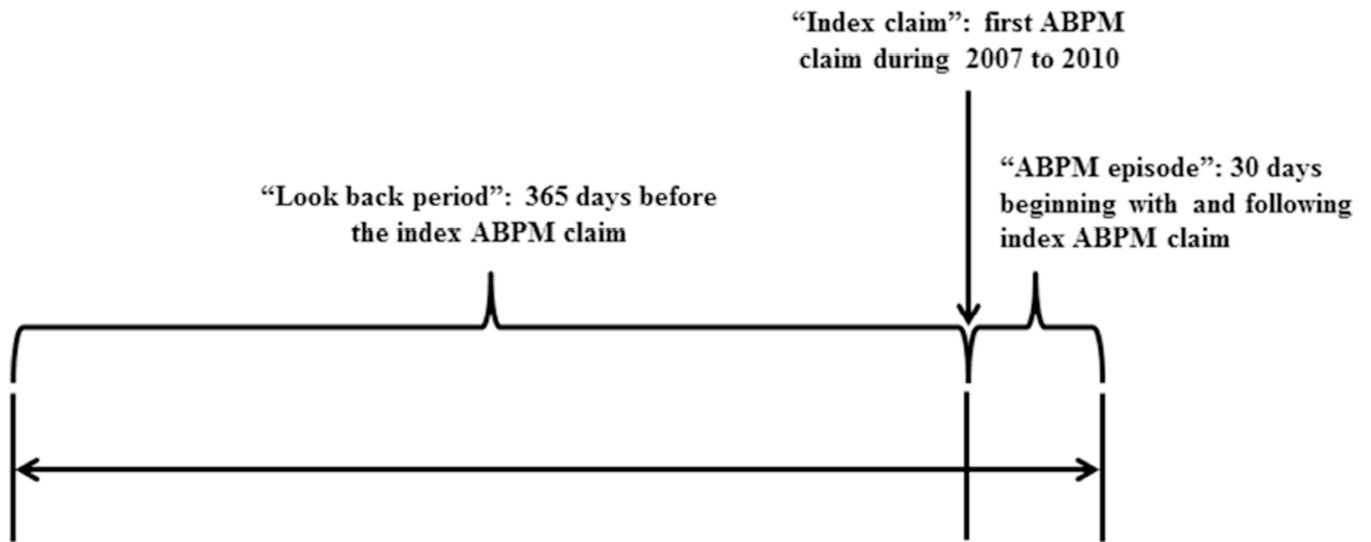


Figure 1.
Study design to examine the reimbursement of ambulatory blood pressure monitoring (ABPM) claims in Medicare

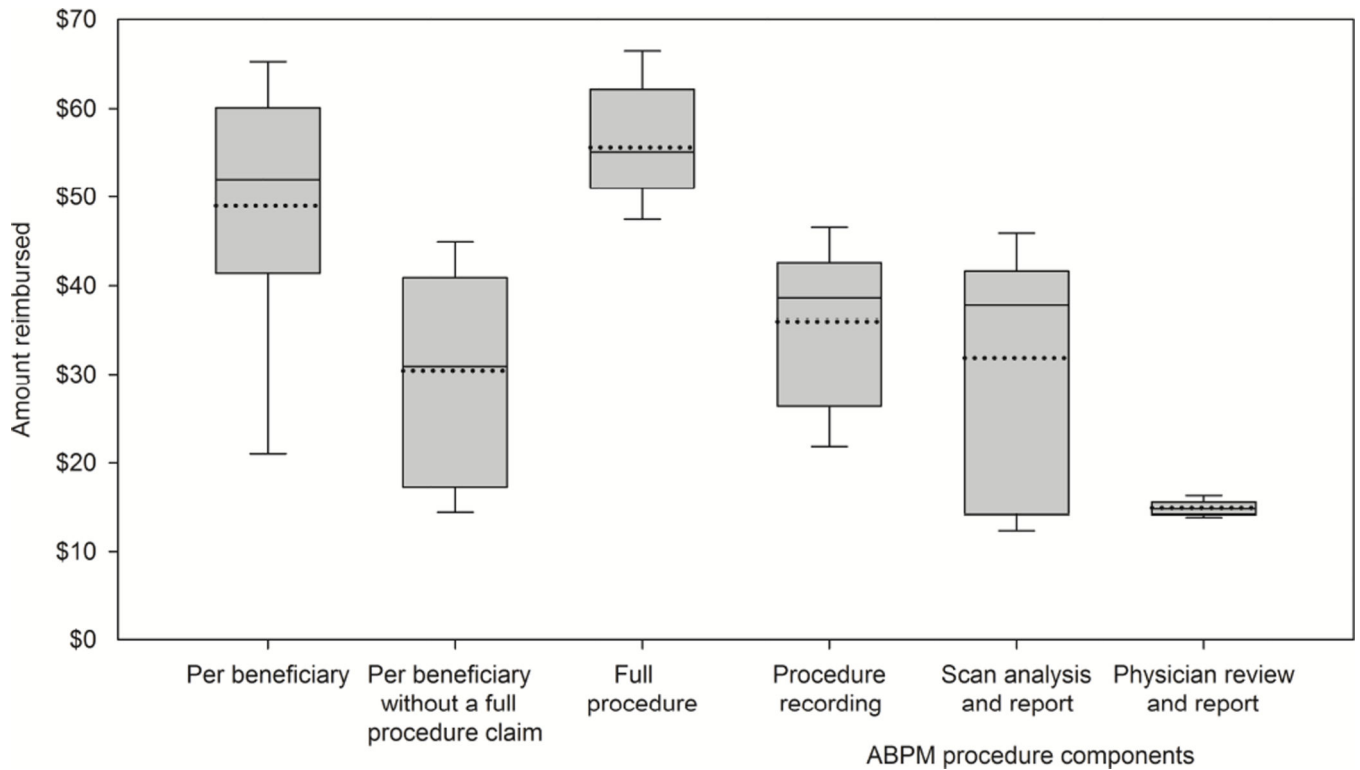


Figure 2. Amount reimbursed for an ambulatory blood pressure monitoring (ABPM) claim, by beneficiary and by Healthcare Common Procedure Coding System (HCPCS) procedure code. Statistics do not include unreimbursed ABPM claims.

Boxes show 25th and 75th percentiles of ABPM claim reimbursement amounts. Solid lines in boxes show the median reimbursement amounts. Dotted lines show mean reimbursement amounts. Whiskers show 10th and 90th percentiles of ABPM claim reimbursement amounts.

“Full procedure” claims were obtained from HCPCS 93784, defined as “ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; including recording, scanning analysis, interpretation and report.”

“Procedure recording” claims were obtained from HCPCS 93786, defined as “ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; recording only.”

“Scan, analysis and report” claims were obtained from HCPCS 93788, defined as “ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; scanning analysis with report.”

“Physician review and report” claims were obtained from HCPCS 93790, defined as “ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; physician review with interpretation and report.”

Table 1

Healthcare Common Procedure Coding System (HCPCS) codes used to identify ambulatory blood pressure monitoring (ABPM) in Medicare claims.

HCPCS code	Description
93784	ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; including recording, scanning analysis, interpretation and report.
93786	ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; recording only
93788	ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; scanning analysis with report.
93790	ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; physician review with interpretation and report.

Table 2

Characteristics of Medicare beneficiaries in the 2007–2010 5% sample, overall and by the presence of a white coat hypertension (WCH) diagnosis on an ambulatory blood pressure monitoring (ABPM) claim.

Characteristics	WCH diagnosis on an ABPM claim			p-value
	Overall (n=1970)	No (n=768)	Yes (n=1202)	
Reimbursed ABPM claim				
No	623 (31.6%)	549 (71.5%)	74 (6.2%)	<.001
Yes	1347 (68.4%)	219 (28.5%)	1128 (93.8%)	
History of WCH				
No	1755 (89.1%)	730 (95.1%)	1025 (85.3%)	<.001
Yes	215 (10.9%)	38 (4.9%)	177 (14.7%)	
ABPM procedure claim type [†]				
Full procedure	1546 (78.5%)	573 (74.6%)	973 (80.9%)	0.001
Components	424 (21.5%)	195 (25.4%)	229 (19.1%)	
ABPM claim filed by cardiologist				
No	1102 (55.9%)	461 (60.0%)	641 (53.3%)	0.004
Yes	868 (44.1%)	307 (40.0%)	561 (46.7%)	
ABPM claim filed by an institutional provider ^{††}				
No	1676 (85.1%)	1061 (88.3%)	615 (80.1%)	<.001
Yes	294 (14.9%)	141 (11.7%)	153 (19.9%)	
Number of hypertension diagnoses before ABPM claims				
0	230 (11.7%)	73 (9.5%)	157 (13.1%)	0.034
1 to 5	1064 (54.0%)	415 (54.0%)	649 (54.0%)	
6 or more	676 (34.3%)	280 (36.5%)	396 (32.9%)	
Number of antihypertensive medication classes filled before ABPM claims				
0	258 (13.1%)	68 (8.9%)	190 (15.8%)	<.001
1 or 2	708 (35.9%)	278 (36.2%)	430 (35.8%)	
3 or more	1004 (51.0%)	422 (54.9%)	582 (48.4%)	
History of diabetes				
No	1479 (75.1%)	558 (72.7%)	921 (76.6%)	0.047
Yes	491 (24.9%)	210 (27.3%)	281 (23.4%)	
History of coronary heart disease				
No	1148 (58.3%)	458 (59.6%)	690 (57.4%)	0.327
Yes	822 (41.7%)	310 (40.4%)	512 (42.6%)	
History of kidney disease				
No	1626 (82.5%)	624 (81.3%)	1002 (83.4%)	0.229
Yes	344 (17.5%)	144 (18.8%)	200 (16.6%)	
Age, years				0.719

Characteristics	WCH diagnosis on an ABPM claim			p-value
	Overall (n=1970)	No (n=768)	Yes (n=1202)	
65 to 74	908 (46.1%)	346 (45.1%)	562 (46.8%)	
75 to 84	816 (41.4%)	322 (41.9%)	494 (41.1%)	
85 and above	246 (12.5%)	100 (13.0%)	146 (12.1%)	
Gender				
Female	1361 (69.1%)	518 (67.4%)	843 (70.1%)	0.209
Male	609 (30.9%)	250 (32.6%)	359 (29.9%)	
Race/ethnicity				
Non-Hispanic white	1758 (89.2%)	683 (88.9%)	1075 (89.4%)	0.726
Other	212 (10.8%)	85 (11.1%)	127 (10.6%)	
Medicare/Medicaid dual eligibility				
No	1666 (84.6%)	647 (84.2%)	1019 (84.8%)	0.751
Yes	304 (15.4%)	121 (15.8%)	183 (15.2%)	
Rural/urban residence				
Urban	1380 (70.1%)	485 (63.2%)	895 (74.5%)	<.001
Rural	590 (29.9%)	283 (36.8%)	307 (25.5%)	

A WCH diagnosis is defined as ICD-9 code 796.2 ("Elevated blood pressure reading without diagnosis of hypertension")

[†]The full ABPM procedure is defined as an ABPM claim with Healthcare Common Procedure Coding System (HCPCS) code 93784, described as "ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; including recording, scanning analysis, interpretation and report." Other HCPCS codes (93786, 93788, and 93790) are for individual ABPM procedure components.

^{††} Claims filed by an institutional provider are defined as those in the outpatient file. Claims filed by a non-institutional provider are defined as those in the carrier file.

Table 3

Number and percent of Medicare beneficiaries in the 2007–2010 5% sample with a reimbursed ABPM claim, overall and among those without a white coat hypertension (WCH) diagnosis on a claim.

Characteristics	All beneficiaries		Without WCH diagnosis on ABPM claim		p-value
	ABPM claim reimbursed	p-value	ABPM claim reimbursed	p-value	
Overall	623 (31.6%)	1347 (68.4%)	549 (71.5%)	219 (28.5%)	--
History of WCH					
No	585 (33.3%)	1170 (66.7%)	526 (72.1%)	204 (27.9%)	0.125
Yes	38 (17.7%)	177 (82.3%)	23 (60.5%)	15 (39.5%)	
Full ABPM procedure claim type [†]					
Full procedure	547 (35.4%)	999 (64.6%)	482 (84.1%)	91 (15.9%)	<.001
Components	76 (17.9%)	348 (82.1%)	67 (34.4%)	128 (65.6%)	
ABPM claim filed by cardiologist					
No	362 (32.8%)	740 (67.2%)	319 (69.2%)	142 (30.8%)	0.085
Yes	261 (30.1%)	607 (69.9%)	230 (74.9%)	77 (25.1%)	
ABPM claim filed by an institutional provider ^{††}					
No	577 (34.4%)	1099 (65.6%)	512 (83.3%)	103 (16.7%)	<.001
Yes	46 (15.6%)	248 (84.4%)	37 (24.2%)	116 (75.8%)	
Number of hypertension diagnoses before ABPM claims					
0	64 (27.8%)	166 (72.2%)	54 (74.0%)	19 (26.0%)	0.880
1 to 5	345 (32.4%)	719 (67.6%)	295 (71.1%)	120 (28.9%)	
6 or more	214 (31.7%)	462 (68.3%)	200 (71.4%)	80 (28.6%)	
Number of antihypertensive medication classes filled before ABPM claims					
0	72 (27.9%)	186 (72.1%)	54 (79.4%)	14 (20.6%)	0.315
1 or 2	220 (31.1%)	488 (68.9%)	196 (70.5%)	82 (29.5%)	
3 or more	197 (34.1%)	381 (65.9%)	183 (69.6%)	80 (30.4%)	
History of diabetes					
No	468 (31.6%)	1011 (68.4%)	405 (72.6%)	153 (27.4%)	0.273

Characteristics	All beneficiaries			Without WCH diagnosis on ABPM claim		
	ABPM claim reimbursed	Yes	p-value	ABPM claim reimbursed	Yes	p-value
Yes	155 (31.6%)	336 (68.4%)		144 (68.6%)	66 (31.4%)	
History of coronary heart disease						
No	365 (31.8%)	783 (68.2%)	0.848	316 (69.0%)	142 (31.0%)	0.063
Yes	258 (31.4%)	564 (68.6%)		233 (75.2%)	77 (24.8%)	
History of kidney disease						
No	515 (31.7%)	1111 (68.3%)	0.920	448 (71.8%)	176 (28.2%)	0.692
Yes	108 (31.4%)	236 (68.6%)		101 (70.1%)	43 (29.9%)	
Age, years						
65 to 74	287 (31.6%)	621 (68.4%)	0.944	251 (72.5%)	95 (27.5%)	0.837
75 to 84	256 (31.4%)	560 (68.6%)		227 (70.5%)	95 (29.5%)	
85 and above	80 (32.5%)	166 (67.5%)		71 (71.0%)	29 (29.0%)	
Gender						
Female	417 (30.6%)	944 (69.4%)	0.160	368 (71.0%)	150 (29.0%)	0.696
Male	206 (33.8%)	403 (66.2%)		181 (72.4%)	69 (27.6%)	
Race/ethnicity						
Non-Hispanic white	553 (31.5%)	1205 (68.5%)	0.644	483 (70.7%)	200 (29.3%)	0.182
Other	70 (33.0%)	142 (67.0%)		66 (77.6%)	19 (22.4%)	
Medicare/Medicaid dual eligibility						
No	523 (31.4%)	1143 (68.6%)	0.605	456 (70.5%)	191 (29.5%)	0.155
Yes	100 (32.9%)	204 (67.1%)		93 (76.9%)	28 (23.1%)	
Rural/urban residence						
Urban	412 (29.9%)	968 (70.1%)	0.010	363 (74.8%)	122 (25.2%)	0.007
Rural	211 (35.8%)	379 (64.2%)		186 (65.7%)	97 (34.3%)	

A WCH diagnosis is defined as ICD-9 code 796.2 ("Elevated blood pressure reading without diagnosis of hypertension")

[†]The full ABPM procedure is defined as an ABPM claim with Healthcare Common Procedure Coding System (HCPCS) code 93784, described as "ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; including recording, scanning analysis, interpretation and report." Other HCPCS codes (93786, 93788, and 93790) are for individual ABPM procedure components.

^{††} Claims filed by an institutional provider are defined as those in the outpatient file. Claims filed by a non-institutional provider are defined as those in the carrier file.

Table 4

Multivariable adjusted relative risks for a reimbursed ambulatory blood pressure monitoring (ABPM) claim associated with Medicare beneficiary characteristics among those without a claim listing a white coat hypertension (WCH) diagnosis (n=768).

	Relative risk (95% confidence interval)	
	Unadjusted	Fully adjusted ^{†††}
History of WCH		
No	1 (reference)	1 (reference)
Yes	1.41 (0.94, 2.13)	1.37 (0.99, 1.90)
ABPM procedure claim type [†]		
Full procedure	1 (reference)	1 (reference)
Components	4.13 (3.34, 5.12)	2.05 (1.45, 2.88)
ABPM claim filed by cardiologist		
No	1 (reference)	1 (reference)
Yes	0.81 (0.64, 1.03)	0.94 (0.77, 1.15)
ABPM claim filed by an institutional provider ^{††}		
No	1 (reference)	1 (reference)
Yes	4.53 (3.72, 5.52)	2.47 (1.79, 3.42)
Number of hypertension diagnoses before ABPM claims		
0	1 (reference)	1 (reference)
1 to 5	1.11 (0.73, 1.68)	1.07 (0.76, 1.52)
6 or more	1.10 (0.71, 1.69)	0.97 (0.67, 1.42)
Number of antihypertensive medication classes filled before ABPM claims		
0	1 (reference)	1 (reference)
1 or 2	1.43 (0.87, 2.36)	1.21 (0.78, 1.87)
3 or more	1.42 (0.87, 2.31)	1.35 (0.87, 2.10)
History of diabetes		
No	1 (reference)	1 (reference)
Yes	1.15 (0.90, 1.46)	1.16 (0.92, 1.45)
History of coronary heart disease		
No	1 (reference)	1 (reference)
Yes	0.80 (0.63, 1.02)	0.83 (0.67, 1.03)
History of kidney disease		
No	1 (reference)	1 (reference)
Yes	1.06 (0.80, 1.40)	0.97 (0.76, 1.23)
Age, years		
65 to 74	1 (reference)	1 (reference)
75 to 84	1.07 (0.84, 1.37)	1.04 (0.84, 1.28)
85 and above	1.06 (0.74, 1.50)	0.99 (0.74, 1.33)
Gender		

	Relative risk (95% confidence interval)	
	Unadjusted	Fully adjusted ^{†††}
Female	1 (reference)	1 (reference)
Male	0.95 (0.75, 1.21)	0.99 (0.80, 1.23)
Race/ethnicity		
Non-Hispanic white	1 (reference)	1 (reference)
Other	0.76 (0.51, 1.15)	0.94 (0.64, 1.36)
Medicare/Medicaid dual eligibility		
No	1 (reference)	1 (reference)
Yes	0.78 (0.55, 1.11)	0.81 (0.60, 1.10)
Rural/urban residence		
Urban	1 (reference)	1 (reference)
Rural	1.36 (1.09, 1.70)	1.09 (0.89, 1.33)

A WCH diagnosis is defined as ICD-9 code 796.2 (“Elevated blood pressure reading without diagnosis of hypertension”)

[†]The full ABPM procedure is defined as an ABPM claim with Healthcare Common Procedure Coding System (HCPCS) code 93784, described as “ABPM, utilizing a system such as magnetic tape and/or computer disk, for 24 hours or longer; including recording, scanning analysis, interpretation and report.” Other HCPCS codes (93786, 93788, and 93790) are for individual ABPM procedure components.

^{††}Claims filed by an institutional provider are defined as those in the outpatient file. Claims filed by a non-institutional provider are defined as those in the carrier file.

^{†††}Fully adjusted risk ratios are adjusted for all characteristics presented in the table.