Home blood-pressure monitoring in a hypertensive pregnant population: cost minimisation study

G. Xydopoulos[1], H. Perry[2,3], E. Sheehan[3], B. Thilaganathan[2,3], R. Fordham[1] and A. Khalil[2,3]

[1]Norwich Medical School, University of East Anglia, Norwich, UK; [2]Vascular Biology Research Centre, Molecular and Clinical Sciences Research Institute, St George's University of London, London, UK; [3]Fetal Medicine Unit, Department of Obstetrics and Gynaecology, St George's University Hospitals NHS Foundation Trust, London, UK

Correspondence to:

Prof. A. Khalil, Fetal Medicine Unit, St George's University of London, London SW17 0RE, UK
(e-mail: akhalil@sgul.ac.uk)

Short title: Cost of home blood-pressure monitoring in pregnancy

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ABSTRACT

Background: Traditional monitoring of blood pressure in hypertensive pregnant women requires frequent visits to the maternity outpatient services. Home blood-pressure monitoring (HBPM) could offer a cost-saving alternative that is acceptable to patients. The main objective of this study was to undertake a health economic analysis of HBPM compared with traditional monitoring in hypertensive pregnant women.

Methods: This was a case–control study. Cases were pregnant women with hypertension who had HBPM with or without the adjunct of a smartphone app, via a specially designed pathway. The control group were managed as per existing hospital guidelines. Specific outcome measures were the number of outpatient visits, inpatient bed stays and investigations performed. Maternal, fetal and neonatal adverse outcomes were also recorded. Health economic analysis was performed using two methods: direct cost comparison of the study dataset and process scenario modelling.

Results: There were 108 women in the HBPM group, of whom 29 recorded their results on the smartphone app (App-HBPM) and 79 in their notes (Non-app HBPM). The control group comprised of 58 patients. There were significantly more women with chronic hypertension in

the HBPM group (49.1% *vs* 25.9%, $P = 0.004$). The HBPM group had significantly longer duration of monitoring (9 weeks *vs* 5 weeks $P = 0.004$) and started monitoring from an earlier gestation (30 weeks vs 33.6 weeks, $P = 0.001$). Despite these differences, the mean saving per week for HBPM compared with the control group was £200.69. For the App-HBPM cohort, the saving per week compared with the control group was £286.53. The process modelling method predicted savings of between £98.32 and £245.80 per week using HBPM compared to the traditional monitoring.

Conclusion: HBPM in hypertensive pregnancies appears to be cost-saving compared with traditional monitoring, without compromising maternal, fetal or neonatal safety. Larger studies are required to confirm these findings.

INTRODUCTION

Hypertensive disorders such as gestational hypertension (GH), chronic hypertension and pre-eclampsia (PE) complicate up to 10% of pregnancies. The incidence of PE is 2–8%.[1-3] While maternal mortality due to PE is decreasing in the UK, it remains a leading cause of direct maternal deaths worldwide as well as causing maternal, fetal and neonatal morbidity. The most recent 'Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK' (MBRRACE-UK) report made several recommendations, including the need for an increased schedule of checks for hypertensive women and the need for prompt control of hypertension.[4-6]

Current care for women who develop hypertensive disorders of pregnancy centres on outpatient attendance to a day assessment unit (DAU) at their maternity hospital for blood-pressure monitoring and urine testing, as well as blood tests and fetal monitoring (cardiotocography and/or ultrasound scan), if indicated. The frequency of visits depends on the underlying diagnosis but is often two to three times a week.[7] Admission to an antenatal ward is common place when initiating medication for uncontrolled blood pressure or if there is suspicion of PE. This frequent monitoring can represent a source of anxiety to these women and their families, it is demanding for them in terms of time, transport costs and work absence, and has significant cost implications for limited healthcare resources.

Home blood-pressure monitoring (HBPM) is used extensively outside of pregnancy and is an accurate and patient-acceptable alternative to clinic visits. HBPM is recommended by the 'British Hypertension Society' and 'National Institute for Health Research' who have produced evidence to support its implementation.[8,9] They advise that more research is needed into HBPM in pregnancy which reflects the need for this innovation to be transferred to the obstetric setting.[8,9] The American College of obstetricians and Gynaecologists advocates the use of HBPM in patients with chronic hypertension and other professional bodies recognise its potential.[8,10,11] HBPM is acceptable to pregnant patients and does not increase anxiety.[12,13]

The main objective of this study was to undertake a health economic analysis of the cost-effectiveness of HBPM compared with traditional monitoring in hypertensive pregnancies.

METHODS

Population and Study Design

This was a cost-minimisation study involving a cohort of hypertensive pregnant women enrolled on a HBPM pathway and a control group managed according to the traditional pathway of regular DAU visits for blood-pressure monitoring. Since the patients presented equivalent health outcomes and the main aim of the study was to assess cost savings of the new pathway compared with the conventional one, we called this study a cost-minimisation study. The study perspective was the direct costs to the healthcare system. Patients presented either via referral to the Hypertension Clinic or to the DAU at St George's University Hospital NHS Foundation Trust between December 2013 and November 2016. Pregnant women with a history of pre-pregnancy hypertension or at increased risk of developing hypertension in pregnancy, systolic blood pressure ≥140mmHg, diastolic blood pressure ≥90mmHg, proteinuria ≤1+ on urine dipstick, normal full blood count, liver and renal function blood tests, English speaking were included in the study. Exclusion criteria were maternal age <16 years at booking, systolic blood pressure >155mmHg, diastolic blood pressure >100mmHg, proteinuria ≥2+ on urine dipstick, severe pre-eclampsia, intrauterine fetal growth restriction, significant mental health concerns, inability to give valid consent or language barrier. The above blood pressure parameters were selected in order to avoid patients developing severe hypertension at home. This is in line with the recommendation of hospital admission for systolic blood pressure of 160mmHg or diastolic blood pressure of 110mmHg.[7] Severe PE was diagnosed in the presence of oliguria of less than 500mL urine output in 24 h, cerebral or visual disturbance, pulmonary oedema, epigastric or right upper quadrant pain, impaired liver function (twice the upper limit of normal levels for AST and/or ALT), thrombocytopenia (platelet count < 100,000/mm^3).

The diagnosis of PE and GH was made according to the criteria of the International Society for the Study of Hypertension in Pregnancy.[14] GH was diagnosed in the presence of systolic blood pressure ≥ 140mmHg and/or the diastolic blood pressure ≥ 90mmHg on at least two occasions 4 h apart developing after 20 weeks of gestation in previously normotensive women in the absence of significant proteinuria. In PE there should be GH with proteinuria of 300mg or more in 24 h, or two readings of at least ++ on dipstick analysis of midstream or catheter urine specimens if no 24-h collection is available. PE superimposed on chronic hypertension was diagnosed if significant proteinuria (as defined above) developed after 20 weeks of gestation in women with known chronic hypertension (history of hypertension before conception or presence of hypertension at the booking visit before 20 weeks of gestation in the absence of trophoblastic disease). The diagnosis of chronic hypertension was made when there was a documented presence of chronic non-GH prior to this pregnancy, or history of anti-hypertensive medication prior to 20+0 weeks. The diagnosis of White-coat Hypertension was made when there were confirmed high blood-pressure recordings in the hospital/clinic with normal readings on HBPM or ambulatory monitoring.

Home blood-pressure monitoring pathway

Women eligible to the home monitoring of pregnancy hypertension pathway were counselled and trained by a specialist midwife and supplied with an automated Microlife® blood-pressure machine (MicrolifeCorporation, Taipei, Taiwan), which has been validated in pregnancy and PE[15], and with urine dipsticks. They were taught how to measure their blood pressure accurately and record readings in their notes or on a specially designed smartphone app (Hampton Medical, Trakka Medical, UK). Women were given a personalized schedule of monitoring based on their underlying diagnosis, which was reviewed by the midwife every 1–2 weeks. While the schedule varied between patients, the frequency of monitoring complied

with National Institute for Health and Care Excellence (NICE) guidance on hypertension in pregnancy.[7] A typical regime for a woman with well-controlled chronic hypertension would be to measure blood pressure two or three times a week and be reviewed every 2–3 weeks, whereas a woman initiating new treatment would be asked to measure blood pressure twice a day and reviewed 1 week later. The same specialist midwife reviewed patients at the interim visits to reduce bias.

The innovative application (App) for smartphone users was developed to enable women to record their blood pressure and urinalysis results and any symptoms at home. The App has a set of trigger questions to determine whether they are developing PE, such as the presence of headache, epigastric pain or visual symptoms. An alert flashes up on the screen if one of the trigger questions have indicated that the woman might be developing PE or the recorded blood pressure or urine results are above the pre-defined thresholds, advising the woman to contact the hospital immediately. Alternatively, if the woman enters blood pressure and urinalysis results which are below the pre-defined thresholds, and does not answer 'yes' to the trigger questions, the App will advise the patient to continue on the routine home monitoring care pathway.

Patients in the control group presented either directly to the DAU or to the Antenatal Clinic. They were managed according to the hospital protocol and had all blood-pressure checks performed in the DAU.

Data collection and planned analysis

All individual patient records as well as maternity, ultrasound and neonatal databases were reviewed to collect data on patient demographics, starting and end diagnosis, birth details and adverse maternal, fetal and neonatal outcomes. Adverse maternal outcomes included acute renal failure (maternal serum creatinine level above 100micromol/L antenatally, or above 130micromol/L postnatally) or need for dialysis, acute myocardial ischaemia, need for a third intravenous agent to control blood pressure (e.g., in addition to labetalol and hydralazine), hypertensive encephalopathy (altered mental status with characteristic cerebral imaging), cortical blindness, retinal detachment, stroke (ischemic or hemorrhagic), pulmonary oedema or adult respiratory distress syndrome (defined as characteristic pulmonary imaging in addition to oxygen requirement), need for mechanical ventilatory support (other than for Cesarean section), disseminated intravascular coagulation, thrombotic thrombocytopenic purpura or haemolytic uraemic syndrome, acute fatty liver, liver haematoma or rupture, placental abruption and maternal death. Adverse fetal outcomes included preterm delivery (< 37+0 weeks' gestation), small for gestational age (birthweight $<10^{th}$ centile for gestational age, fetal growth restriction (birthweight $< 5^{th}$ centile for gestational age) and antepartum or intrapartum fetal death. Adverse neonatal outcomes included neonatal death, respiratory distress syndrome, intraventricular haemorrhage, necrotising enterocolitis, bronchopulmonary dysplasia, periventricular leukomalacia, retinopathy of prematurity, seizures and admission to the neonatal unit for more than 48 h (for full-term infants).

Data on the utilisation of health resources were recorded, including the duration of blood-pressure monitoring in weeks, the number of blood-pressure-related visits to the DAU, the Hypertension Clinic, the General Practitioner (GP) and out-of-hours maternity triage and blood-pressure-related hospital admissions to the antenatal or postnatal ward or to the High Dependency Unit (HDU) for severe PE. The number of investigations for blood-pressure-related reasons was recorded, including hematological and biochemistry tests of maternal

blood and ultrasound scans for assessment of fetal growth. Administration of corticosteroids for fetal lung maturity and magnesium sulphate for severe PE was also recorded.

The healthcare economic evaluation was performed using two methods: a direct cost comparison of the dataset between the two groups and process scenario modelling. The cost inputs were derived from a series of costing templates based on NICE guidelines, NHS practices' reports as well as recent scientific research papers with high impact factor (Table 1).[15-21] All the costs were collected in or inflated to 2015 values. The processing modelling was based on two common scenarios: in the first, a woman develops GH and requires ongoing monitoring on an outpatient basis; in the second, a woman requires admission for control of hypertension. The differences between the scenarios based on traditional and HBPM are shown in Table 2. The calculations performed for the process modelling are shown in Figure 1. The following assumptions were made to estimate costs: the midwife would be of band 6 grading (this relates to payscale and represents the banding of most midwives working in this area), the doctor would be either registrar/associate specialist or a consultant (the mean hourly rate was used) and every clinic and consultation appointment was assumed to have a duration of 1 hour apart from the Hypertension clinic and extra consultation sessions which were calculated as 30 minutes.

In the UK, healthcare is free at the point of access and patients do not have to pay hospital bills. For this reason, bills for individual patients are not created and therefore could not be used in this analysis. Hospitals use tariffs for their services based on a coding system in order to generate funding from the state. However, this information is not easy to extrapolate, does not cover all the items we considered and is dependent on the accuracy of the information entered. Therefore, we decided on the above methods for assessment of cost to ensure a robust review of each patient's case.

Statistical analysis

Categorical variables were described as *n* (%) and continuous variables as median (interquartile range). The chi-Square test, or Fisher's exact test when appropriate, was used to compare the categorical variables. The Kruskal-Wallis test and Mann–Whitney U-test were used for the analysis of continuous data. $P < 0.05$ was deemed statistically significant. All statistical analyses were performed using the IBM SPSS Statistics version 24 (IBM Corporation, Armonk, NY, USA).

RESULTS

Description of the study population

There were 108 women in the HBPM group, of whom 29 recorded their results on the smartphone app (App-HBPM) and 79 them in their medical notes (Non-app HBPM). The control group comprised of 58 patients. Details of patient demographics, diagnosis at the beginning of the blood-pressure monitoring and at the end of the pregnancy and the duration of monitoring are outlined in Tables 3 and 4. When compared as three separate groups, there were significant differences in body mass index (BMI) at booking ($P = 0.05$), ethnicity ($P < 0.05$) and initial diagnosis ($P < 0.05$) between the groups (Table 3). Women in the App-HBPM group had a higher BMI, were more likely to be of Afro-Caribbean ethnicity and have chronic hypertension as initial diagnosis (Table 3). When all the HBPM patients were combined as one group and compared with the control group, there were no significant differences in maternal age ($P = 0.185$), BMI ($P = 0.986$), ethnicity ($P > 0.05$), parity ($P = 0.871$) or smoking status ($P = 0.673$) (Table 4); the differences in the underlying diagnosis remained, with significantly more women in the HBPM group having chronic hypertension (49.1% *vs* 25.9%, $P = 0.004$). The HBPM group had significantly longer duration of monitoring (9 weeks *vs* 5 weeks, $P = 0.004$) and started monitoring at an earlier gestation (30 weeks *vs* 33.6 weeks, $P = 0.001$) compared with the control group.

Direct cost comparison of the study dataset

The App-HBPM cohort had significantly fewer visits to the DAU over the course of the monitoring compared with the Non-App and control groups (median (IQR), 1 (0-11) vs 5 (0-14) and 6 (0-18), respectively; $P < 0.001$) but had significantly more attendances to the hypertension clinic ($P < 0.001$). There were no differences in the number of midwifery clinic ($P = 0.14$), obstetric clinic ($P = 0.19$), GP ($P = 0.67$) or triage ($P = 0.12$) visits (Table 5). The costs per patient and patient per week based on this direct comparison of used services are shown in Table 6. The mean saving per week for the HBPM compared with the control group was £200.69 and for the App-HBPM cohort, the saving per week compared with the control group was £286.53.

Process modelling

Based on the calculations shown in Figure 1, the cost saving by using HBPM instead of traditional monitoring for scenario 1 was between £98.32 and £245.80 depending on the number of visits reduced. For scenario 2, the admission to hospital was modelled to be an infrequent occurrence and therefore a potential reduction in the number of bed days would incur significant savings.

DISCUSSION

Summary of study findings

Our findings demonstrate that HBPM reduces the number of antenatal outpatient appointments for blood-pressure-related reasons in a hypertensive pregnant population when compared with a similar population managed according to existing local guidelines, and therefore, reduces the cost of blood-pressure monitoring per patient per week. We have demonstrated these findings using two methods of cost evaluation: direct cost comparison of the study dataset and process scenario modelling. There was no difference in the number of adverse maternal, fetal or neonatal outcomes between the two groups. Sub-analysis of the HBPM cohort suggests that the adjunct of a smartphone app could further reduce the cost of monitoring per patient, per week.

Interpretation of study findings and comparison to the existing literature

The findings of the study demonstrate that HBPM appears to be a cost-saving alternative to traditional monitoring. These findings are likely to be important to the clinicians, patients and policy-makers. Similar cost analysis has been performed in other areas of obstetrics. For example, in a study of home-monitoring for signs of preterm labor, Morrison *et al.* demonstrated cost savings.[22] In a retrospective modelling study, Buysse *et al*. did include hypertensive women in their 'high risk' cohort, but the analysis included all the diagnoses together and the savings predicted were hypothetical.[23] Our findings of a reduction in the hospital visits with HBPM without an increase in adverse outcomes are supported by previous studies of HBPM in hypertensive and normotensive pregnant women.[12,24-26]

Study strengths and limitations

Our study has several strengths. Firstly, the fact that the control group were managed without the knowledge of being included in a cost analysis could potentially reduce the risk of bias, as it gives a true reflection of the cost of current management. Secondly, two different methods of cost evaluation were used. The consistent finding of cost reduction in the HBPM group gives further credibility to the concept that HBPM is cost-saving compared with traditional monitoring. Finally, the two groups were similar in terms of maternal demographics. This is important when comparing not only the cost of monitoring but also the adverse outcomes between the groups. For example, if the HBPM group had a lower proportion of smokers and obese patients compared with the control group (risk factors for adverse outcomes), this would not be a fair comparison.

There are some limitations to our study. Although there was no difference in the maternal demographics between the two groups, there were differences in the underlying hypertensive disorder, with significantly more women with chronic hypertension in the HBPM cohort. The patients in this group were also monitored for a longer period. It is possible that these patients had a more stable disease process and were therefore deemed to require less frequent monitoring, influencing the number of visits and therefore cost of monitoring. Secondly, the process modelling technique of cost evaluation is based on several assumptions, for example, that every attendance to the DAU lasts for 60 min. We recognise that this may not be representative of real clinical situations, which vary over time due to several factors. In this study, we did not include the cost of anti-hypertensive medication or costs to the patient themselves in the cost evaluation. This is something to be considered in future studies. The results of our study relate only to antenatal practice in the UK and the cost savings therefore may not occur in other settings. Finally, it is possible that incorrect entries were recorded by patients and this could influence results. However, it is also

possible for healthcare professionals to document incorrectly a result. Bluetooth or wireless technology can resolve this potential problem by transmitting the result directly from device to output.

Clinical and research implications

Hypertensive disorders of pregnancy remain an important healthcare problem and cause of maternal morbidity and mortality. While advances have been made in recognising women at risk and offering preventive treatment,[7,27,28] little has changed in the way women are monitored and treated once they have been diagnosed with hypertension in pregnancy. HBPM offers several advantages over traditional monitoring: it is more accurate and can allow for diagnosis of white-coat hypertension and masked hypertension, it offers autonomy to patients, allows for more frequent monitoring (patient's check their blood pressure daily compared with two or three times a week in traditional monitoring) allowing sooner detection of hypertension and, from the findings of this study, it appears to be cost-saving. While our study may not be powered to assess differences in adverse outcomes, other small studies of HBPM in hypertensive pregnant women also reported no increase in adverse outcomes.[24-26] Our findings support the notion that a larger prospective study of HBPM in a hypertensive pregnant population is feasible and safe. Any such study should consider economic evaluation as part of its analysis.

Innovation in healthcare, including the use of smartphone and remote monitoring technology has been recognised for its potential to improve patient care. The European Union eHealth action plan states that the development of mobile applications to support patients' autonomy and provide a better quality of care should be a research priority.[29] In their review article, Lanssens *et. al* demonstrate that the uptake of eHealth and telemonitoring has been relatively low in obstetrics, with only 14 studies identified.[30] It is estimated that around 30% of the worldwide population own and use a smartphone whilst over 60% own and use a mobile phone with these figures projected to grow further.[31] This highlights the potential for eHealth and innovative models of patient-centred care in both high- and low-income countries.

Conclusions

HBPM appears to be cost-saving compared with the traditional monitoring pathways in hypertensive pregnancies without any increase in the maternal, fetal or neonatal harm. Larger studies are now warranted to confirm these findings. If affirmed, such pathways have the potential to improve care for women with pregnancy hypertension worldwide.

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Disclosure

A.K. holds ownership rights of the smartphone application used by some participants in the study.

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Table 1 Cost inputs used in the study[15-21]

	Cost/Year (£)	**Cost/hour or cost/intervention (£)**	**Reference**
Midwife (Nurse Band 6)	32,114	44	Department of Health: NHS reference costs 2015 to 2016 Curtis, L. & Burns, A. (2016)
General Practitioner (GP)		124	
Associate specialist	78,217	101	
Consultant (medical)	87,229	104	
Consultant (surgical)	88,684	105	
Mean costs for Doctor		103.33	
Ambulance Services		99	Department of Health: NHS reference costs 2015 to 2016
Triage			
-Nurse led		6.1	Curtis, L. & Burns, A. (2016)
-Doctor led		14.4	
Blood Tests			
-Full blood count		2.65	Akhtar, W. & Chung, Y., 2014
-Liver function tests		2.78	
-Renal function tests		2.12	
Fetal heart monitoring		27	
Day Case cost		698	Department of Health: NHS reference costs 2015 to 2016 Curtis, L. & Burns, A. (2016)
Non-elective inpatient average cost excluding excess bed days		1,542	
The average cost of an excess bed day		283	

Table 2 Modelling Scenarios for the HBPM and traditional monitoring pathways

	Scenario 1: woman with mild/moderate hypertension requiring ongoing outpatient assessment	**Scenario 2: woman with moderate/severe hypertension requiring admission to initiate treatment/control BP**
Traditional monitoring pathway	DAU 2-3 times/week: Midwife review BP Profile Blood Tests Fetal CTG (40 minutes) Doctor Review (20 minutes)	Admission to hospital Blood tests Fetal CTG Inpatient costs/day
HBPM pathway	DAU 1-2 times/fortnight: Midwife review BP Profile Blood Tests Fetal CTG (40 minutes) Doctor Review (20 minutes)	Admission infrequently required

HBPM: Home blood pressure monitoring; CTG: cardiotocography

Table 3 Demographic characteristics of the three study groups

	App HBPM (n=29)	**Non-App HBPM (n=79)**	**Control (n=58)**	**P**
Maternal age (years)	32.0 (28.0-38.0)	33.0 (29.0-37.0)	32.0 (28.0-35.3)	0.41
Body mass index (Kg/m^2)	29.4 (25.6-39.0)	27.1 (23.6-31.8)	27.9 (24.9-31.2)	0.05
Ethnicity				
Caucasian	10 (34.5)	59 (74.7)	38 (65.5)	0.001
Afro-Caribbean	10 (34.5)	10 (12.7)	13 (22.4)	0.35
Asian	8 (27.6)	8 (10.1)	7 (12.1)	0.59
Mixed/other	1 (3.4)	2 (2.5)	0 (0)	0.419
Nulliparous	13 (44.8)	48 (60.8)	32 (55.2)	0.331
Smoker	2 (6.9)	1 (1.3)	1 (1.7)	0.223
Assisted conception	1 (3.4)	5 (6.3)	1 (1.7)	0.405
Gestational age at first visit (weeks)	22.0 (15.8-27.5)	32.0 (24.9-36.1)	33.6 (28.2-36.2)	<0.001
Duration of monitoring (weeks)	17 (10.9-23.3)	6.4 (2.6-12.0)	5.0 (3.3-9.3)	<0.001
Initial Diagnosis				
Chronic hypertension	21 (72.4)	32 (40.5)	15 (25.9)	<0.001
Gestational hypertension	2 (6.9)	45 (57)	37 (63.8)	<0.001
History of pre-eclampsia	4 (13.8)	2 (2.5)	4 (6.9)	0.088
White-coat hypertension	2 (6.9)	0 (0)	2 (3.4)	0.095
Final Diagnosis				
Chronic hypertension	16 (55.2)	27 (34.2)	11 (19)	0.003
Gestational hypertension	2 (6.9)	31 (39.2)	25 (43.1)	0.002
Pre-eclampsia	5 (17.2)	17 (21.5)	20 (34.5)	0.124
Normotensive	5 (17.2)	3 (3.8)	2 (3.4)	0.020
White-coat hypertension	1 (3.4)	1 (1.3)	0 (0)	0.380

Values are given as median (interquartile range) or *n* (%).

Table 4 Demographic characteristics at inclusion and diagnoses in hypertensive pregnant women using home blood-pressure monitoring (HBPM) and in hypertensive controls managed according to local protocol

	HBPM (n=108)	**Control (n=58)**	**P**
Maternal age (years)	32.5 (29.0-37.8)	32 (28.0-35.3)	0.185
Body mass index (Kg/m^2)	27.7 (23.8-33.2)	27.9 (24.9-31.2)	0.986
Ethnicity			
Caucasian	69 (63.9)	38 (65.5)	0.834
Afro-Caribbean	20 (18.5)	13 (22.4)	0.549
Asian	16 (14.8)	7 (12.1)	0.625
Mixed/other	3 (2.8)	0 (0)	0.200
Nulliparous	61 (56.5)	32 (55.2)	0.871
Smoker	3 (2.8)	1 (1.7)	0.673
Assisted conception	6 (5.6)	1 (1.7)	0.242
Gestational age at first visit (weeks)	30.0 (22.0-35.0)	33.6 (28.2-36.1)	0.001
Duration of monitoring (weeks)	8.9 (3.4-16.5)	4.9 (3.3-9.3)	0.004
Initial diagnosis			
Chronic hypertension	53 (49.1)	15 (25.9)	0.004
Gestational hypertension	47 (43.5)	37 (63.8)	0.013
History of pre-eclampsia	6 (5.6)	4 (6.9)	0.729
White-coat hypertension	2 (1.9)	2 (3.4)	0.522
Final diagnosis			
Chronic hypertension	43 (39.8)	11 (19)	0.006
Gestational hypertension	33 (30.6)	25 (43.1)	0.106
Pre-eclampsia	22 (20.4)	20 (34.5)	0.046
Normotensive	8 (7.4)	2 (3.4)	0.307
White-coat hypertension	2 (1.9)	0 (0)	0.543

Values are given as median (interquartile range) or *n* (%).

Table 5 Average number of visits to services for blood-pressure-related reasons, per patient according to the study groups

	App-HBPM (n=29)	Non-App HBPM (n=79)	No HBPM (n=58)	P
Hypertension clinic	4.0 (2.0-7.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	<0.001
Day assessment unit	1.0 (0.0-3.0)	5.0 (2.0-7.0)	6.0 (5.0-8.0)	<0.001
Maternity triage	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.12
General Practitioner appointments	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.67
Midwifery clinic appointments	0.0 (0.0-2.0)	0.0 (0.0-1.0)	0.0 (0.0-0.0)	0.14
Obstetric clinic appointments	0.0 (0.0-0.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.19

Values are given as median (interquartile range). HBPM, Home blood pressure monitoring

Table 6 Average cost of monitoring per patient per week

	App HBPM	Non-App HBPM	All HBPM	No HBPM
Average cost per patient	£1244.29	£1853.56	£1692.56	£2275.26
Average duration of monitoring (weeks)	17.2	8.34	10.7	6.43
Average cost per week	£72.34	£222.25	£158.18	£358.87

Figure legends

Figure 1 Cost-saving by using home blood-pressure monitoring (HBPM) instead of traditional monitoring, using economic modelling method