

# **NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE**

## **Medical technology guidance**

### **Assessment report overview**

# **WatchBP Home A for diagnosing and monitoring hypertension and detecting atrial fibrillation**

This assessment report overview has been prepared by the Medical Technologies Evaluation Programme team to highlight the significant findings of the assessment report. It includes key features of the evidence base and the cost analysis, any additional analysis carried out, and additional information, uncertainties and key issues the Committee may wish to discuss. It should be read along with the sponsor's submission of evidence and with the assessment report. The overview forms part of the information received by the Medical Technologies Advisory Committee when it develops its recommendations on the technology.

This report contains information that has been supplied in confidence and will be redacted before publication. This information is highlighted in yellow.

This overview also contains:

- Appendix A: Sources of evidence
- Appendix B: Comments from professional bodies
- Appendix C: Comments from patient organisations
- Appendix D: Additional analyses
- Appendix E: Additional submission information
- Appendix F: Sponsor's factual check of the assessment report and the External Assessment Centre's responses

# 1 The technology

The WatchBP Home A device (Microlife) is an oscillometric blood pressure monitor. It automatically detects pulse irregularity that may be caused by symptomatic or asymptomatic atrial fibrillation. The device measures blood pressure based on the guidelines from the European Society of Hypertension (ESH), the American Heart Association (AHA) and the British Hypertension Society (BHS). The monitor can be used initially in a clinical setting with the first measurement taken under the supervision of a clinician. If hypertension is detected or suspected, the device can then be used by the person at home for a longer period of blood pressure monitoring.

The WatchBP Home A device has an embedded algorithm that calculates the irregularity index (standard deviation divided by mean) based on interval times between heartbeats. To reduce the effect of premature beats, each of the pulse beat intervals that deviates more than 25% from the average interval time is excluded from analysis. If the irregularity index is above a certain threshold value, atrial fibrillation is likely to be present and an atrial fibrillation icon is displayed on the device. The user is then advised to consult a clinician so that the diagnosis of atrial fibrillation can be pursued further. If atrial fibrillation is persistent then the diagnosis will be established from an electrocardiograph (ECG). If the atrial fibrillation is intermittent (paroxysmal), further ambulatory electrical monitoring tests may be necessary to confirm the diagnosis.

The WatchBP Home A device can be used either in 'diagnostic' mode (four measurements, two between 6 am and 9 am and two between 6 pm and 9 pm, taken on 7 consecutive working days) or in 'usual' mode (single measurements taken at any time). Results are stored in an internal memory or can be downloaded to a USB flash drive and taken to the clinician for evaluation; this would be after 7 days for 'diagnostic' mode or after an agreed interval using 'usual' mode. The device automatically displays the mean morning, evening and overall blood pressure results in table form.

## **2 Proposed use of the technology**

### **2.1 *Disease or condition***

Hypertension (high blood pressure) increases the risk of serious illness including stroke, myocardial infarction and heart failure. It is the most significant risk factor for atrial fibrillation. The Health Survey of England (2006) estimated that, on average, 31% of men and 28% of women over 16 years of age have high blood pressure of up to 160/100 mmHg. The proportion of people with hypertension increases with age; in the UK, about 1 in 4 middle aged adults and over half of those aged 60 or over have hypertension.

Atrial fibrillation is the most common sustained cardiac arrhythmia, occurring in around 1.2 million people across the UK. Atrial fibrillation pre-disposes people to thromboembolic events and therefore increases the risk and severity of stroke; 12,500 strokes per year in the UK are directly attributable to atrial fibrillation. The prevalence of atrial fibrillation is age dependent and increases from 0.5% at age 50–59 years to almost 9% at age 80–90 years.

Stroke is the third largest cause of death in the United Kingdom and is the leading cause of adult disability. Approximately a third of stroke victims will die within the first 10 days. Up to 4,500 strokes per year and 3,000 deaths may be preventable through improved services and optimal therapy.

### **2.2 *Patient group***

The WatchBP Home A device is intended for use in diagnosing and monitoring hypertension and can simultaneously detect the irregular pulse which is characteristic of atrial fibrillation. This evaluation considers the use of the device to opportunistically screen for hitherto undetected (most likely paroxysmal) atrial fibrillation in people with suspected or existing hypertension, or those who are being screened for hypertension. Therefore it is likely that the patient group will consist of those at higher risk of atrial fibrillation, either because of age or the presence of hypertension and/or other

risk factors. It is also likely to include people in whom opportunistic pulse palpation has failed to detect an irregular pulse.

### **2.3      *Current management***

Hypertension is diagnosed by measuring blood pressure either manually or with an automated blood pressure monitor, as outlined in NICE guidance 'Hypertension: clinical management of primary hypertension in adults' (NICE clinical guideline 127). Readings are taken initially in a clinic setting and can be followed by ambulatory blood pressure monitoring to confirm the diagnosis. Home blood pressure monitoring (usually using an automated monitoring device) can be undertaken for between 4 and 7 days as an alternative to ambulatory monitoring if this is unsuitable for the person being monitored. Treatment options for hypertension include lifestyle modifications and/or antihypertensive drugs.

The current care pathway for atrial fibrillation is described in the NICE guidance 'Atrial fibrillation' (NICE clinical guideline 36). Atrial fibrillation can be difficult to diagnose as it is often asymptomatic and intermittent. The irregularity of heart rhythm caused by atrial fibrillation can be detected by pulse palpation. It may be present in people with symptoms such as palpitations, dizziness, blackouts and breathlessness but may also be an incidental finding in people without symptoms during routine examination. NICE clinical guideline 127 recommends that the pulse should be palpated before measuring blood pressure if using an automated monitor. The diagnosis of atrial fibrillation must be confirmed with an ECG for all people in whom atrial fibrillation is suspected because of the detection of an irregular pulse.

Current treatment options for atrial fibrillation are dependent on type (acute, persistent, paroxysmal or permanent), response to previous treatment and comorbidities. Treatment is focused on controlling heart rhythm or rate with antiarrhythmic drugs or electrical DC cardioversion, and reducing the risk of

thromboembolic complications with anti-coagulant or anti-platelet drugs, according to an individual person's risk algorithm.

## **2.4      *Proposed management with new technology***

The aim of the WatchBP Home A device is to provide an alternative device for diagnosing or monitoring hypertension in line with NICE clinical guideline 127, while simultaneously offering a means of detecting an irregular pulse that may be caused by atrial fibrillation. It is likely to be used in people who could be at risk from atrial fibrillation but who have no symptoms and no pulse irregularities detected by manual pulse palpation.

## **2.5      *Equality issues***

People who do not have access, or who cannot operate, an internet-connected personal computer at home would be unable to perform telemonitoring with the device. However, the device automatically stores blood pressure readings so the person could take the device to the surgery or clinic where the reading data could be downloaded.

Some people may be unable to use any blood pressure monitoring device such as WatchBP Home A because of mental or physical conditions that may make the device difficult to use.

# **3            *Issues for consideration by the Committee***

## **3.1      *Claimed benefits***

The benefits to patients claimed by the sponsor are:

- a convenient, portable means of measuring blood pressure while simultaneously detecting atrial fibrillation
- reducing the risk of stroke by earlier diagnosis of atrial fibrillation, allowing the initiation of appropriate treatment to reduce thromboembolic risk
- reducing morbidity and mortality associated with stroke events.

The benefits to the healthcare system claimed by the sponsor are:

- reducing the need for clinic appointments for blood pressure measurement
- cost savings from the reduced incidence of stroke resulting from the enhanced diagnosis and treatment of atrial fibrillation.

### **3.2 Main issues**

The External Assessment Centre (EAC) considered the dual functionality of the WatchBP Home A device to monitor or diagnose hypertension and detect pulse irregularity characterised by atrial fibrillation to be of significant potential benefit, given the relationship between the two conditions, their asymptomatic presentation and their impact on health and NHS resources.

#### **Clinical evidence**

The EAC considered that the sponsor's submission failed to focus sufficiently on a specific, well-defined clinical question to address the main benefits of the device. The EAC excluded five studies from the original ten submitted by the sponsor as not relevant to the decision problem. These mainly evaluated the diagnostic accuracy or acceptability of the device for blood pressure monitoring alone. The EAC highlighted the lack of evidence for use of the device to measure blood pressure in people with an irregular pulse. After enquiry, the sponsor confirmed that research was underway to answer this question. The EAC reported that oscillometric upper arm devices such as the WatchBP Home A device compare favourably with other devices in this scenario.

The five included studies focused mainly on the diagnostic accuracy of the WatchBP Home A algorithm (not necessarily the WatchBP Home A device) to detect atrial fibrillation, comparing it to the gold standard 12-lead ECG (Stergiou et al., 2009; Wiesel et al., 2004; Wiesel et al., 2009). Although these studies were considered to be internally valid, the EAC raised concerns over the differing measurement protocols used in the studies, in terms of the number of readings needed to detect atrial fibrillation. The EAC considered

this to be a source of uncertainty in the diagnostic accuracy of the algorithm compared with the protocol used by the WatchBP Home A device.

The EAC also questioned the generalisability of these studies to the NHS community setting, because the studies were conducted in clinical settings outside the UK and were in populations whose atrial fibrillation status was known or where the prevalence of atrial fibrillation was likely to be high. Despite these limitations the EAC concluded that the diagnostic accuracy of the WatchBP Home A device was likely to be high.

Two studies (one unpublished) were conducted in a home setting. The published study (Wiesel et al., 2007) was a small case series in a population with previous history of atrial fibrillation and thus was considered to have limited generalisability.

[REDACTED]

[REDACTED] The EAC concluded that existing evidence on home use of the device was insufficient to fully evaluate the benefits of the device.

The EAC considered pulse palpation to be an appropriate comparator to the WatchBP Home A device in a community setting, as outlined in the scope. The sponsor did not address this in the clinical submission. The EAC did not find any studies that directly compared pulse palpation and the WatchBP Home A device, so carried out an indirect comparison using studies comparing pulse palpation and WatchBP Home A to the gold standard 12-lead ECG. The EAC felt that this work could have been done by the sponsor.

The EAC concluded that the evidence showed the sensitivity and specificity of pulse palpation to be lower than that of the WatchBP Home A device and that this appeared to support the sponsor's claim that the device reduces false positives and therefore the amount of confirmatory ECGs needed. However,

the evidence relating to pulse palpation was of higher quality and greater generalisability to the primary care population than that for the WatchBP Home A device. The EAC suggested that further evidence would be needed to confirm this claim.

### **Economic evidence**

The sponsor did not provide any specific published economic evidence relating to the WatchBP Home A device but presented a new cost analysis investigating the cost consequences of using the device compared with pulse palpation by a nurse or GP. The EAC were of the opinion that the sponsor used appropriate methodology and reference sources (that is, NHS and personal social services costs) and the model was replicable. Within this de novo analysis the WatchBP Home A device was found to be cost saving when compared with pulse palpation, in all cases.

The main issue raised by the EAC was that the population studied, people without symptoms of atrial fibrillation, deviated from the scope.

There were further uncertainties in the inputs used to populate the model. The model structure was calculated 'backwards' from an atrial fibrillation incidence rate, which the EAC did not consider to be the best approach. The time horizon was not sufficiently long to consider costs and benefits over time, particularly the consequences of stroke as outlined in the scope. The diagnostic accuracy of the WatchBP Home A device was estimated from studies with limited generalisability to the population defined in the scope.

No time costs were included for use of the WatchBP Home A device itself, however costs for pulse palpation were included. The EAC ran additional sensitivity analysis to exclude the pulse palpation costs and the device was still found to be cost saving.

No device costs were included in the model. The sponsor assumed a zero cost to purchase the device, as it considered that GP practices would need to



buy a home blood pressure monitor anyway. The EAC considered this to be an omission from the model.

The EAC considered that the assumptions in the sponsor's sensitivity analysis relating to symptomatic atrial fibrillation were of limited relevance.

The EAC was asked to carry out additional analysis to model use of the device in a home setting to opportunistically screen for atrial fibrillation during blood pressure monitoring. Using variables from the sponsor's model, device costs and costs of home monitoring taken from NICE guidance, the EAC found that in all cases, use of the WatchBP Home A device would incur additional costs to the NHS in the range of £4.44 to £10.30 per person when compared with current practice for home blood pressure monitoring. Despite the device's potential to prevent 22 strokes (range 0 to 202) per 100,000 people screened, the costs of prevention did not outweigh the costs of screening and treating patients in order to prevent stroke in patients diagnosed with atrial fibrillation. The Committee may wish to consider the possible variability in long-term costs of stroke that may affect the model.

The EAC did not include a direct comparison of WatchBP Home A use against ambulatory monitoring, as this was not considered to be an equivalent technology. However, the EAC cited evidence from NICE clinical guideline 127, which found that ambulatory monitoring was more cost effective than home blood pressure monitoring. The EAC also cited the guidance recommendation of ambulatory monitoring as the preferred option for confirming a diagnosis of hypertension. It questioned whether the WatchBP Home A device would be used instead of ambulatory monitoring as the benefits of accurately diagnosing hypertension could outweigh the added value of detecting atrial fibrillation opportunistically. The Committee may wish to consider the likely scenarios in which the WatchBP Home A device would be used for home monitoring, including the most appropriate population.

## 4 The evidence

### 4.1 *Summary of evidence of clinical benefit*

The sponsor identified seven published studies and three unpublished studies relevant to the scope. Of these ten studies, the EAC considered that three published and one unpublished study were not directly relevant to the decision problem and would not be considered further in the evaluation. Two published studies were excluded because they were device validation studies for blood pressure measurement. One published case series survey study was excluded because it concerned the acceptability of the device for measurement of blood pressure only with no reference to atrial fibrillation. The EAC considered that as the WatchBP Home A device is validated for blood pressure monitoring, these studies were not directly relevant to the decision problem. The excluded unpublished study was a randomised controlled trial comparing patient adherence to different monitoring regimens using the device.

Another unpublished comparative diagnostic study was considered to be highly relevant to the decision problem. However, this was at the recruitment stage and was therefore excluded because no results were available for consideration. Details of this study are included in section 5 of this report, 'Ongoing research'.

The five included studies comprised three cross-sectional diagnostic studies (Stergiou et al., 2009; Wiesel et al., 2004; and Wiesel et al., 2009), a small case series with diagnostic outcomes (Wiesel et al., 2007) and an unpublished [REDACTED] study (Wiesel et al., 2012).

No additional studies relating to the device were identified by the EAC. However, it did refer to two further studies evaluating the diagnostic accuracy of pulse palpation (Cooke et al., 2006; Hobbs et al., 2005) in order to make a comparison with the WatchBP Home A device.

## **Published evidence**

Wiesel et al. (2004) compared the sensitivity, specificity and diagnostic accuracy of a home blood pressure monitoring device (the Omron 712C automatic sphygmomanometer), modified to detect pulse irregularity (and hence atrial fibrillation), with a 12-lead ECG. The study used the same algorithm as that contained in the WatchBP Home A device. The study included an initial cohort of 125 inpatients from a hospital in New York, USA and a main cohort of 450 outpatients from a US urban cardiology clinic, all of whom had had 12-lead ECGs prior to the intervention. Of these patients, 53 inpatients and 54 outpatients had atrial fibrillation rhythms on ECG examination. Patients with a pacemaker were excluded from the study and data for four patients did not include two readings. The included outpatients (n = 446) had two successive readings taken with the modified sphygmomanometer during a scheduled clinic visit. An irregularity index, defined as the standard deviation of the time intervals between beats divided by the mean of the time intervals, was used to analyse ECGs from the inpatient cohort. A threshold irregularity index was selected at a level which all ECGs with atrial fibrillation would exceed. The threshold index was then used to determine the diagnostic accuracy of the device; the rhythm was considered to be irregular if two successive, paired readings were greater than the threshold index. The EAC noted that the protocol to detect atrial fibrillation was two successive positive results for irregular pulse, as opposed to the 'usual' mode of the WatchBP Home A which is three successive positive readings. An analysis of 446 paired readings showed that the device had a sensitivity of 100%, a specificity of 91%, and a diagnostic accuracy of 92% for detecting atrial fibrillation. The confidence intervals and statistical significance of these results were not reported.

Wiesel et al. (2009) conducted a study on 405 cardiology outpatients visiting two urban clinics in the US to determine the diagnostic accuracy of a Microlife oscillometric automatic home blood pressure monitor (BP3MQ1) to detect pulse irregularity likely to be atrial fibrillation. The study population was

considered representative of people at risk for atrial fibrillation. A 12-lead ECG and three sequential readings with the home monitor were taken for each patient during their visit to the clinic. Two out of three positive readings were considered positive for atrial fibrillation. Patients with pacemakers or defibrillators were excluded. The irregularity index and threshold value identified in the earlier study by Wiesel et al. (2004) were used to determine diagnostic accuracy. This study used a bootstrapping technique to estimate the sensitivity and specificity of a single measurement with the device, and retrospectively analysed patients who were classified as false positives. Chi-squared analysis found a statistically significant relationship between the ECG and monitor readings, both single and three-sequential ( $p < 0.0001$ ;  $\chi^2$  value not quoted). Of the 405 patients tested, 93 (23%) patients had atrial fibrillation based on ECG readings and of those, 90 (22%) were correctly identified using the home monitor after three readings. For single readings the home monitor had a sensitivity of 95% (95% confidence interval [CI] 93 to 98) and a specificity of 86% (95% CI 84 to 89), and for three sequential readings it had a sensitivity of 97% (95% CI 91 to 99) and a specificity of 89% (95% CI 85 to 92). Of the 64 patients with abnormal rhythms not attributable to atrial fibrillation identified by ECG, the home monitor correctly classified more than 50%. The device specificity for patients in sinus rhythm was 97%.

Stergiou et al. (2009) carried out a study to determine the diagnostic accuracy of a Microlife oscillometric automatic home blood pressure monitor with embedded algorithm (BPA100 Plus) to detect atrial fibrillation. Patients were recruited from people attending an outpatient hypertension clinic or admitted to a university department medicine ward in Athens, as well as healthy volunteers. In total, 73 patients were recruited, including 27 with known sustained atrial fibrillation, 23 with other non-atrial fibrillation arrhythmias, and 23 controls with sinus rhythm. Patients with pacemakers or defibrillators were excluded. Three successive blood pressure readings were taken for each patient using the home monitor, while a 12-lead ECG was recorded simultaneously during each measurement. The algorithm used the irregularity index and threshold value identified in the study by Wiesel et al. (2004). The

sensitivity and specificity of the home monitor for atrial fibrillation diagnosis were assessed for single, duplicate and triplicate measurements. A kappa-statistic was calculated to measure agreement with the ECG recordings. A total of 217 simultaneous blood pressure measurements and ECG recordings were obtained from 73 patients; two patients had only two readings. The device showed 93% sensitivity (95% CI 74 to 99) and 89% specificity (95% CI 76 to 96) for detecting atrial fibrillation from a single measurement. Where one positive reading from two or three taken was needed to indicate atrial fibrillation, the sensitivity was 100% (95% CI 84 to 100) and specificity was 76% (95% CI 60 to 87). For triplicate measurements, where two positive readings were needed to detect atrial fibrillation, the sensitivity was 100% (95% CI 84 to 100) and specificity was 89% (95% CI 75 to 96). The kappa statistic showed substantial agreement in all scenarios, with the highest level of agreement observed when two out of three readings were used to detect atrial fibrillation ( $\kappa = 0.86$ ). The authors considered this to be the optimal diagnostic mode for the device. Five false positive cases of atrial fibrillation were observed, however all showed some heartbeat irregularity during measurement.

Wiesel et al. (2007) carried out a case-series study to examine the efficacy of a modified home blood pressure monitor (Omron 712C automatic sphygmomanometer with algorithm as described in Wiesel et al. [2004]), to detect atrial fibrillation when used by patients at home over an extended period of up to five months. Nineteen outpatients in sinus rhythm during their clinic visit, but with at least one previous episode of atrial fibrillation, were recruited from a hospital-based clinic in the US. Of these patients, 13 were female and the mean age was 74. During the study period, six patients were taking anti-arrhythmic medication and 11 were taking warfarin. Patients were given the device to monitor their blood pressure once per day for up to 30 days if no irregularity was detected. If any irregularity was detected, patients were asked to repeat their readings up to three times and in the case of three positive readings, to return to the clinic for an ECG. Patients were monitored for between 5 days and 5 months and an ECG was carried out at each clinic

visit regardless of the home monitor readings. The monitor correctly identified recurrent atrial fibrillation in seven patients. Nine patients had no irregular readings throughout the study period. Three patients with irregular readings were false positively identified as having atrial fibrillation; this was due to sinus arrhythmia or ectopy. One patient with atrial fibrillation had intermittently regular readings; this was likely to be caused by an atrial flutter.

**Unpublished evidence**

[Redacted content]

[REDACTED]

The EAC considered that the comparator in the three published studies (Wiesel et al., 2004; Wiesel at al., 2009; and Stergiou et al., 2009) was appropriate for assessing the diagnostic accuracy of screening techniques. The EAC considered these studies to have minimal potential for operator or observer bias and to have high internal validity. The EAC highlighted concerns over the interpretation of the study data from clinical settings where the atrial fibrillation status of the patients was either known, or the pre-test probability of the patients having atrial fibrillation was high. In addition, the devices used had differing measurement protocols (for example, needing one, two or three positive measurements in succession for positive detection of atrial fibrillation) which could lead to different results from those using the WatchBP Home A device. The EAC had concerns about the generalisability of the results of these studies to the population described in the scope, and to the WatchBP Home A device.

The EAC considered that the study by Wiesel et al. (2007) carried out in a home setting lacked the methodological quality and generalisability to inform the decision problem because it was a small case series.

[REDACTED]

[REDACTED] Overall the EAC was of the opinion that there was a lack of evidence to support home use of the WatchBP Home A for atrial fibrillation detection, rather than evidence of no benefit.

## **Evidence on the diagnostic accuracy of pulse palpation**

The EAC considered that the sponsor's submission did not satisfactorily address the question of the diagnostic accuracy of pulse palpation, outlined in the decision problem. As such the EAC carried out additional work to try and address this problem. Neither the EAC or the sponsor found any studies directly comparing WatchBP Home A to pulse palpation and so the EAC decided to make an indirect comparison by evaluating evidence comparing both methods of screening for atrial fibrillation with a reference standard, 12-lead ECG.

Two studies were identified and reference was made to evidence in NICE clinical guideline 36. Cooke et al. (2006) conducted a systematic review and meta-analysis which identified three studies comparing pulse palpation with 12-lead ECG in UK general practice settings. Overall sensitivity of pulse palpation was found to be 94% (95% CI 84 to 97) and specificity was 72% (95% CI 69 to 75). Assuming a prevalence of 3% for undetected atrial fibrillation in the people aged 65 or over, the authors concluded that opportunistic pulse palpation in this group would detect an irregular pulse in 30% of screened patients.

The studies identified in this systematic review were also included in NICE clinical guideline 36. The EAC pointed out that evidence used to inform this guideline indicated that a regular pulse has a relatively high negative predictive value (> 96%) and thus there will be a relatively low number of false negative diagnoses with pulse palpation.

Hobbs et al. (2005) carried out a large (n = 14,802) multicentre randomised controlled trial (the 'Screening for atrial fibrillation in the elderly' [SAFE] study) to investigate the clinical and cost effectiveness of opportunistic screening for atrial fibrillation using pulse palpation compared with systemic screening with nurse or GP-led ECG in people aged 65 and over. Opportunistic screening proved to be the most cost effective. Both techniques were compared with 12-lead ECG. Pulse palpation was found to have a sensitivity of 87.2% (95% CI



82.1 to 91.1), a specificity of 81.3% (95% CI 79.7 to 82.8), a positive predictive value of 30.1% (95% CI 26.7 to 33.8), and a negative predictive value of 98.6% (95% CI 97.9 to 99.0).

The EAC concluded that the included evidence showed the sensitivity and specificity of pulse palpation compared with 12-lead ECG to be lower than that of the WatchBP Home A device. This appeared to support the sponsor's claim that the device reduces false positives; however the evidence relating to pulse palpation, that is, the SAFE study, was of higher quality and greater generalisability to the primary care population than that for WatchBP Home A. The EAC suggested that further evidence would be needed to confirm the claim.

The EAC also made a similar point about the positive predictive value of the device, which was found to be higher than that of pulse palpation, from the included evidence. The populations in the WatchBP Home A studies were at higher risk and had a higher probability of having atrial fibrillation than the primary care populations in the pulse palpation studies, which may affect the generalisability of the results.

## **4.2 Summary of economic evidence**

The sponsor identified four studies from the literature in order to verify the reliability of pulse palpation. Two studies were excluded and so the sponsor used the remaining two studies (Hobbs et al., 2005; Morgan et al., 2002).

### **De novo cost analysis**

The sponsor submitted a de novo cost analysis which adopted a cost consequence model comparing the diagnostic accuracy of WatchBP Home A with pulse palpation to detect irregular pulse in a primary care setting. The sponsor did not present any analyses for the use of WatchBP Home A in a home environment.

The costs and consequences of atrial fibrillation screening and treatment when using WatchBP Home A and pulse palpation by a nurse or GP were

compared in people with suspected or existing hypertension or those who were being screened for hypertension. The main consequences were: referral for confirmation of atrial fibrillation with consultant-led 12-lead ECG, use of anticoagulant drugs and aspirin, adverse effects of anticoagulants and aspirin, and number of strokes prevented. The time horizon of the model was one year.

The key assumptions used in the model were:

- A fixed number (87,000) of new cases of atrial fibrillation screened each year.
- Atrial fibrillation is related to an annual 4% risk of developing stroke.
- 56% of patients diagnosed with atrial fibrillation are prescribed anticoagulants and 32% are prescribed aspirin.
- 2.4% of all patients prescribed anticoagulants had major bleeds and 15.8% had minor bleeds.
- For every 5.7 patients detected as having an irregular pulse only one is confirmed as having atrial fibrillation by ECG.

The diagnostic accuracy of WatchBP Home A was estimated from Wiesel et al. (2009) (96.8% sensitivity and 88.8% specificity) and Stergiou et al. (2009) (100% sensitivity and 89% specificity). The diagnostic accuracy of pulse palpation was estimated from Morgan et al. (2002) (91% sensitivity and 74% specificity) and Hobbs et al. (2005) (87.2% sensitivity and 81.3% specificity).

The clinical variable estimates used in the economic analysis were derived from the NICE costing report from NICE clinical guideline 36. These were: probability of starting anticoagulant drugs or starting antiplatelets, absolute risk reduction of having a stroke if on anticoagulants or if on antiplatelets, and the probability of a minor bleed or a major bleed.

The EAC considered that two of the studies used to estimate the diagnostic accuracy of WatchBP Home A and pulse palpation were unsuitable for inclusion; these were Stergiou et al. (2009) for WatchBP Home A and Morgan

et al. (2002) for pulse palpation. The study by Stergiou et al. (2009) was excluded on the grounds that it had potential for operator or observer bias, was small (n = 73) and used a different protocol for atrial fibrillation diagnosis than that used by the WatchBP Home A device; there was also the possibility of confirmation bias in the results selected for use by the sponsor. The study by Morgan et al. (2002) was excluded because it used an ECG rhythm strip rather than the gold standard 12-lead ECG.

The EAC considered that there were some limitations of the model. The sponsor considered people who were clinically suspected of having atrial fibrillation, which was not the population defined in the scope (people with suspected or existing hypertension or those being screened for hypertension). The EAC considered that even though the prevention of stroke is a long-term outcome, the model had a time horizon of 1 year and the sponsor had not attempted to extrapolate into the future using a state transition model or a decision tree. The parameters used in the model were estimated from the literature and were not based on a randomised controlled trial. The initial calculation of cost consequences was based on steady-state model, and a non-steady-state model was not considered, which could have been useful. For example, if WatchBP Home A identified more cases of atrial fibrillation than current practice it would be expected that in the early years of the introduction of the device, the rates of detection would be higher to reflect the previously undiagnosed population pool.

In the sponsor's analyses, no time was allowed for WatchBP Home A use even though three successive cuff inflations are needed, one minute apart. The EAC also noted that the costs had been adjusted for inflation assuming that inflation is 5%, which is probably an overestimate. The sponsor did not include the cost of purchasing the WatchBP Home A or any costs for replacement cuffs incurred over the lifetime of the device. The EAC acknowledged that the price of WatchBP Home A is similar to other devices, but it considered that there is uncertainty in assuming a zero cost. The EAC also commented that the population needing screening was back calculated

from the number of people successfully diagnosed with atrial fibrillation, which implied that all the people screened must have been actively considered clinically at high risk of atrial fibrillation. The EAC considered that a better approach would have been to take a realistic estimate of the prevalence of atrial fibrillation in the population, and applying this to the sensitivity and specificity parameters reported in the published clinical studies.

### **Costs and benefits**

The costs directly associated with the WatchBP Home A and with pulse palpation were considered to be the cost of the time taken for the procedure itself and the cost of confirmation of the diagnosis with ECG. The capital cost of the WatchBP Home A device was not included in the analysis because the sponsor assumed that GPs would need to purchase a blood pressure monitor as routine practice. The cost of an ECG was £36.03, which was taken from the NICE costing report from NICE clinical guideline 36, adjusted for inflation (5%). The cost of pulse palpation was £2.32 and was derived from Hobbs et al. (2005) and adjusted for inflation. This was calculated by taking the mean average of 1 minute salary costs of a nurse and GP.

Indirect costs and potential resource savings of the WatchBP Home A device were also derived from the NICE costing report from NICE clinical guideline 36 and adjusted for inflation. These included the cost of medication for management of confirmed atrial fibrillation with anticoagulants (mainly warfarin or aspirin), the cost of treating adverse effects associated with these drugs and savings from the number of strokes prevented. The indirect costs and stroke prevention savings were included in the model for both the WatchBP Home A and pulse palpation groups.

The sponsor did not clearly state from whose perspective the economic analysis was performed but based on the data inputs supplied, the EAC assumed that it was from an NHS and personal social services perspective.

## Results

The base-case analysis showed that the WatchBP Home A device in a primary care setting would lead to an annual saving of £9,165,000 for the NHS in England and Wales by displacing pulse palpation, based on the assumption that all people with atrial fibrillation were symptomatic and that the cost of stroke was £9,906 per person. The WatchBP Home A device was associated with the prevention of 221 strokes, freeing NHS resources equivalent to £2,289,000.

A deterministic sensitivity analysis was carried out by the sponsor testing the proportion of people with atrial fibrillation who are symptomatic (100%, 65% or 50%) and the cost of stroke (£44,000 rather than £9,906). The sensitivity analysis demonstrated that an increasing proportion of asymptomatic patients leads to a reduced saving by the WatchBP Home A device. If the more expensive estimate of stroke is used, both pulse palpation and the WatchBP Home A device become cost effective and release resources for the NHS. The EAC considered that the sensitivity analyses should be considered with caution because the proportion of asymptomatic patients in the general population is unknown. In addition, the assumption that atrial fibrillation is only screened for in symptomatic patients does not reflect the decision problem. The EAC considered that the higher cost of stroke represented an estimate from a societal perspective and not that of the NHS or personal social services.

The EAC carried out a multivariate sensitivity analysis to examine the impact of changing the following parameters:

- prevalence of atrial fibrillation in the study population
- sensitivity and specificity of pulse palpation and the WatchBP Home A device
- inclusion and exclusion of the cost of pulse palpation.

The finding of the sensitivity analyses showed that excluding the time cost associated with pulse palpation did not make pulse palpation less costly than

the WatchBP Home A in any single scenario. In addition, the worst case sensitivity and specificity values increased costs in all cases; similarly the best case sensitivity and specificity values decreased costs in all cases compared with the base-case sensitivity and specificity. Total cost was highly sensitive to prevalence of atrial fibrillation, with populations with a higher prevalence consuming more costs than those with a lower prevalence, both for the WatchBP Home A device and for pulse palpation.

### **Additional cost analysis**

The sponsor's de novo cost analysis focused on the use of WatchBP Home A to screen for atrial fibrillation in a clinic environment, compared with pulse palpation. It did not include any analysis on the use of the device to detect paroxysmal atrial fibrillation which could be missed by pulse palpation, or the potential for use of the WatchBP Home A device at home for diagnosing or monitoring hypertension while opportunistically screening for atrial fibrillation. The EAC were therefore asked to carry out additional analysis to estimate the costs and consequences of using the device in this way to the NHS and personal social services in England and Wales. The EAC's report on the analysis is included in appendix D.

The EAC used studies from the sponsor's submission to inform the model and did not conduct any additional literature searches. One published and one unpublished study included in the review of clinical evidence were carried out in a home setting ( [REDACTED] Wiesel et al., 2007). The EAC did not consider their methodology and populations to be suitable in providing parameters to inform the model, however

[REDACTED]  
[REDACTED]

The EAC developed a monetised cost consequence model for patients needing home monitoring for hypertension following a reading indicative of hypertension taken in a clinical setting. The population included a proportion

with paroxysmal atrial fibrillation and also those permanently in atrial fibrillation. No assumptions were made about age or gender.

The intervention was use of the WatchBP device at home for either 4 days, morning and evening (in 'usual' mode), or for 7 days, morning and afternoon (in 'diagnostic' mode). The comparator was defined as an alternative home blood pressure monitoring device without an atrial fibrillation detection algorithm. Ambulatory blood pressure monitoring was considered to be a potential comparator as outlined in the scope and in NICE clinical guideline 127, however the EAC felt that it could not include this in the model because the superior diagnostic accuracy of ambulatory monitoring rendered it incomparable to a home monitoring device.

The model was used to simulate a cohort of 100,000 patients using the WatchBP device at home to detect paroxysmal atrial fibrillation. This figure was used because the exact number of patients using home monitoring for blood pressure is not currently known. The EAC used the study by Wiesel et al. (2009) to provide sensitivity and specificity values for atrial fibrillation detection of 95.3% and 86.4% respectively from single diagnostic measurements, using the assumptions that all variability in individual measurements was due to the included patients and single measurements in each patient were not independent of each other. The atrial fibrillation detection algorithm was used for either 4 or 7 days to simulate use in 'usual' or 'diagnostic' mode. Each subject was randomly assigned the outcome of either presence of atrial fibrillation detected or absence confirmed.

As the EAC was unable to ascertain the prevalence of paroxysmal atrial fibrillation in the model population from the literature, the following prevalence estimates were used:

- 0.5%, representing the prevalence in people aged 50–59 years (NICE clinical guideline 36)
- 1.28%, representing the prevalence in the general population (Majeed et al., 2001)
- 4.4%, the sponsor's estimate of atrial fibrillation prevalence
- 7.9%, representing the prevalence in people aged over 65 years in the community (Hobbs et al, 2005)
- 9%, representing the prevalence in people aged 80–89 years NICE clinical guideline 36).

The EAC was unable to find generalisable information on the patterns of paroxysmal atrial fibrillation episodes from the literature and therefore used sensitivity analysis to model time spent in atrial fibrillation as 2%, 5%, 20% and 50%. The EAC also used 100% time spent in atrial fibrillation and in doing so were able to replicate and validate the sponsor's de novo analysis model.

### **Costs and benefits**

Costs were calculated and evaluated according to the sponsor's de novo analysis (cost of confirmatory ECGs, anticoagulant and antiplatelet drugs and associated adverse effects, and savings associated with strokes prevented). The EAC also included additional calculations to take into account costs associated with replacing existing home blood pressure monitoring devices with the WatchBP Home A, which the sponsor did not include in its de novo cost analysis, based on the assumption that home blood pressure monitors are already used in current practice. The EAC used costs from NICE clinical guideline 127 for use of a typical home blood pressure monitoring device (£45 annually). The EAC considered that other than the purchase cost of WatchBP Home A (£75 compared with £42 for a standard home blood pressure monitor), all other costs would be equivalent.



The EAC considered that using the WatchBP Home A device could incur additional capital outlay if it displaced other home blood pressure monitoring devices from use in practice. This would depend on the number of people sent home with the device, at present an unknown variable. For the 8245 GP practices in England, assuming one device purchased per GP practice, the initial outlay would be around £620,000; for individual GPs, this would increase to £2,700,000. If additional devices were purchased for routine in-office use, total investment costs in the first year could rise significantly.

The EAC considered the number of strokes prevented per 100,000 people screened as a separate output.

## **Results**

The EAC carried out quality assurance on its model by adjusting the time spent in atrial fibrillation, the number of monitoring days, and increasing the prevalence.

For the base-case analysis the EAC selected the sponsor's estimate of prevalence of atrial fibrillation (4.4%) and the mid-range figure for time spent in atrial fibrillation (20%) for use. The base-case analysis showed that using the device would consume NHS and personal social service resources of around £5.32 per person and prevent 22 strokes per 100,000 people screened. This would be an additional cost over and above the estimated cost of using a standard home blood pressure monitoring for the process of diagnosing hypertension, £39.13 (NICE clinical guideline 127). The total cost per patient of using the WatchBP Home A device to diagnose hypertension and screen for paroxysmal atrial fibrillation was therefore estimated to be £44.45 (excluding the cost of the device).

The EAC carried out a multivariate sensitivity analysis to examine the impact of changing the following parameters:

- prevalence of atrial fibrillation
- proportion of patients in atrial fibrillation when measured
- number of days blood pressure measured for (four or seven).

In all cases using the WatchBP Home A device incurred a cost to the NHS and personal social services. Excluding those in permanent atrial fibrillation (100%), the additional costs incurred per patient ranged from £4.44 per person (9% prevalence, 2% time in atrial fibrillation, 7 day monitoring) to £10.30 per person (9% prevalence, 50% time in atrial fibrillation, 7 day monitoring). Little difference in cost was found between monitoring for 4 or 7 days. The majority of costs incurred related to the treatment of atrial fibrillation rather than the cost of the device. Increases in atrial fibrillation prevalence and time spent in atrial fibrillation led to increased NHS costs in terms of anticoagulant or antiplatelet therapy, which was not outweighed by the costs of stroke prevention, except when low rates of time spent in atrial fibrillation were used (10% or less), leading to lower detection rates.

The EAC highlighted that there was uncertainty in the number of strokes prevented depending on the parameters used in the sensitivity analysis. This number ranged from 0 to 202. The EAC considered that stroke prevention is an important endpoint in terms of quality of life and mortality.

The EAC was unable to model use of ambulatory monitoring. However it did examine the costs of this in light NICE clinical guideline 36, which recommends ambulatory monitoring as the preferred method for diagnosing hypertension and that home monitoring should only be used in those unable to tolerate ambulatory monitoring. The EAC considered that diagnosis of hypertension would take precedence over the opportunity to detect atrial fibrillation. Results of a cost analysis carried out during the guideline development showed that ambulatory monitoring was more cost effective than home monitoring.

## 5 Ongoing research

[REDACTED]



## **6 Authors**

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NICE Medical Technologies Evaluation Programme

March 2012

## Appendix A: Sources of evidence considered in the preparation of the overview

### A Details of assessment report:

- Willits I, Reay C, Keltie K et al. Watch BP Home A for diagnosing and monitoring hypertension and detecting atrial fibrillation (February 2012) - NUTH and YHEC EAC

### B Submissions from the following manufacturer/sponsors:

- Microlife (Manufacturer)

### C Related NICE guidance

- Atrial fibrillation: the management of atrial fibrillation. NICE clinical guideline 36 (2006). Available from [www.nice.org.uk/guidance/CG36](http://www.nice.org.uk/guidance/CG36)
- Hypertension: the clinical management of primary hypertension in adults. NICE clinical guideline 127 (2011). Available from [www.nice.org.uk/guidance/CG127](http://www.nice.org.uk/guidance/CG127)
- Dronedarone for the treatment of nonpermanent atrial fibrillation. NICE technology appraisal guidance 197 (2010). Available from <http://guidance.nice.org.uk/TA197>
- Stroke: diagnosis and initial management of acute stroke and transient ischaemic attack (TIA). NICE clinical guideline 68 (2008). Available from <http://guidance.nice.org.uk/CG68>
- Alteplase for the treatment of acute ischaemic stroke. NICE technology appraisal guidance 122 (2007). Available from <http://guidance.nice.org.uk/TA122>

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Atrial Fibrillation: the management of atrial fibrillation. NICE clinical guideline 36 (2006)

Cooke G, Doust J, Sanders S (2006) Is pulse palpation helpful in detecting atrial fibrillation? A systematic review. *Journal of Family Practice* Feb; 55(2): 130–134

Hobbs F, Fitzmaurice DA, Mant J et al. (2005) A randomised controlled trial and cost-effectiveness study of systematic screening (targeted and total population screening) versus routine practice for the detection of atrial fibrillation in people aged 65 and over. The SAFE study. *Health Technology Assessment* Oct; 9(40): iii-iv, ix-x, 1–74

Hypertension: the clinical management of primary hypertension in adults. NICE clinical guideline 127 (2011)

Majeed A, Moser K, Carroll K (2001) Trends in the prevalence and management of atrial fibrillation in general practice in England and Wales, 1994-1998: analysis of data from the general practice research database. *Heart* Sep; 86(3): 284–288

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Wiesel J, Wiesel DJ, Messineo FC (2007) Home monitoring with a modified automatic sphygmomanometer to detect recurrent atrial fibrillation. *Journal of Stroke and Cerebrovascular Diseases* 16(1): 8–13

Wiesel J, Fitzig L, Herschman Y et al. (2009) Detection of atrial fibrillation using a modified microlife blood pressure monitor. *American Journal of Hypertension* Aug; 22(8): 848–852

Wiesel J, Abraham S, Messineo F

(2012) [REDACTED]  
[REDACTED]  
[REDACTED]

## **Appendix B: Comments from professional bodies**

Expert advice was sought from experts who have been nominated or ratified by their Specialist Society, Royal College or Professional Body. The advice received is their individual opinion and does not represent the view of the society.

### **Dr Ameet Bakhai**

Cardiology Consultant, British Cardiovascular Society

### **Professor John Cleland**

Professor of Cardiology, Royal College of Physicians

### **Dr Neil Sulke**

Cardiology Specialist, British Cardiovascular Society

- One expert has had direct involvement with the technology and manages patients who use it. Two experts would like to use this technology but it is not available to them. One has been involved in research on this product.
- Three expert advisors believe that it is a significant modification of an existing technology.
- One expert stated he would expect it to be used for screening in practices and in health checks. One expert stated it should be used for opportunistic detection of atrial fibrillation while taking blood pressure and one expert stated it would be used in patients with hypertension who are at risk of atrial fibrillation.
- One expert stated that nurse-led pulse check, ECG and 24hr Holter are appropriate comparators. One stated that single lead ECG equipment used in conjunction with a smartphone are in development. One expert stated that standard 24-hour blood pressure monitors is a comparator.
- The experts stated that screening and detection for people at risk of stroke is the main patient benefit. Barriers to uptake include lack of widespread use, that it detects but does not diagnose atrial fibrillation, and the reluctance to take anti-coagulants to prevent stroke.

- Benefits can be measured by having screening program pilots, randomised trials and recording the detection rates for atrial fibrillation.
- One expert stated that the evidence for additional benefits is reasonable. One expert stated that there is strong evidence that anti-coagulants reduce stroke in atrial fibrillation, and atrial fibrillation contributes to overall risk of stroke.
- All three experts stated that the main healthcare system benefit is the potential reduction of strokes.
- Minimal training is needed to use this technology.
- One expert believes that it would be cost effective compare to ECGs. One expert believes that the costs of managing atrial fibrillation will increase but the costs of stroke care will reduce. He states that the technology itself is low cost. One expert stated that it would lead to a minor increase in costs
- One expert believes that NICE guidance would be very useful; one was uncertain how useful it would be.



## **Appendix C: Comments from patient organisations**

Advice and information was sought from patient and carer organisations. The following patient and carer organisations responded:

### **Atrial Fibrillation Association**

- The patient group stated that the main benefit of WatchBP Home A compared with current clinical practice is the ease of detecting atrial fibrillation within a GP practice or local centre.
- The patient group stated that there are many groups of patients who may benefit from using WatchBP Home A, but especially those who are at greater risk of atrial fibrillation and stroke (that is, those with hypertension, angina, chronic obstructive pulmonary disease, having falls and blackouts, who have contracted pneumonia, coronary heart disease, diabetes, hypercholesterol and the elderly).
- The group stated that atrial fibrillation is associated with social stigma as it is often only diagnosed after suffering a stroke, which can have a huge impact on life expectancy and quality of life.
- No disadvantages or problems with the technology were identified.
- The patient group stated that special considerations need to be given to gender groups, specific age groups, people with physical or learning disabilities and people with communication difficulties.
- The group stated that it believed guidance on WatchBP Home A should be produced as a matter of urgency because the prevalence of atrial fibrillation is known to be increasing.
- The group commented that WatchBP Home A offers an effective means of detecting atrial fibrillation early leading to prompt treatment and is available to use in many local settings where blood pressure is measured. The group noted that the device provides an instant reading with better sensitivity and specificity than other 'on the spot' options, does not need specially trained staff and is cheaper than mass referral for ECG.

## **Appendix D: Additional analyses**

Additional analysis of new economic evidence considered relevant to fully address the issues in the scope.

The Newcastle upon Tyne Hospitals  
NHS Foundation Trust



Y O R K  
**Health Economics**  
C O N S O R T I U M

**ADDITIONAL WORK SUPPLEMENT**

### **Cost analysis of the Watch BP Home A for diagnosing hypertension and detecting atrial fibrillation in a home environment**

**Produced by NUTH and YHEC EAC**

DR IAIN WILLITS, Medical Technologies Evaluator, NUTH

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FEBRUARY 2012

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## ***Rationale for additional work***

The sponsor's *de novo* cost analysis focused on the use of the WatchBP Home A in a clinic environment (such as a GP's or nurse's office), using the WatchBP Home A in "usual" mode compared with pulse palpation for the detection of atrial fibrillation (AF). In this context, the device could opportunistically detect AF as an incidental finding.

However, patients with paroxysmal AF but without an irregular rhythm at pulse palpation would be missed in the scenario modelled by the sponsor.

The use of the WatchBP Home A in a home environment is another potential indication for the device. In this scenario, patients who have been identified as having possible hypertension (for example have had a clinic blood pressure [BP] measurement exceeding 140/90 mmHg), or already have hypertension but require monitoring, could be issued with a home blood pressure measurement (HBPM) device to take home. For the diagnosis of hypertension, this would entail measurement of BP in the morning and evening for at least 4 days and preferably 7 days to confirm hypertension (1); if the WatchBP Home A was used the "diagnostic" mode could be used for the 7 day regimen, otherwise twice daily use with the "usual" mode could be considered. As the WatchBP Home A has an inbuilt pulse irregularity algorithm, this would allow for the incidental detection of paroxysmal AF whilst hypertension was confirmed or excluded.

Although the sponsor had discussed the possible benefits of home use in the narrative component of the *de novo* analysis, cost consequence analysis was not attempted, and thus no quantifiable results were provided. However, because the benefits of home use were potentially large, the EAC was asked to carry out an analysis to estimate the costs and monetized consequences to the NHS and PSS in England and Wales in this scenario of use. Where possible, the inputs and assumptions made in the sponsor's submission have been used in the EAC's model, to retain consistency with the original submission.

### ***Existing literature on AF detection in a home setting***

The EAC used studies identified by the sponsor which provided values for some of the parameters used in the model. The sponsor's search strategy and findings have previously been reviewed by the EAC in its report on the sponsor's submission. No additional searches were done to support this additional analysis.

[REDACTED]

The only published study in a home setting identified was a case series by Wiesel *et al* (2007)(3). Nineteen patients with a past history of AF were recruited and given the Omron 712C automatic sphygmomanometer to monitor their blood pressure and screen for AF over a period of five days to five months (three positive readings at various time points were regarded as positive for AF). If AF was "diagnosed", the patients were asked to report to a clinic the next day to receive confirmation by 12-lead ECG. In total, seven patients were identified as having recurrent AF, nine patients had no irregular readings and three (out of 19) patients had false-positive irregular readings. However, because of the methodology employed by the case series, it was not possible to estimate how many cases of paroxysmal AF it may have

missed, particularly asymptomatic paroxysmal AF. Therefore it was not possible for the EAC to draw meaningful conclusions from this study which would inform the model.

### ***Description of the model***

The EAC developed a cost consequence analysis model to estimate the NHS and PSS resource burden caused by the WatchBP Home A in a home environment. This was based on the scenario of a patient being sent home with an HBPM device after having recorded a clinical BP reading indicative of possible hypertension (i.e. above 140/90 mmHg).

### **Population**

The model considered patients requiring home monitoring for the diagnosis of hypertension. This included a proportion who have paroxysmal AF, and for completeness people who are permanently in AF (although it would be assumed this group would most likely have been detected in the clinic). As virtually all the population may be screened for hypertension opportunistically, no assumptions have been made regarding age or gender.

### **Intervention**

Use of the WatchBP Home A in a home setting. Two scenarios have been considered reflecting current national guidelines for the diagnosis of hypertension (1). These are use of the “usual” mode in the morning and evening for 4 days, and use of the “diagnostic” mode (once in the morning and once in the afternoon) for 7 days.

### **Comparator**

The comparator is use of an alternative HBPM oscillometric device without a pulse irregularity detection algorithm. As detection of AF is the outcome of interest, this is effectively a non intervention. However, as in practice BP measurement is the primary reason for the patient being issued with the device, ambulatory blood pressure measurement (ABPM) devices, which

have not been modeled, must be borne in mind (see [Ambulatory Blood Pressure Monitoring devices](#)).

The EAC could not include the use of an ABPM device in the current model because of equivalency issues. The WatchBP Home A is a fully validated BP monitor which can be assumed to be equivalent to other validated CE marked HBPM devices (see [www.bhsoc.org](http://www.bhsoc.org)) with respect to the accuracy of the measurement of BP. However, ABPM devices have significantly improved diagnostic accuracy (1).

### **Outcomes**

Outcomes are the same as those used in the sponsor's *de novo* analysis and are the costs of the consequences that have arisen by use of the WatchBP Home A. Capital costs associated with purchasing the device (including replacement of existing HBPMs) have been considered separately.

### **Model design**

A mathematical model was written in Matlab (Mathworks Ltd, Cambridge, UK) and was used to simulate a cohort of 100,000 subjects using the WatchBP device at home in order to detect paroxysmal AF. Settings of simulation assumed that each member of the cohort uses the device twice a day for a total of 4 or 7 days, consistent with NICE clinical guidelines on *Hypertension* (1).

In the home setting, use of the WatchBP Home A involves making repeated measurements (e.g. twice in the morning and evening for up to 7 days in "diagnostic" mode). The probability of getting a positive measurement in a series of measurements in any single disease positive subject is not necessarily the same as the sensitivity of the measurement itself, which is usually derived from a single measurement in each member of a group of subjects. For example, a measurement sensitivity of 90% does not necessarily mean that 90% of measurements in a disease positive subject will be positive. The overall values for sensitivity and specificity for the intervention (i.e. series of measurements) depend on the relative contribution to variability from i) the measurement itself (e.g. noise) and ii) the subjects. When source

(i) dominates, successive measurements can be treated as independent of each other, but when source (ii) dominates, the outcome of every measurement for a particular subject will tend to be the same. The study of Wiesel *et al*, 2009 (4) provided sensitivity and specificity values in a group of subjects for a single measurement and for a protocol which required two of three successive measurements to be positive. The EAC simulated the second of these protocols using sensitivity and specificity values from the single measurement for two assumptions: (i) all variability was due to the measurement and (ii) all variability was due to the subjects. Assumption (i) led to significantly different values for the intervention sensitivity and specificity and assumption (ii) did not. Wiesel *et al* (4) reported no significant difference between the protocols, consistent with assumption (ii). The EAC used this assumption in the model.

The EAC then used random number generation in order to determine if each member of the cohort had presence of AF detected or absence of AF confirmed. These sensitivity and specificity values chosen for each patient were maintained throughout the duration of monitoring.

### ***Inputs and outputs***

#### **Number of patients undergoing home measurement of BP**

It is unknown how many patients may require home monitoring to diagnose or exclude hypertension, and this figure was not estimated in the NICE clinical guidelines on *Hypertension* (1). Consequently the EAC simulated an arbitrary cohort of 100,000 patients and calculated per patient costs associated with this cohort.

#### **Sensitivity and specificity of WatchBP Home A to detect AF**

These figures (95.3% and 86.4% respectively) were taken from the single diagnostic measurements reported in the study by Wiesel *et al* (2009) (4).



### **Detection regimen**

The AF algorithm was performed once in the morning and once in the evening for 4 days to simulate “usual” mode or 7 days to simulate “diagnostic” mode. Because it was found that individual measurements in the regimen (i.e. three successive for usual mode and two successive for diagnostic mode) were not independent of each other, the sensitivity and specificity of a single measurement was used (i.e. the variation was entirely due to the patient, see [Model design](#)).

### **Proportion of patients with paroxysmal AF**

The EAC was unable to identify any studies in the literature which had estimated the prevalence of paroxysmal AF in the population that was investigated by the model (i.e. people undergoing home monitoring for the diagnosis or exclusion of hypertension). Therefore this was essentially an unknown variable. To compensate for this, a wide range of prevalence estimates of clinically detected AF values were used. These were values of:

- 0.5%, representing the prevalence in people aged 50-59 years (5).
- 1.28%, representing the prevalence in the general population (6).
- 4.4%, the sponsor’s estimate of AF prevalence.
- 7.9%, representing the prevalence in people aged over 65 years in the community (7).
- 9%, representing the prevalence in people aged 80-89 years (5).

### **Proportion of time spent in AF**

The EAC did not identify any studies that could be generalised regarding the natural history or pathophysiology of paroxysmal AF and in particular the frequency and duration of paroxysmal episodes in these patients. Therefore the EAC used sensitivity analysis to cover most the possible inputs. A semi-logarithmic scale was used to assume time spent in AF was 2%, 5%, 20%, 50%.

A value of 100% of the time spent in AF was also calculated, which would represent permanent AF. Using this, the EAC was able to replicate the

sponsor's *de novo* analysis results (found in Appendix B and C of the EAC's assessment report) and validate the model.

## **Costs**

Costs were calculated and evaluated according to the methodology provided by the sponsor's *de novo* analysis. Namely these were costs associated with confirmatory ECGs; anticoagulant and antiplatelet drugs; adverse effects of these drugs; and savings associated with strokes prevented. The EAC made some additional calculations to take into account possible costs associated with replacing existing HBPM devices with the WatchBP Home A (see [Cost of the WatchBP Home A](#)).

## **Outputs**

The consequences of using the WatchBP Home A in the context of AF detection were monetized, and it was the summation of these costs that informed the final output (cost to the NHS and PSS per patient per year). One clinical output that might be considered important was the number of strokes prevented per 100,000 people screened using the WatchBP Home A device. This has been reported as a separate output.

## **Results**

### **Model quality assurance**

The mathematical model simulating detection of paroxysmal AF was checked by:

- Setting the time spent in AF to 100% (i.e. simulating patients permanent AF), in which we were able to replicate the results of the sponsor and Appendix B and C of EAC assessment report.
- Setting the time spent in AF to 100% and increasing the number of monitoring days in order to ensure that intervention sensitivity and specificity remained constant.
- Increasing the prevalence to ensure more true positives were detected.

- Increasing the time spent in AF to ensure more true positives were detected.
- Setting the time spent in AF to 0% to ensure that no true positives were detected.

### Base case analysis

The full results for the EAC cost model on home use of the WatchBP Home A to detect AF in patients undergoing home diagnosis of hypertension are given in Appendix A.

As there is a large amount of uncertainty in two inputs (prevalence of paroxysmal AF and chance of being in AF) it is difficult to establish what the base case analysis is. Table 1 shows the number of strokes prevented and the costs associated with AF detection according to the sponsor's estimate of AF (4.4%) and the mid value of 20% proportion of time spent in AF.

*Table 1 Base case analysis of the use of the WatchBP Home A in a home environment.*

<b>Number of days measuring BP*</b>	<b>Strokes prevented (per 100,000)</b>	<b>Cost per patient</b>
<b>4 days</b>	<b>17</b>	<b>£5.17</b>
<b>7 days</b>	<b>27</b>	<b>£5.46</b>

**\*4 days minimum time specified by NICE, could be measured by twice daily use of usual mode. 7 days measured by diagnostic mode.**

So, using the base case analysis, use of the device would use NHS and PSS resources equivalent to about £5.32 per person, and prevent 22 strokes per 100,000 screened. Note that this cost would be expected to be additional to the cost of use of a standard HBPM, which has been estimated to be £39.13 in the NICE clinical guidelines on *Hypertension* (1)(this included consultation times and training), meaning that the total cost per patient for the diagnosis of hypertension and screening of paroxysmal AF would be about £44.45 using the WatchBP Home A device. However, this excludes the cost of the device itself.

## Sensitivity analysis

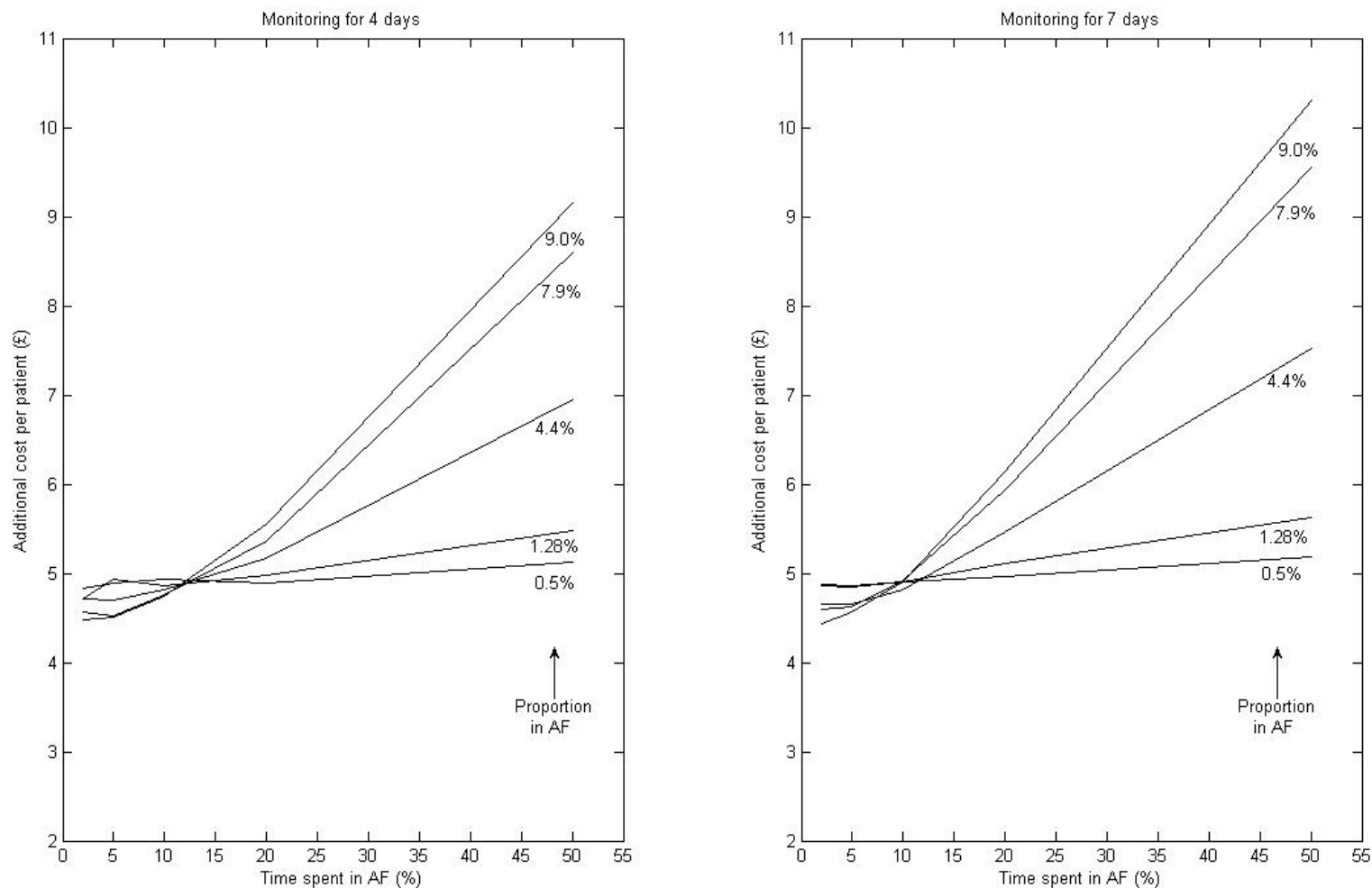
Multivariate sensitivity analysis was undertaken by varying the values of three inputs into the model. These were the prevalence (proportion of patients with paroxysmal AF), the proportion of patients who are having a paroxysm at the time of measurement), and the number of days BP was measured for (4 or 7, corresponding to a potential use of the usual mode and use of the diagnostic mode). The EAC considered that given the current evidence base these values were unknowable.

The full results of the sensitivity analysis are reported in Appendix A. In all cases use of the WatchBP Home A incurred a cost to the NHS and PSS. This is to be expected as it was seen in the sponsor's *de novo* cost analysis that at the cost of stroke used in their analysis (£9906), the cost of detection and treatment always outweighed savings from prevention.

Excluding permanent AF (100% time in paroxysmal episode), the most extreme values were £4.44 at the lower end (9% prevalence, 2% time in AF, and 7 days monitoring) and £10.30 at the higher end (9% prevalence, 50% time in AF, and 7 days monitoring). Thus there was a 2.3-fold variation in cost per patient across the modelled ranges of prevalence, time in AF, and number of days monitored.

Figure 1 shows the relationship and trends between the variables changed in the sensitivity analysis. Firstly it can be seen that there is little difference in costs associated with monitoring for 4 or 7 days. Secondly, in general, as the prevalence and time spent in AF increase, so do the costs to the NHS, as more money is spent on ECGs and anticoagulant and antiplatelet drugs, which is not outweighed by savings from strokes prevented. The exception to this is that at low rates of time spent in AF (10% and less), where fewer people are detected by the device resulting in slightly lower costs in high prevalence populations.

Figure 1: Sensitivity analysis showing the relationship between time spent in AF with additional cost per patient (£) with varying prevalence and days monitoring.



## Cost of the WatchBP Home A

The sponsor did not include the cost of the WatchBP Home A in their *de novo* cost analysis, with the justification that GPs and nurses already use HBPM devices in current practice. However, the EAC considered that introduction of the WatchBP Home A would incur a one-off replacement cost as, if introduced, the device would displace current HBPMs in use. The EAC considered this would still be the case when the device is used in a home setting.

The NICE clinical guideline on *Hypertension* (1) undertook a cost effectiveness study which estimated the cost of a single usage (7 days) of a typical HBPM device for the diagnosis of hypertension at home. This included factors such as the cost of the unit (£42, median price from NHS supply chain catalogue), 5 year lifetime (discounting applied), 40 uses per year, calibration costs, service costs, and batteries. In total, the median HBPM device cost £45 annually or £1.13 per weekly use, with most of the costs being due to consumables and servicing rather than the purchase cost. The EAC considered that other than the initial purchase cost (£75 cited by sponsor for WatchBP Home A), all other costs for the device would be equivalent. Hence the use of the WatchBP Home A would cause a marginal increase in cost per usage, but this is unlikely to be significant compared to costs associated with the AF detection (£4.44 to £10.30 per use), or the BP diagnosis process overall which includes costs associated with consultation and patient training (£39.13).

However, as discussed, introduction of the WatchBP Home A may be expected to incur an initial capital outlay as it displaces other HBPM devices from service. The absolute cost of this is dependent on the number of people who would be sent home with the device for the diagnosis of hypertension, but this is an unknown variable, complicated by the fact that ABPM is the first-line diagnostic device for ABPM (1)(see [Ambulatory Blood Pressure Monitoring devices](#)). There are 8245 GP practices in England (8) and around 36,000 GPs in England and Wales (see [www.bma.org.uk](http://www.bma.org.uk)) . Assuming only one device was required for loan use per GP practice, the initial outlay would be around £620,000. If one device was required per GP, the capital outlay would increase to £2,700,000. In addition to this, it would be anticipated that some WatchBP Home A devices would be routine for office use, in

line with the scenario described in the sponsor's *de novo* cost analysis. Thus total investment costs in the first year could feasibly exceed £5 million, although there is a great deal of uncertainty surrounding this figure.

### ***Discussion***

The EAC has designed a cost analysis model that has estimated the costs to the NHS and PSS associated with the incidental detection of AF during the diagnosis (or exclusion) of hypertension using the WatchBP Home A in a home environment. The analysis was limited by a lack of data available to populate key inputs, particularly regarding the prevalence and pathophysiology of paroxysmal AF. However, the EAC attempted to compensate for this by using extensive sensitivity analysis, covering a wide range of possible scenarios.

In all scenarios, the device incurred a cost per patient compared with the comparator of no detection. This cost ranged from £4.44 to £10.30 per use, and will be marginally higher when the costs of the device itself are included.

The principal clinical benefit of the device is that it reduces the number of strokes compared with an HBPM device that does not have the AF detection algorithm. In the base case scenario, this amounted to about 22 cases prevented per 100,000 people monitored. However, there was significant uncertainty surrounding this figure, with the number of strokes being prevented ranging from 0 to 202, depending on the prevalence of AF and the proportion of affected patients experiencing a paroxysmal episode at any one time. Although cost consequence models are not designed to evaluate cost-effectiveness, it is apparent that the numbers of strokes prevented is an important concern considering the loss of quality of life and shortened life expectancy associated with it.

In summary, introduction of the WatchBP Home A in a home setting would increase costs to the NHS compared with other HBPM devices without AF detection.

However, most of this cost is not associated with the direct cost of the device *per se*, but is due to the indirect costs associated with diagnosing and treating AF. The main clinical benefit of the device is the prevention of stroke, which poses a large burden to individuals in terms of mortality and morbidity, and resources used by the NHS.

However, at the base case cost of stroke used in the model, the device is not cost neutral in this regard.

### **Ambulatory Blood Pressure Monitoring devices**

The EAC were unable to incorporate the use of ABPM into the cost consequence model as a direct comparison could not be made. However, ABPM devices are an important consideration for this aspect of the decision problem.

The NICE clinical guideline on *Hypertension* recommends the use of ABPMs as the first line strategy for the diagnosis of hypertension (1). In contrast, HBPM devices are recommended only if the person “is unable to tolerate ABPM”. Since the population of the model is patients who require diagnosis or exclusion of hypertension as the primary concern (AF being an incidental finding) it is probable that most (if not the large majority) patients would be excluded from using the WatchBP Home A.

Diagnosis of hypertension would usually be considered to take precedence over detection of AF as it has a higher prevalence, and is associated with a much larger health burden (including a significantly increased risk of most cardiovascular diseases, such acute coronary syndrome, myocardial infarction, and stroke).

As part of the clinical guideline on *Hypertension*, NICE developed a cost effectiveness model that considered the incremental cost effectiveness of HBPM and ABPM compared with standard practice; that is the diagnosis of hypertension using clinical blood pressure measurement (CBPM) [1]. This model is described fully in [Appendix J](#) of the guidelines. A Markov model was constructed which allowed for subgroup analyses (age, gender) as well as extensive sensitivity analysis, and detailed costs were incorporated. For this study, ABPM was considered as the gold standard (sensitivity 100%, specificity 100%) whereas HBPM (sensitivity 85.7%, specificity 62.4%) and CBPM (sensitivity 85.6%, specificity 45.9%) showed poorer diagnostic accuracy.

The results of the base case analysis showed that in all scenarios ABPM was more cost effective than HBPM, and in the majority of scenarios ABPM actually dominated HBPM (i.e. it was more effective and it was less expensive). The guideline development group commented that “ABPM is cost-effective compared to CBPM and HBPM [and] was robust to a wide range of sensitivity analyses including those



varying the cost of ABPM". The cost savings of ABPM compared to CBPM ranged from £323 per person (female aged 40 years) to £63 per person (female aged 75 years). In comparison, the cost savings with HBPM were significantly less, ranging from £68 (female aged 40 years) to £16 (male aged 75 years, not significantly superior to CBPM).

### **Conclusion**

Clinical measurement of BP, typically in a GPs or nurse's office, is a common practice, and an abnormally high result (higher than 140/90 mmHg, the diagnostic threshold of hypertension) may prompt the healthcare professional to investigate and formally diagnose the presence of hypertension. Current guidelines by NICE (1) recommend two options for the measurement of BP to inform the diagnosis of hypertension.

- The preferred choice is ABPM. In most scenarios, this option has been shown to be both more effective and less expensive than measurement of hypertension with HBPM.
- An alternative option is HBPM, recommended for use in people who cannot tolerate ABPM. This is less preferred, because it has poorer diagnostic capabilities than ABPM, which ultimately results in greater costs to the NHS through under-treatment of hypertension.

The WatchBP Home A is an HBPM device that, if recommended, would displace the second-line diagnostic technique, HBPM without a pulse irregularity detection algorithm, from current practice. The EAC estimated, excluding the cost of the device itself, that this would lead to an additional cost of around £5.32 (range £4.44 to £10.30) per patient screened. This would be a relatively small increase (around 14%) on the current cost of performing HBPM (£39.13 per patient). However, the EAC anticipated that introduction of the device might incur significant initial capital investment costs (£75 per device) and ongoing costs as devices are replaced (cost difference compared with standard HBPM equivalent to £33 per device).

Additionally, the device may prevent about 22 strokes (range 0 to 202) per 100,000 screened. Most of the cost associated with the WatchBP Home A do not result from

the cost of the device *per se*, but relate to the screening and treatment costs required to prevent stroke, which is clearly a desirable clinical endpoint.

Appendix A 7 days monitoring (“diagnostic mode”)

<i>Input</i>		<i>Output (per 100,000 monitored at home)</i>					<i>Cost</i>
Time in AF (%)	Proportion with AF (%)	No. of AF detected (True positive)	No of AF missed (False negative)	Total patients with paroxysmal AF	Total ECG required (Test positive)	No. of additional strokes prevented	Additional cost per patient (£)
2	9.0	24	8,938	8,959	12,568	2	4.44
2	7.9	22	7,883	7,905	12,611	1	4.60
2	4.4	10	4,337	4,347	12,897	0	4.65
2	1.28	8	1,218	1,226	13,473	0	4.86
2	0.5	1	483	484	13,530	0	4.88
5	9.0	137	9,042	9,155	12,516	4	4.56
5	7.9	134	7,740	7,874	12,669	4	4.62
5	4.4	74	4,357	4,431	12,851	2	4.66
5	1.28	20	1,294	1,314	13,418	1	4.84
5	0.5	8	493	501	13,493	0	4.86
10	9.0	587	8,424	9,011	12,917	16	4.90
10	7.9	537	7,322	7,859	13,040	14	4.92
10	4.4	279	4,158	4,437	13,055	8	4.82
10	1.28	71	1,158	1,229	13,510	2	4.90
10	0.5	40	455	495	13,583	1	4.91
20	9.0	2,102	6,791	8,893	14,586	57	6.14
20	7.9	1,801	5,993	7,794	14,366	49	5.93
20	4.4	1,013	3,461	4,474	13,974	27	5.46
20	1.28	300	964	1,264	13,842	8	5.11
20	0.5	118	383	501	13,635	3	4.96
50	9.0	7,486	1,571	9,057	19,874	202	10.30
50	7.9	6,468	1,377	7,845	18,984	174	9.55
50	4.4	3,603	789	4,392	16,682	97	7.52
50	1.28	1,025	211	1,236	14,425	28	5.63
50	0.5	414	100	514	13,922	11	5.19
100	9.0	8,424	418	8,842	20,802	227	11.02
100	7.9	7,615	315	7,966	20,132	205	10.44
100	4.4	4,106	213	4,319	17,223	114	7.93
100	1.28	1,220	71	1,291	14,785	33	5.84
100	0.5	481	26	507	14,060	13	5.27

Appendix A 4 days monitoring ("usual mode")

<i>Input</i>		<i>Output (per 100,000 monitored at home)</i>					<i>Cost</i>
Time in AF (%)	Proportion with AF (%)	No. of AF detected (True positive)	No of AF missed (False negative)	Total patients with paroxysmal AF	Total ECG required (Test positive)	No. of additional strokes prevented	Additional cost per patient (£)
2	9.0	17	9,017	9,029	12,419	0	4.48
2	7.9	11	7,964	7,975	12,649	0	4.56
2	4.4	7	4,409	4,416	13,056	0	4.71
2	1.28	2	1,338	1,340	13,341	0	4.71
2	0.5	0	546	5,446	13,416	0	4.83
5	9.0	75	8,773	8,848	12,435	2	4.51
5	7.9	70	7,770	7,840	12,470	2	4.52
5	4.4	33	4,404	4,437	13,007	1	4.70
5	1.28	15	1,251	1,266	13,659	0	4.93
5	0.5	7	463	470	13,572	0	4.89
10	9.0	349	8,561	8,910	12,739	9	4.74
10	7.9	332	7,595	7,927	12,959	9	4.81
10	4.4	174	4,277	4,451	13,059	5	4.82
10	1.28	54	1,247	1,301	13,419	1	4.86
10	0.5	23	472	495	13,654	1	4.93
20	9.0	1,333	7,535	8,868	13,842	36	5.55
20	7.9	1,062	6,810	7,872	13,644	29	5.36
20	4.4	629	3,769	4,398	13,653	17	5.17
20	1.28	183	1,046	1,229	13,610	5	4.98
20	0.5	78	431	509	13,482	2	4.89
50	9.0	5,965	3,126	9,091	18,495	161	9.16
50	7.9	5,234	2,834	8,068	17,761	141	8.59
50	4.4	2,977	1,605	4,582	15,833	80	6.95
50	1.28	815	429	1,244	14,275	22	5.48
50	0.5	329	147	476	13,865	9	5.13
100	9.0	8,437	426	8,863	20,842	227	11.04
100	7.9	7,411	348	7,759	20,055	200	10.33
100	4.4	4,143	209	4,352	17,130	112	7.91
100	1.28	1,240	66	1,306	14,913	33	5.89
100	0.5	461	23	484	14,037	12	5.25

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## Appendix E: Additional submission information

### National Institute for Health and Clinical Excellence

#### Additional Submission Information

##### WatchBP Home A for diagnosing and monitoring hypertension and detecting atrial fibrillation

The purpose of this table is to show where the External Assessment Centre relied in their assessment of the topic on information or evidence not included in the original manufacturer submission. This is normally where the External Assessment Centre:

- a) become aware of additional relevant evidence not submitted by the manufacturer
- b) need to check “real world” assumptions with NICE’s Expert Advisers, or
- c) need to ask the manufacturer for additional information or data not included in the original submission

These events are recorded in the table to ensure that all information relevant to the assessment of the topic is made available to MTAC. The table is presented to MTAC in the Assessment Report Summary, and is made available at public consultation.

<b>Submission Document Section/Sub-section number</b>	<b>Question / Request to Manufacturer or Expert Adviser</b>  <i>Please indicate whether Manufacturer or Expert Adviser was contacted. If an Expert Adviser, only include significant correspondence and include clinical area of expertise.</i>	<b>Response</b>  <i>Attach additional documents provided in response as Appendices and reference in relevant cells below.</i>	<b>Action / Impact / Other comments</b>
<p>2.1.1</p> <p>2.1.5.2 &amp; 3.11.2</p>	<p>Two telephone conferences took place between the EAC and manufacturer's representative, Willem Verberk on Thursday 8<sup>th</sup> December 2011 and Wednesday 18<sup>th</sup> January 2012 (Jo Higgins, NICE advisor was present for both).</p> <p>Questions asked were:</p> <p>1. Five studies are described in the clinical submission, Can we clarify that these used equivalent devices to the WatchBP Home A, particularly the same algorithm? Especially since the Wiesel et al paper 2004 (and follow up paper in a home setting in 2007) – used a modified Omron 712C during development of the device.</p> <p>2. Has the WatchBP Home A been studied or validated for the accurate measurement of BP in patients who have active AF? Our understanding is many automated devices do not measure BP accurately in the presence of pulse irregularity hence NICE hypertension guidelines recommend manual pulse palpation. (Important because if BP measurement in AF patients not accurate then dual</p>	<ol style="list-style-type: none"> <li>1. The sponsor clarified that the algorithm used for the detection of AF irregularity was the same in all the devices referenced and was independent of the BP measurement. Therefore we can assume equivalence of the intervention in the provided studies regarding 'AF' detection.</li> <li>2. The sponsor clarified that the device had not been specifically validated to measure BP in patients with irregular pulse. He recommended that current practice would be to take the BP measurement several times and to use an average result, or to switch to manual measurement of BP. He also stated that the sponsor was conducting further research into this area although he did not give any details of future or submitted studies.</li> <li>3. The sponsor noted that AF would be rare in this population, so this aspect of the device is less useful.</li> <li>4. The sponsor commented that there was currently a one minute pause between cuff inflations (as recommended in guidelines), meaning that the total time in the usual</li> </ol>	<p><b>This information was incorporated into the EAC assessment report</b></p>



<b>Submission Document Section/Sub-section number</b>	<b>Question / Request to Manufacturer or Expert Adviser</b> <i>Please indicate whether Manufacturer or Expert Adviser was contacted. If an Expert Adviser, only include significant correspondence and include clinical area of expertise.</i>	<b>Response</b> <i>Attach additional documents provided in response as Appendices and reference in relevant cells below.</i>	<b>Action / Impact / Other comments</b>
<p>2.3.6</p> <p>4.3.4.4</p> <p>2.2</p>	<p>monitoring will not be possible).</p> <p>3. Is the device indicated for pregnant women or for monitoring for pre-eclampsia? [One study included states it is validated for this].</p> <p>4. How is the device used in practice in a clinical setting? In particular, we understand that the 'usual mode' of the device is used which requires three successive cuff inflations (and all three must be positive for irregular rhythm for AF to be diagnosed). How long does this take in practice?</p> <p>5. Is the sponsor aware of any other research of the device being used in a home setting? We are aware that TRIPPS 2.0 and a component of the Oxford study will investigate this but currently numbers are quite limited to understand the potential of the device in this setting.</p>	<p>mode was slightly over 3 minutes. However, as clinicians had complained this was too long the WatchBP Home A device has an override button meaning the device can be used with only a 15 second break between cuff inflations.</p> <p>5. The sponsor confirmed that another study is currently being carried out by Wiesel (based in New York) that will investigate the home use of the device in patients with intermittent AF. We will be sent information concerning this study (academic in confidence).</p>	

**Appendix F: Sponsor's factual check of the assessment report and the External  
Assessment Centre's responses**

**National Institute for Health and Clinical Excellence**

**Centre for Health Technology Evaluation**

**Pro-forma Response**

**Assessment Report**

**WatchBP Home A for diagnosing and monitoring hypertension and detecting atrial fibrillation**

Please find enclosed the response from the manufacturer's factual check of the assessment report.

The attached proforma document details any inaccuracies found by the manufacturer and how and why they should be corrected. An additional column has been included for the EAC's response.

**16th February 2012**

Issue 1

Description of factual inaccuracy	Description of proposed amendment	Justification for amendment	EAC response
<p><b>5.2.2</b></p> <p><i>“Sensitivity analysis. The EAC did not consider that all aspects of the sponsor’s sensitivity analysis were relevant to the decision model (e.g. the consideration of different proportions of symptomatic AF)”</i></p> <p><b>NICE comment: We suspect that this isn’t the correct section and are checking with the manufacturer.</b></p>	<p>We believe that the EAC might have taken into account some uncertainty with regard to human aspect in relation to pulse palpation. From literature we know that guidelines are not always known by GP’s and often poorly followed<sup>1-4</sup>. Therefore, it seems unlikely that 100% of the GP’s follow the guidelines. In this case, it still is not unlikely that patients without symptoms are not considered for screening.</p> <p>Although we are aware that it is difficult to provide a right estimate of this uncertainty, we also believe that it may not be correct to assume that all GPs always perform pulse palpation during blood pressure measurement.</p>	<p>We believe an important advantage of the WatchBP Home A may be overlooked: By using the WatchBP device the GPs /nurses will automatically follow the guidelines (AF screening during BPM). The initial reason for Microlife to develop the WatchBP family was to help healthcare workers to be adherent to guidelines as this is a common global problem in general health care.</p> <p>The fact that the guidelines state that pulse palpation should be performed before blood pressure measurement does not mean that this is done in general practice.</p> <p>As an example: the Nice Guidelines also state that double arm measurements should be performed at each first visit when a patient is suspected of hypertension. However a survey of Heneghan <i>et al.</i> learns us that 77% of all GP’s is aware that blood pressure should be measured in both arms, but only 30% agreed with it (95% CI =26 to 34%) and 13% (95% CI = 10 to 16%) adhere to it.<sup>5</sup></p>	<p><b>NICE comment: There may be variations between best practice and current practice, however this is not a factual inaccuracy.</b></p> <p>No bibliography was supplied for these references. We are aware that guidelines are not always adhered to but we have to assume they represent current optimal practice and are the appropriate comparator.</p> <p>No change.</p>

### Issue 2

Description of factual inaccuracy	Description of proposed amendment	Justification for amendment	EAC response
<p><b>2.1.1 Technology</b></p> <p>...Of these, the WatchBP Home A, the WatchBP Home S, and the WatchBP Office AFIB utilize the AF</p>	<p>The WatchBP office ABI also utilizes AF</p>	<p>In addition, it might be good to mention that the WatchBP Office AFIB is also equipped with auscultatory mode. The reason for this is that it is still recommended to measure e.g. patients with AF manually in auscultatory mode, as is clearly explained by the EAC and rightfully mentioned as an important item.</p>	<p><b>NICE comment: The evaluation is only concerned with the WatchBP Home A device.</b></p> <p>Reference to other devices in the range have been deleted.</p>

### Issue 3

Description of factual inaccuracy	Description of proposed amendment	Justification for amendment	EAC response
<p><b>2.1.6 changes to current service</b></p> <p>The EAC considered pulse palpation required no capital investment and limited time investment, as palpation is carried out simultaneously, or immediately following, BP measurement.</p>	<p>This is not according to the guidelines as this state that pulse palpation should be done before blood pressure measurement. But we agree that it is a limited time investment. The costs were not estimated by us but obtained from the SAFE study.</p>	<p>We would like to mention that the use of an automated device is accepted by the BHS guidelines<sup>6</sup> and even recommended “when possible” by the ESH guidelines<sup>7</sup>. This means that a GP in the UK also could use an oscillometric device.</p> <p>Pulse palpation has a lower sensitivity than the WatchBP Home device. This means that with PP some patients with AF are missed. When they are measured with a regular automated device this provides</p>	<p>We have changed the text to reflect that the recommendation is for pulse palpation to be used first.</p> <p>We recognise the costs of pulse palpation were derived from a high-quality study (an HTA) but feel we are justified in asking if these are realisable savings, especially considering the sponsor did</p>

		<p>erroneous measurements without knowledge of the GP. We wonder if this should not be considered in the analysis</p>	<p>not make any allowance for the triple cuff inflation used in the WatchBP. The sensitivity of pulse palpation vs WatchBP has been covered extensively in the critique.</p> <p>Our sensitivity analysis has covered both the inclusion and exclusion of pulse palpation costs. In all cases, the WatchBP was cost saving.</p>
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**Issue 4**

<b>Description of factual inaccuracy</b>	<b>Description of proposed amendment</b>	<b>Justification for amendment</b>	<b>EAC response</b>
<p>We do not think it can be considered a factual inaccuracy but we think it cannot be ignored as it is relevant for clinical practice.</p> <p>The sensitivity and specificity values for pulse palpation (also provided by the sponsor) are based on studies of Hobbs and Morgan. However, the</p>	<p>To take some uncertainty into account with regard to pulse palpation.</p>	<p>The WatchBP Home makes patient less dependent of the skills of the observer.</p>	<p>The sensitivity and specificity for pulse palpation was derived from a high quality, pragmatic, HTA in a population relevant to the decision problem. Confidence intervals have been supplied. Additionally, the figures were broadly consistent with an earlier systematic review.</p>

<p>participants in the study of Hobbs received extra training and the observers in the study of Morgan most likely have a special interest in AF. Based on that it can be expected that the overall sensitivity and specificity is not that high as in the study. A problem that is not to be expected (or less) with the WatchBP Home</p>			<p>Uncertainty in sens/spec was addressed by our additional sensitivity analysis. In all cases, the WatchBP was cost saving. Therefore we don't see a change is required or how it could be practically done.</p>
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### Issue 5

<b>Description of factual inaccuracy</b>	<b>Description of proposed amendment</b>	<b>Justification for amendment</b>	<b>EAC response</b>
<p>5.1.2. No evidence was presented about how accurately the device measures BP in people who are in irregular rhythm. Little evidence was presented in how effective the device is in detecting paroxysmal AF which may be more relevant in the home setting</p>	<p>The device is accurate for systolic blood pressure measurement but not for diastolic blood pressure measurement.</p>	<p>At the ESH congress in June a study to the accuracy of automated oscillometric blood pressure measurement in patients with atrial fibrillation was presented.<sup>8</sup> The study was performed with another blood pressure monitor of Microlife; the BP 100plus. This is not the WatchBP Home but as a company we can confirm that the BP 100 plus is identical to the WatchBP Home and has the same algorithm for both blood pressure measurement and AF. The results showed that the device has satisfactory accuracy in measuring systolic BP but not in diastolic BP in AF patients. The authors also came</p>	<p>We did not receive this reference.</p> <p>We are unclear about the implications of inaccurate diastolic readings. We appreciate further research is ongoing in this area but this will not currently affect the WatchBP Home A.</p> <p>Therefore feel we are unable to alter the report at present.</p>

		to the conclusion that the device can be recommended for self-measurement of BP. As a company we are currently working on the improvement of the diastolic BP readings of the device.	
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**Issue 6**

Description of factual inaccuracy	Description of proposed amendment	Justification for amendment	EAC response
<p>5.2.2 Although not a factual inaccuracy: The authors wonder whether or not the "usual" mode operation of the WatchBP, which requires three successive inflations, may take longer than current practice.</p>		<p>To the best of my knowledge the NICE guidelines do not recommend the number of measurements but the British Hypertension Society state to take the mean of at least two readings and that more recordings are needed if marked differences between initial measurements are found <sup>6</sup>. This means that either two or three measurements are required for accurate blood pressure measurement. Three automated measurements could take as much time as two manual readings. In addition, when using the automated device the GP or Nurse can do minor administration or reading a patient file.</p>	<p><b><i>NICE comment: This is a subjective assumption and not a factual change.</i></b></p> <p>The point about minor administration is interesting but still is unlikely to realise resource savings in the EAC's opinion. Therefore we consider it is appropriate to include sensitivity analysis with and without the time cost of pulse palpation and express our doubts in the narrative. No change.</p>