Cost analysis of ambulatory blood pressure monitoring in initiating antihypertensive drug treatment in Australian general practice

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ABSTRACT

Objective: To compare the cost of ambulatory blood pressure monitoring (ABPM) with the putative savings made through treatment avoided by identification and non-treatment of those with "white coat" hypertension.

Design: A cost analysis based on a model of four alternative strategies (no ABPM, yearly, two-yearly, or three-yearly monitoring) over a seven-year period applied to a case series from Australian general practice.

Participants: 62 patients newly diagnosed by their GPs as having hypertension and requiring drug treatment.

Main outcome measures: The proportion of patients shown to not need treatment. The discounted costs to the Pharmaceutical Benefits Scheme, Medical Benefits Scheme and patients.

Results: 16 of 62 patients (26%; 95% CI, 15%–37%) were normotensive on ABPM and did not require treatment. All monitoring strategies are more expensive in the first year, but the initial costs are offset by year 3 and the monitoring strategies are cost saving thereafter. Sensitivity analysis shows that this result holds across a range of costs of pharmacotherapy and proportion of patients with white coat hypertension.

Conclusion: The additional costs of 24-hour ABPM in the first year are offset by savings associated with patients with white coat hypertension who would otherwise have been treated.

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TWENTY-FOUR-HOUR ambulatory blood pressure monitoring (ABPM) is more expensive than traditional blood pressure measurement. However, ABPM can identify some patients with normal average blood pressures despite apparent hypertension on office readings (ie, "white coat" hypertension). Such patients do not require treatment.

ABPM has been used extensively in specialist hypertension clinics. The reported prevalence of white coat hypertension among newly diagnosed people with hypertension is about 20%,[1] but this is greatly influenced by the cut points used.[2] The rate of progression to sustained hypertension is estimated to be 10% per year.[3]

We set out to compare the savings made through not treating white coat hypertension with the costs of ABPM of every newly diagnosed hypertensive patient.

METHODS

Patient recruitment

Previously untreated patients diagnosed as having hypertension by conventional blood pressure measurement were recruited from general practitioners in two Divisions of General Practice from August 1996 to February 2000. The entry criterion was that the GP had decided the patient needed antihypertensive drug treatment. GPs were prompted that there should have been three readings showing diastolic blood pressure $\geqslant$ 95 mmHg; however, this was not a requirement, so this study reflects usual practice. We did not insist on "gold standard" clinical measurement of blood pressure, as this may not be usual care in general practice.

Blood pressure monitoring

Monitoring with a QuietTrak (Welch Allyn, Skaneateles Falls, NY) auscultory automatic sphygmomanometer was performed for a single 24-hour period using an appropriate-sized cuff, after calibration against a mercury sphygmomanometer on each subject. During set-up, each patient was asked his or her usual time of going to bed and rising, and the monitor was set to record blood pressure each half-hour during the day and evening and hourly while they were in bed. Rise and sleep times were all within an hour of 6:00 AM and 10:00 PM, as used in the Verdecchia criteria. We used Verdecchia's 1994[4] threshold values of a daytime (6:00 AM to 10:00 PM) average of $\geqslant$ 131/86 mmHg in women and $\geqslant$ 136/87 mmHg in men. The QuietTrak has been previously shown to meet the standards set down in the Association for the Advancement of Medical Instrumentation guideline in validation studies.[5] The result was fed back to the referring GP for treatment decisions, with interpretation advice following Verdecchia's threshold values.

The study was approved by the Alice Springs Institutional Ethics Committee, and the ethics committee of the Royal Australian College of General Practitioners.

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1: Strategies evaluated in the model

Strategy 1: No ABPM	Drug treatment, no monitoring
Strategy 2: Annual ABPM	Monitor initially, withhold treatment if WCH demonstrated, and re-monitor annually if not on treatment.
Strategy 3: Two-yearly ABPM	Monitor initially, withhold treatment if WCH demonstrated, and re-monitor at years 1, 3 and 5 if not on treatment.
Strategy 4: Three-yearly ABPM	Monitor initially, withhold treatment if WCH demonstrated, and re-monitor if not on treatment at years 1 and 4.

ABPM = ambulatory blood pressure monitoring. WCH = white coat hypertension.

Cost analysis

The cost analysis compared four alternative strategies, as described in Box 1.

The costs considered were cost of pharmaceuticals, consultations, pathology and ABPM. The perspectives of the Pharmaceutical Benefits Scheme (PBS), Medical Benefits Scheme (MBS) and patients were considered. The objectives of the cost analysis were to:

- provide an estimate of the discounted annual financial costs of each strategy;
- estimate the number of years before which the additional costs in year one would be offset by the savings from reduced treatment costs in subsequent years; and
- inform discussion of the merits of listing such an item on the MBS.

Model structure

A model was constructed to simulate the costs over a seven-year period of treating a cohort of 100 patients diagnosed with hypertension under the four strategies.

Key assumptions of the model include:

- patients are monitored at the start of the year;
- patients with white coat hypertension not receiving treatment and who become hypertensive over the year will become hypertensive at the end of that year; and
- patients will have one standard GP consultation before each episode of monitoring.

The inclusion of a second monitoring at year one in all three monitoring strategies addresses clinicians' anxiety about withholding treatment on the basis of just one test result. A seven-year period was chosen so that three and two cycles of strategies 3 and 4, respectively, were completed.

In addition to the cost analysis, estimates were made of the number of years of treated white coat hypertension and untreated real hypertension for each of the strategies.

A sensitivity analysis was performed to test the robustness of the results to key assumptions.

A threshold analysis, which tested the sensitivity of thresholds for decision-making purposes, was also performed.

Costs

The costs of providing ABPM are dependent on the capital costs of the equipment, staff time for set-up, detachment and data handling, volume of tests done, life span of the equipment, depreciation rates, and institutional overheads. As the test is not generally commercially available, it was necessary to estimate the likely commercial cost per test if it were widely introduced. An estimate of the cost per patient of providing the service was made using cost data collected during the trial. Using three-year depreciation, the expected cost varies between $140 and $133 per patient for annual throughputs of 100 and 150 patients, respectively.

Currently, there is no item for ABPM on the MBS schedule, so the likely cost to the MBS if it were listed was estimated using the Medical Services Advisory Committee guidelines.[6] The guidelines consider both the full costs of a procedure and reference to similar items already on the MBS schedule. Two items for 24-hour ECG monitoring (MBS Items 1109 and 1108) are similar procedures that are generally available commercially, with scheduled fees of $130.40 and $99.55, respectively. A proposed fee of $128.80 is consistent with the costs of provision and with the current schedule. The cost to the MBS of the ABPM used for our model was $133, being 85% of the proposed scheduled fee plus the rebate for a level B general practitioner consultation. This estimate was varied in the sensitivity analysis.

Pharmaceutical costs for the treatment of hypertension are based on the study by Nelson et al,[7] which presented an estimate of 1 223 000 Australians receiving an average of 1.6 antihypertensive medications each under the PBS in 1998, at a cost of $365.3m per year to the government and a further $110.9m to consumers through copayments. Per patient, this equates to $299 to the PBS, $90 in patient costs, and $389 in total drug-acquisition costs. There is a bias inherent in these estimates of cost to consumers, as the PBS data do not include drugs costing patients less than the copayment amount of $21.90 per script. The effect of this bias is to underestimate the savings to patients of strategies that reduce the number of patients treated. For comparison, the total annual drug-acquisition cost per patient at standard doses for atenolol is $117, ramipril $459, and felodipine plus ramipril $827.

There are no Australian data on the costs of consultations and pathology tests in the care of hypertensive patients, so we have used the conservative assumptions of two level B general practice consultations at a cost to the MBS of $23.50 each, and one pathology test at a cost of $20 per year. Most patients will be seen more frequently during the first months of treatment, but, without observational data, we have allowed only two consultations a year. The maximum prescribed quantity for most drugs is a six-month supply, so two consultations per year is the minimum possible. The cost to the patient depends upon fee structures and whether they are concessionary or non-concessionary patients. We have excluded consideration of this cost.

Model inputs

Box 2 summarises the inputs used in the base case of the model and the sensitivity analysis. Sources of estimates are discussed above.

From a government perspective, a key decision threshold is whether ABPM is likely to remain cost saving for a full range of possible values of key variables. We assumed a threshold for financial

viability of ABPM that requires the additional costs in the first year to be offset by savings in the following two years (ie, the strategy becomes cost neutral compared with usual care by the end of three years). We believe this is a conservative threshold. We then used the base-case values of all variables and varied first the prevalence of white coat hypertension and then treatment costs until strategy 2 was cost neutral by the end of year 3.

RESULTS

The 62 patients (44 women) had a median blood pressure of 154/98 mmHg, as recorded by the referring GP. The prevalence of white coat hypertension in our group of newly diagnosed hypertensive patients was 16/62 (26%; 95% CI, 15%–37%). This is similar to the results of other series.[8] Adverse outcomes of monitoring were sleep disturbance for two patients.

The results of the model over a seven-year period (Box 3) indicate that all the strategies including monitoring are cost saving when compared with no monitoring. All monitoring strategies are more expensive than strategy 1 in the first year, but break even after the third year (ie, the additional costs in the first year are offset by savings in the subsequent two years). The average government cost per patient over seven years is $317 for a strategy that does not include ABPM, which is more than for the other strategies (Box 3).

Comparison of the performance of each strategy revealed that the incremental costs for a group of 100 patients over seven years of moving from strategy 4 to strategy 2 is $13 700, preventing 12 years of untreated true hypertension at a cost of $1141 per patient-year. Under each of the monitoring strategies, patients with white coat hypertension would not be treated, representing 19% of total patient-years.

Sensitivity analysis

A univariate sensitivity analysis was performed for each of four variables, within the ranges indicated in Box 2. Even though financial indicators of cost per patient per year over seven years and savings per patient are sensitive to assumptions regarding the key variables, all the monitoring strategies remain less expensive than no monitoring (Box 4).

Threshold analysis

The threshold analysis indicated that, with all other variables at the base case, the threshold prevalence of white coat hypertension is 17%, below which strategy 2 is no longer cost saving at three years. Similarly, with all other variables at base case, if treatment costs were below $332 strategy 2 would no longer be cost saving at three years. Finally, with a prevalence of white coat hypertension of 20% and a cost of treatment per year of $400, the strategy is cost neutral at the end of year 3.

This analysis suggests that it is likely that strategy 2 will be cost neutral within three years, and result in financial savings thereafter, even if the prevalence of white coat hypertension and the treatment costs, the main determinants of savings, are lower than specified in the base case.

2: Model Inputs

Variable	Base case estimate	Low value	High value
Total annual costs of blood pressure for treated patients	**$456**	**$396**	**$506**
Annual costs to PBS	$299	$240 (– 20%)	$360 (+ 20%)
Annual costs to patients of pharmacotherapy	$90		
Annual costs to MBS of consultations and pathology	$67		
Total annual costs for untreated patients	**Cost of monitoring if occurred in that year**		
Cost of monitoring including consultation $23.50 (proposed government share)	$133	—	$160
Cost of monitoring excluding consultation (proposed patient share)	$20	—	$24
Discount rate	0.05	—	—
Proportion with WCH	26%	15%	37%
Proportion of WCH progressing to true hypertension per year	0.1	0.05	0.15

MBS = Medical Benefits Scheme. PBS = Pharmaceutical Benefits Scheme. WCH = white coat hypertension.

3: Results of cost analysis

	Cost per patient in year one		Cost per patient in year three		Average cost per patient over seven years		Savings per year per patient compared with strategy 1 (% of strategy 1 cost)	
	Govt	Total	Govt	Total	Govt	Total	Govt	Total
Strategy 1*	$366	$456	$332	$413	$317	$396	—	—
Strategy 2	$404	$490	$290	$359	$294	$362	$23 (7%)	$34 (8%)
Strategy 3	$404	$490	$254	$317	$282	$350	$35 (11%)	$46 (12%)
Strategy 4	$404	$490	$254	$317	$277	$343	$40 (13%)	$53 (13%)

* See Box 1 for descriptions of strategies. Govt = costs to the government (Pharmaceutical Benefits Scheme and Medical Benefits Scheme).

DISCUSSION

Our study provides evidence that the introduction of ABPM to the routine diagnosis of hypertension in Australian general practice would be cost saving if it were used in a manner similar to our study to confirm sustained hypertension before initiating drug treatment.

There is evidence to support the clinical practice of not treating white coat hypertension. There have been six cohort studies[4,9-13] of cardiovascular outcomes after 24-hour ABPM, in which large groups of subjects have been followed for up to 13 years.

4: Key results of sensitivity analysis

	Total annual costs per patient: average over seven years (savings per patient per year compared with strategy 1)			
	Cost of treated hypertension: reduce by 20% to $396	Costs of monitoring: increase by 20% to $184	Percentage of patients with WCH: reduce from 26% to 15%	Rate of progression from WCH to true hypertension per year: increase from 10% to 15%
Strategy 1*	$344	$396	$396	$396
Strategy 2	$320 ($24)	$371 ($25)	$385 ($11)	$369 ($27)
Strategy 3	$308 ($36)	$356 ($40)	$378 ($18)	$357 ($39)
Strategy 4	$302 ($42)	$349 ($47)	$374 ($22)	$350 ($46)

See Box 1 for description of strategies. WCH = white coat hypertension.

Although these studies differed widely in design, all suggest that ambulatory blood pressure gives a better prediction of prognosis than clinic blood pressure. The corollary is that patients with white coat hypertension have a more benign prognosis than those with sustained hypertension, and treatment thresholds could be better determined by ABPM. Some authors[14,15] are more guarded about the significance of white coat hypertension, and there is evidence that white coat hypertension can eventually progress to sustained hypertension.

Our sensitivity and threshold analyses demonstrate that monitoring, although more expensive in the first year, becomes cost neutral after three years and cost saving thereafter. This holds true over a reasonable range of values of key variables. A strength of this study is that GPs were asked to decide on conventional grounds that drug treatment was indicated before ordering ambulatory monitoring. These patients were all about to commence drug treatment, so the result reflects the realities of current Australian practice.

A limitation of the current study is its small sample size; however, larger series[6] have shown a similar prevalence of white coat hypertension. Although use of observed costs from the participating practices would have been sounder economic practice, national cost estimates for the treatment of hypertension are a reasonable substitute. The use of break-even threshold analysis allows application of the modelling results to patient series from other settings. The strategies compared took as their starting point the decision by the GP that drug treatment was necessary. In widespread use, ABPM is likely to be ordered earlier in the workup of hypertensive patients, resulting in the saving of some consultation costs and the ABPM monitoring of a greater number of patients. These effects cannot be assessed by this study.

Monitoring was well tolerated in this study, and readily adopted by GPs and patients. Patients shown to have low 24-hour average blood pressures were often greatly relieved not to start lifelong medication, and those with sustained hypertension were anecdotally more accepting of the diagnosis after ABPM, which may aid compliance.

Risks of ABPM are, firstly, of false results if adequate quality assurance protocols are not adhered to. Monitors must be calibrated to a reference sphygmomanometer during the set-up for each patient, which can be time consuming. Secondly, the results must be interpreted against ABPM reference values, not against clinic blood pressure values. Clinicians could mistakenly deny treatment to patients who would benefit if they compared 24-hour results with the conventional treatment threshold, such as diastolic pressures of 95 mmHg.

An alternative strategy to detect white coat hypertension is home monitoring with semi-automated devices. This involves cheaper equipment, but more time teaching the patient the method. Home monitoring strategies should be subjected to similar analysis.

COMPETING INTERESTS

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