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Research Article

Cardiovascular Outcomes in Patients with Normal and Abnormal 24-Hour Ambulatory Blood Pressure Monitoring

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Introduction. 24-hour ambulatory blood pressure monitoring (ABPM) plays an important role in assessing cardiovascular prognosis, through presence or absence of ABPM-related prognostic features. *Objectives*. To study relationship between 24-hour ABPM and cardiovascular outcomes in patients from Chesterfield Royal Hospital. *Material and Methods*. Over 12 months from the 1st of August 2002, 1187 individuals had 24-hour ABPM performed. Cardiovascular outcomes were studied in a subset (297) of the original cohort, made up by every 4th consecutive subject. The following ABPM-related prognostic features were studied—high day time systolic and diastolic BP (≥135, ≥85 mmHg), high night time systolic and diastolic BP (≥120 mmHg, ≥75 mmHg), absence of nocturnal dip (≤10% fall in night time SBP), high early morning SBP (≥140 mmHg), and morning surge (≥20/15 mmHg). The cardiovascular outcomes studied in the fourth table included fatal and nonfatal MI, new diagnosis of angina, acute coronary syndrome, sudden cardiac death, cardiac arrhythmias, acute LVF, cerbrovascular events, peripheral vascular disease, abdominal aortic aneurysm, and CKD stage 3 or above. *Results*. Over a followup period of 2015 ± 116 days (1720–2305 days) 82 cardiovascular events occurred in 61 subjects. Cardiac arrhythmias were the most common CV outcome (34 events) followed by cerebrovascular events (15). Statistically significant associations found were between cerebrovascular events and absent nocturnal dip ≤ 10% ($P = .05$) and high day time DBP ($P = .029$), peripheral vascular disease and morning surge ≥ 20/15 mmHg ($P = .014$), cardiac arrhythmias and high day time and night time DBP ($P = .009$ and .033, resp.). *Conclusion*. Significant associations were found between cerebrovascular events and absent nocturnal dip ≤ 10% and high day time DBP, peripheral vascular disease and morning surge ≥ 20/15 mmHg, cardiac arrhythmias and high day time and night time DBP.

1. Introduction

24-hour ABPM plays an important role in determining cardiovascular prognosis and has been shown to be a better predictor of cardiovascular morbidity and mortality as compared to office blood pressure measurements [1–3].

2. Objectives

The objective was to study the relationship between 24 H ABPM and cardiovascular outcomes in patients from Chesterfield Royal hospital. It was a retrospective observational study based on review of clinical case notes.

3. Material and Methods

Over 12 months from the 1st of August 2002, 1187 individuals had 24-hour ABPM performed. These individuals represented a typical spectrum of patients attending for 24 H ABPM with blood pressure at different stages and with varying durations of hypertension. Cardiovascular outcomes were studied in a subset (297) of the original cohort, made up by every 4th consecutive subject.

The inclusion criteria were as follows.

(i) Individuals must have one of the recognized indications for 24-hour ABPM, as outlined in Table 1.

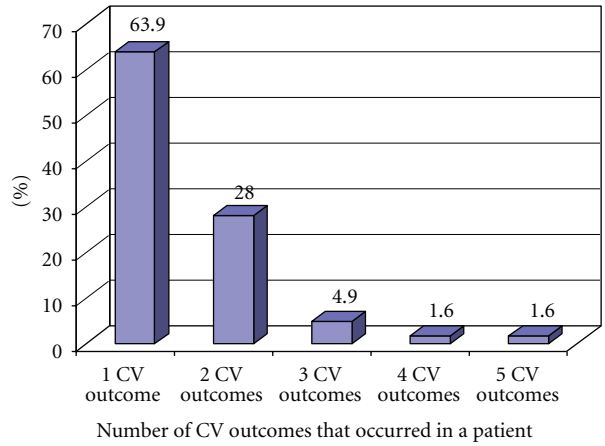

Figure 1: Distribution of number of CV outcomes in 61 patients.

(ii) Every 4th consecutive patient was entered into the study, giving a total of 297, patients. Table 2 outlines demographics and blood pressure criteria between the original cohort and the study cohort.

The exclusion criteria were as follows.

(i) Clinical case notes to study prognostic information were not available from 52 subjects and they were excluded leaving 245 patients.

The following ABPM-related prognostic features were studied (Table 3) high day time systolic and diastolic BP (≥135, ≥85 mmHg), high night time systolic and diastolic BP (≥120 mmHg, ≥75 mmHg), absence of nocturnal dip (≤10% fall in night time SBP), high early morning SBP (≥140 mmHg), and morning surge (≥20/15 mmHg rise in the first two morning readings from 7 AM as compared to average night time BP) [4]. The cardiovascular outcomes studied (Table 4) included fatal and nonfatal MI, new diagnosis of angina, acute coronary syndrome, sudden cardiac death, cardiac arrhythmias, acute LVF, cerebrovascular events, peripheral vascular disease, abdominal aortic aneurysm, and CKD stage 3 or above.

4. Results

Over a followup period of 2015 ± 116 days (1720–2305 days) 82 cardiovascular events occurred in 61 subjects. Cardiac arrhythmias were the most common CV outcome (34 events) followed by cerebrovascular events (15). Statistically significant associations found were between cerebrovascular events and absent nocturnal dip ≤ 10% ($P = .05$) and high day time DBP ($P = .029$), peripheral vascular disease and morning surge ≥ 20/15 mmHg ($P = .014$), cardiac arrhythmias and high day time and night time DBP ($P = .009$ and, 033, resp.). Age and gender did not have any statistical associations with the outcomes.

Table 1

Indications for 24-hour ABPM
Borderline hypertension
Variable clinic blood pressure
Suspected white coat hypertension
Suspected white coat effect
Resistant hypertension
Hypertension in pregnancy
Hypertension in elderly patients
Evaluation of symptoms suggesting postural hypotension
Evaluation of symptoms suggesting drug induced hypotension
Blood pressure evaluation in patients with the suspected or proven autonomic dysfunction
As an overall guide to hypertension treatment
As a prognostic cardiovascular tool

5. Discussion

In this study, cardiac arrhythmias were the most commonly observed event accounting for 13.9% of the total events. Atrial fibrillation was the most common cardiac arrhythmia seen in 14/38 (52.9%) patients with cardiac arrhythmias, followed by symptomatic ventricular ectopics in 13 subjects (38.2%) and supraventricular tachycardia and sinoatrial pause in 1 patient each.

Atrial fibrillation is being recognised as a common problem in patients with hypertension. It has been shown to be associated with systolic hypertension [4] and high pulse pressure [5]. Atrial fibrillation may complicate even mildly raised blood pressure, and it would be reasonable to assume that there is no threshold below which the risk of atrial fibrillation is not increased [6]. To the best of our knowledge, our study is the first one to show an increased risk of atrial fibrillation with high day time and night time diastolic blood pressure. Having said that, one of the recent Japanese studies has shown that control of both systolic and diastolic blood pressure is important in reducing risk of new onset atrial fibrillation [7].

Table 2: Comparison of cohorts 1 and 2.

	Cohort 1: 1187 patients		Cohort 2: 245 patients		Statistical significance
Age	59.13 yrs ± 13.9		60.1 yrs ± 13.6		NS
	N	%	*N*	%	
Male	547	46.1	107	43.7	NS
Female	640	53.9	138	56.3	
Adverse features	*N*	%	*N*	%	
High PP ≥ 50 mmHg	736	62.0	161	65.7	NS
High DSBP ≥ 135 mmHg	703	59.2	146	59.6	NS
High DDBP ≥ 85 mmHg	515	43.4	101	41.2	NS
High NSBP ≥ 120 mmHg	639	54.0	138	56.3	NS
High NDBP ≥ 75 mmHg	404	34.0	83	33.9	NS
Absent ND ≤ 10%	677	57.0	134	54.7	NS
High EM SBP ≥ 140 mmHg	396	33.4	74	30.2	NS
High MS ≥ 20/15 mmHg	552	46.5	106	43.3	NS
No. adverse features	*N*	%	*N*	%	NS
0	63	5.3	13	5.3	NS
1	114	9.6	22	9.0	NS
2	177	14.9	35	14.3	NS
3	168	14.2	43	17.6	NS
4	176	14.8	35	14.3	NS
5	182	15.3	37	15.1	NS
6	151	12.7	30	12.2	NS
7	119	10.0	23	9.4	NS
8	37	3.1	7	2.9	NS
Adverse Features groups	*N*	%	*N*	%	
0–2	354	29.8	70	28.6	
3–5	526	44.3	115	46.9	NS
6–8	307	25.9	60	24.5	

There was no significant difference between the two cohorts.
(Oneway Anova was used for comparing cohort 1 and 2 ages; cross-tabulation with chi-square Test was used to compare adverse features; no. of adverse features and adverse features groups and gender).

Table 3: List of adverse prognostic features noted on 24-hour ABPM.

Adverse features	Values*
High pulse pressure	≥50 mmHg
High day systolic BP	≥135 mmHg
High day diastolic BP	≥85 mmHg
High night systolic BP	≥120 mmHg
High night diastolic BP	≥75 mmHg
Absent nocturnal dip	≤10 %
High early morning systolic BP	≥140 mmHg
High morning surge	≥20/15 mmHg

*K. Madin and P. Iqbal (PMJ 2006)

Over the years a variety of other risk factors for atrial fibrillation have been identified such as large left-atrial size, obesity, thyrotoxicosis, and high alcohol. Our study does not take into account these risks factors.

The exact mechanism for atrial fibrillation in hypertensive subjects is not understood but is believed to be related to left ventricular hypertrophy and an increase in left-atrial size [8], left-atrial fibrosis secondary to high systolic blood pressure [9] and changes in autonomic tone with higher in-treatment heart rate on serial ECGs [10].

Atrial fibrillation is an important cardiovascular risk factor for thromboembolic cardiovascular disease and adds to the existing risk from hypertension itself. Treatment of hypertension exclusively with ACE inhibitors, angiotensin-II-receptor blockers, and beta blockers was shown to be associated with a lower risk of developing atrial fibrillation than current exclusive therapy with calcium-channel blockers [11].

In summary, our study shows that diastolic hypertension plays an important role in leading to cardiac arrhythmias, in particular atrial fibrillation, and should be treated as vigorously as systolic hypertension.

The study's main limitation is that it did not take into account presence or absence of other cardiovascular risk factors, such as diabetes mellitus, smoking, hyperlipidaemia, or family history, and has relied entirely on blood pressure criterias. The authors would like to acknowledge that this may have had bearing on some of the findings.

Table 4

List of CV outcomes, detected on retrospective case notes review.
Non-fatal ST segment elevated MI (ESC/ACC 2000)
Non-fatal non-ST segment elevated MI (ACC/AHA2007)
Non-fatal acute coronary syndrome
New diagnosis of angina pectoris (typical history and positive treadmill cardiac test)
Fatal ST segment elevated MI (ESC/ACC 2000)
Fatal non-ST segment elevated MI
Fatal acute coronary syndrome
Sudden cardiac death (ACC/AHA 2006)
Cardiac arrhythmias (resting or ambulatory ECG documented evidence of any supraventricular and ventricular arrhythmias)
Acute left ventricular failure (typical clinical history backed by chest X-ray finding)
Fatal or non-fatal cerebrovascular event (typical clinical history and CT/MRI findings)
Renal failure (CKD stage 3 or above, developing during the followup period, according to K/DOQI 2002)
Peripheral vascular disease, typical symptoms supported by bilateral lower limb arterial Doppler
Fatal or non-fatal abdominal aortic aneurysm $\geq$ 4 cm on abdominal ultrasound done in the followup period

Table 5

82-Cardiovascular outcomes in 61 patients	Frequency
Myocardial infarction	6 (2.4%)
Acute coronary syndrome	3(1.2%)
New diagnosis of angina pectoris	4(1.6)
Sudden cardiac death	0
Cardiac arrhythmias	34 (13.9%)
Acute left ventricular failure	0
Fatal or non-fatal cerebrovascular event	15 (6.5%)
Peripheral vascular disease	5 (2%)
Fatal or non-fatal abdominal aortic aneurysm	1 (0.4%)
Renal failure (CKD $\geq$ stage 3)	14 (5.7%)
Statistically significant associations (Fisher exact test)	
Cerebrovascular events and absent nocturnal dip $\leq$ 10%	$P = .50$
Cerebrovascular events high day time DBP	$P = .029$
Peripheral vascular disease and morning surge $\geq$ 20/15 mmHg	$P = .014$
Cardiac arrhythmias and high day time	$P = .009$
Cardiac arrhythmias and night time DBP	$P = .033$

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