ORIGINAL ARTICLE

Abnormalities in ambulatory blood pressure monitoring in hypertensive patients with diabetes

Manuel Gorostidi¹, Alejandro de la Sierra², Olga González-Albarrán³, Julián Segura⁴, Juan J de la Cruz⁵, Ernest Vinyoles⁶, José L Listerri⁷, Pedro Aranda⁸, Luis M Ruilope⁴ and José R Banegas⁵, on behalf of the Spanish Society of Hypertension ABPM Registry investigators⁹

Our aim was to assess the ambulatory blood pressure monitoring (ABPM) characteristics or patterns in hypertensive patients with diabetes compared with non-diabetic hypertensives. We performed a cross-sectional analysis of a 68 045 patient database from the Spanish Society of Hypertension ABPM Registry, a nation-wide network of >1200 primary-care physicians performing ABPM under standardized conditions in daily practice. We identified 12 600 (18.5%) hypertensive patients with diabetes. When compared with patients without diabetes, diabetic hypertensives exhibited higher systolic blood pressure (BP) levels in every ABPM period (daytime 135.4 vs. 131.8, and nighttime 126.0 vs. 121.0 mm Hg, $P<0.001$ for both) despite they were receiving more antihypertensive drugs (mean number 1.71 vs. 1.23, $P<0.001$). Consequently, diabetic patients suffered from lack of control of BP more frequently than non-diabetic subjects particularly during the night (65.5% vs. 57.4%, $P<0.001$). Prevalence of a non-dipping BP profile (64.2% vs. 51.6%, $P<0.001$) was higher in diabetic patients. In the other hand, prevalence of 'white-coat' hypertension in diabetic patients was 33.0%. We conclude that there was a remarkably high prevalence of alterations in ABPM in patients with diabetes. Abnormalities in systolic BP, particularly during the night, and in circadian BP pattern could be linked with the excess of BP-related cardiovascular risk of diabetes. A wider use of ABPM in diabetic patients should be considered.

Hypertension Research (2011) 34, 1185–1189; doi:10.1038/hr.2011.100; published online 11 August 2011

Keywords: ambulatory blood pressure monitoring; circadian profile; diabetes; hypertension control

INTRODUCTION

Hypertension affects the majority of patients with diabetes and constitutes a major risk factor for vascular complications.¹ Ambulatory blood pressure monitoring (ABPM) provides a high-quality approach in estimating the true levels of blood pressure (BP).² Several population- and patient-based studies have showed the benefits of ABPM in exploring the relationship between BP and cardiovascular events.^{2,3} A series of reports dealing with diabetic patients have also shown a close correlation between ambulatory BP and diabetic complications.^{4,5} Evidences are available for the entire cardiorenal continuum of diabetic damage from the prediction of microalbuminuria by early changes in nocturnal BP in type 1 patients⁶ to the effect of a riser pattern on mortality in patients with type 2 diabetes.⁷ Nevertheless, information about the ABPM characteristics of large cohorts of diabetic hypertensives attending primary care centers is scarce. We aimed to assess such characteristics in comparison with non-diabetic hypertensives by using the Spanish Society of Hypertension ABPM Registry.

METHODS

The Spanish Society of Hypertension ABPM registry

The methods of the Spanish Society of Hypertension ABPM Registry have been reported previously.^{8,9} Briefly, >1200 primary care physicians perform ABPM under standardized conditions. They send the registries together with corresponding clinical data through a web platform (<http://www.cardiorisc.com>) and receive a result report on real time. The protocol was approved by a series of Ethics Committees from different sites of Spain and patients gave an informed consent.

Patients

Inclusion criteria were a diagnosis of hypertension, age ≥ 18 years and a conventional indication for ABPM.¹⁰ Briefly, indications for ABPM were a suspected 'white-coat' hypertension, assessment of drug treatment efficacy, assessment of dipper status, resistant hypertension and high-risk hypertension. Diagnosis of hypertension was established following the Spanish Society of Hypertension guidelines,¹¹ which, for diagnosis and classification purposes, adopt the 2003 recommendations of the European Society of Hypertension/European Society of Cardiology (ESH/ESC).¹² In summary, the diagnosis of

¹Nephrology Service, Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain; ²Department of Internal Medicine, Hospital Universitario Mutua Terrassa, Universidad de Barcelona, Barcelona, Spain; ³Endocrinology Service, Hospital Ramón y Cajal, Madrid, Spain; ⁴Hypertension Unit, Hospital 12 de Octubre, Madrid, Spain; ⁵Department of Preventive Medicine, Universidad Autónoma, Madrid, Spain; ⁶CAP La Mina, Universidad de Barcelona, Barcelona, Spain; ⁷Centro de Salud Ingeniero Benlloch, Valencia, Spain and ⁸Nephrology Service, Hospital Universitario Carlos Haya, Málaga, Spain

⁹A list of investigators is available at <http://www.cardiorisc.com>

Correspondence: Dr M Gorostidi, Servicio de Nefrología, Hospital Universitario Central de Asturias, Celestino Villamil s/n, Oviedo 33006, Asturias, Spain.

E-mail: manuel.gorostidi@sespa.princast.es

Received 3 December 2010; revised 31 March 2011; accepted 21 April 2011; published online 11 August 2011

hypertension was based on a series of BP measurements, taken on separate occasions, showing values $\geq 140/90$ mm Hg. Exclusion criteria for entering in this study were an arm circumference above 42 cm and highly irregular arrhythmias.

ABPM assessment

More than 900 Spacelabs 90207 devices (Spacelabs, Redmond, Washington, DC, USA) were used for 24-h ABPM. The monitors recorded BP every 20 min during the 24 h. The vast majority of registries were performed on working days and the patients were instructed to maintain their usual activities. Cuffs of large-adult size were used when arm circumference was between 35 and 42 cm. Daytime and nighttime periods were defined in each case according to the patient self-reported data of going-to-bed and waking-up hours. Quality controls were performed to exclude registries not fulfilling any of pre-specified criteria, which were (1) 24-h duration, (2) 1 BP measurement per hour at least, (3) 14 BP recordings during the activity period at least and (4) 7 BP recordings during the rest period at least.^{10,13}

Variables

Clinical information was collected via an electronic case record form. This included age, gender, weight, height, waist circumference, duration of hypertension, known cardiovascular risk factors, such as smoking habit, dyslipidemia and family history of premature cardiovascular disease at age <55 years in men or <65 years in women, data about target organ damage and previous cardiovascular events, and number and type of antihypertensive drugs if the patient was under pharmacological treatment. Definitions for variables were those of the 2003 ESH/ESC guidelines.¹² Diabetes diagnosis was performed following the American Diabetes Association criteria of having a fasting plasma glucose ≥ 126 mg dl⁻¹, a 2-h value in an oral glucose tolerance test ≥ 200 mg dl⁻¹ or a random plasma glucose concentration ≥ 200 mg dl⁻¹ when symptoms are present.¹ Office BP was recorded according the recommendations of the 2003 ESH/ESC guidelines. In summary, two BP determinations were performed in the sitting position after a 5-min resting period with a calibrated mercury sphygmomanometer or a validated automatic oscillometric device. Appropriate size of cuff (large-adult) was used when arm circumference was 35–42 cm. The reference value was the average of the two measurements.

Definitions of control

Office BP was considered as controlled when the reference value was $<140/90$ mm Hg. Control of ambulatory BP was considered for the three conventional periods of ABPM when average BP levels were $<135/85$ mm Hg (daytime), $<120/70$ mm Hg (nighttime) and $<130/80$ mm Hg (24 h).¹³ These office and daytime BP thresholds were used to establish the diagnoses of office resistant control or 'white-coat' (office BP $\geq 140/90$ mm Hg and daytime ambulatory BP $<135/85$ mm Hg) and isolated office control or masked hypertension (office BP $<140/90$ mm Hg and daytime ambulatory BP $\geq 135/85$ mm Hg). A parallel analysis with clinic BP $<130/80$ mm Hg and daytime ambulatory BP $<125/75$ mm Hg was also performed.

Definitions of circadian patterns

A normal dipping pattern (dipper) was diagnosed when the reduction in the average systolic BP during the night period was $>10\%$ of mean systolic BP during the day. When this proportion was $>20\%$ the patient was classified as extreme dipper. An abnormal dipping pattern (non-dipper) was diagnosed when night average systolic BP levels were $<10\%$ with respect to day values. When mean night systolic BP was higher than day one the patient was classified as riser. Night-to-day ratio of systolic BP (mean nighttime systolic BP $\div$ mean daytime systolic BP) was also used to assess circadian profiles.

Data analysis

Qualitative variables are expressed as number and percentages and quantitative variables as mean (s.d.). Differences between groups were sought using χ^2 test for qualitative variables and Student's *t*-test for quantitative data. Numerical variables were adjusted for age, sex, body mass index and the presence of established cardiovascular disease by multivariate analysis of variance, and categorical variables were adjusted for the same confounding factors by

multiple logistic regression. A value of $P < 0.05$ was considered to indicate statistical significance. All analyses were two-tailed. The SPSS for Windows version 13.0 software (SPSS, Chicago, IL, USA) was used for statistical analysis.

RESULTS

The basic characteristics of patients included in our database have been reported previously.^{8,9} In brief, we deal with patients of 58.5 years of age, 53.1% male, with a high prevalence of overweight and obesity (45.1% and 35.8%, respectively), and of accompanying cardiovascular risk factors, but a relatively low prevalence of established cardiovascular disease.

Data from the comparison between patients with or without diabetes are shown in Table 1. Diabetic subjects were older, more frequently male, and exhibited higher prevalences of accompanying risk factors and vascular disease. Patients with diabetes were receiving a higher number of antihypertensive drugs per day.

Table 2 shows data from office BP and ABPM. Office systolic BP was higher and office diastolic BP was lower in patients with diabetes than in non-diabetic individuals. Ambulatory systolic BP levels were higher in diabetic patients with respect to that from non-diabetic subjects in every ABPM period being differences wider during the night. Consequently, lack of control of daytime BP (51.5% vs. 49.0%) and nighttime BP (65.5% vs. 57.4%) was more frequent within diabetic patients than in their counterparts.

Figure 1 shows the distribution of diabetic patients according to clinic and daytime ambulatory BP. Approximately 15% showed concordant control of office and ambulatory BP and nearly 50% showed concordant lack of control. The prevalence of office resistant control ('white-coat') was 33.0% and that of isolated office control (masked hypertension) was 4.9%. When this figure was analyzed with the other cutoff values, clinic BP 130/80 mm Hg and daytime BP 125/75 mm Hg, prevalence of concordant control, concordant lack of control, 'white-coat' and masked hypertension were 3.7%, 77.6%, 15.4% and 3.3%, respectively.

Figure 2 shows the prevalences of the circadian patterns. A non-dipping BP was observed in 64.2% of diabetic patients whereas this abnormality was present in 51.6% of their counterparts. This was mainly because of the difference in the prevalence of the riser pattern as shown in the four-category distribution of the circadian profiles, 21% of patients with diabetes suffered from a riser pattern of BP. Sub-analysis of circadian profiles was performed by weight status and by the presence or absence of established cardiovascular disease. The diabetes condition conferred a worse circadian pattern independently of a body mass index $<$ or ≥ 30 kg m⁻² or the presence/absence of cardiovascular disease. Table 3 shows the night-to-day ratio of systolic BP for all these subgroups.

DISCUSSION

To our knowledge this is the largest study to date evaluating ABPM in hypertensive patients with diabetes. More than 50% of these subjects had their daytime BP uncontrolled and two of three patients had nocturnal hypertension and/or a blunted circadian pattern of BP. One of five diabetic patients showed a riser profile of nocturnal BP. These abnormalities were more frequent in diabetic subjects than in their diabetes-free counterparts. On the other hand, 33% of patients with diabetes showed the so-called 'white-coat' hypertension.

Assessment of control rates of hypertension using ABPM offers a much better figure than that based in office measurements.⁸ In our series, 20.3% of patients with diabetes showed clinic BP levels $<140/90$ mm Hg whereas 48.5% of patients had daytime ambulatory BP $<135/85$ mm Hg. Nevertheless, the burden of uncontrolled

Table 1 Comparison between diabetic and non-diabetic patients. General characteristics

Variable	Patients with diabetes	Patients without diabetes	Significance ^a
<i>Basic characteristics</i>			
Number	12 600	55 445	
Age (years)	63.8 ± 11.5	57.3 ± 14.1	<0.001
Male subjects (%)	55.4	52.6	<0.001
Duration of hypertension (years)	7.20 ± 8.01	5.57 ± 6.84	<0.001
BMI (kg m ⁻²)	30.1 ± 4.92	28.6 ± 4.52	<0.001
Overweight, BMI 25 to <30 kg m ⁻² (%)	40.6	46.2	<0.001
Obesity, BMI ≥ 30 kg m ⁻² (%)	47.0	33.3	<0.001
Fasting glucose (mg dl ⁻¹)	142.4 ± 43.2	97.2 ± 14.2	<0.001
<i>Accompanying risk factors^b</i>			
Family with premature vascular disease (%)	13.3	12.6	0.045
Smoking (%)	14.2	17.3	<0.001
Dyslipidaemia (%)	59.3	33.2	<0.001
Abdominal obesity (%)	52.0	39.3	<0.001
<i>Target organ damage^b</i>			
Any manifestation of subclinical damage (%)	25.0	10.9	<0.001
<i>Established vascular disease^b</i>			
Coronary heart disease (%)	11.3	4.6	<0.001
Cerebrovascular disease (%)	6.5	3.4	<0.001
Congestive heart failure	3.3	1.5	<0.001
Renal disease (%)	3.8	1.3	<0.001
Any cardiovascular disease	21.6	9.9	<0.001
<i>Antihypertensive treatment</i>			
Non-drug treatment (%)	21.0	39.5	<0.001
Monotherapy (%)	20.0	23.4	<0.001
Receiving a two-drug combination (%)	25.1	20.2	<0.001
Receiving a three-drug combination (%)	20.2	11.4	<0.001
Receiving four or more drugs (%)	13.6	5.6	<0.001
Mean number of antihypertensive drugs	1.71 ± 1.43	1.25 ± 1.27	<0.001
<i>Type of drug</i>			
ACE inhibitors (%)	21.7	10.0	<0.001
ARBs (%)	28.8	16.1	<0.001
Diuretics (%)	40.0	26.5	<0.001
Calcium antagonists (%)	26.7	14.7	<0.001
β-blockers (%)	19.7	16.4	<0.001
α-blockers (%)	10.4	4.9	<0.001
Other (%)	1.0	0.5	<0.001

Abbreviations: ACE, angiotensin converting enzyme; ARBs, angiotensin II receptor blockers; BP, blood pressure; BMI, body mass index. Quantitative variables are expressed as mean ± s.d. Qualitative variables are expressed as percentages.

^aDifferences between groups were sought using χ^2 test for qualitative variables and Student's *t*-test for quantitative data. Numerical variables were age, sex and BMI adjusted by multivariate analysis of variance, and categorical variables were age, sex and BMI adjusted by multiple logistic regression.

^bDefinitions of concomitant risk factors and established vascular diseases were that of the 2003 European Society of Hypertension/European Society of Cardiology guidelines for the management of arterial hypertension.¹²

ambulatory hypertension was enormous. Almost 52% of diabetic patients had daytime BP ≥ 135/85 mm Hg and two of three cases had nighttime hypertension. When a more strict threshold of control was applied (daytime BP < 125/75 mm Hg) the figure of lack of control was > 80%. We had previously observed the finding of a worse control rate during the night than day in our general sample of high-risk hypertensives.⁹ Diabetic patients in our study, as in many others, showed a worse cardiovascular risk profile with respect to that observed in patients without diabetes. It has been suggested that a high night-to-day ratio of BP could be a marker of vascular damage or disease.¹⁴ Moreover, the traditional management of hypertension with office-based measurement of BP could lead to higher control rates during the activity period. This has been related to the fact that many antihypertensive drugs do not encompass a complete 24-h period.¹⁵

The unfavorable control rates of ambulatory BP showed by diabetic patients with respect to those in non-diabetic subjects were observed in spite of diabetic patients were receiving more antihypertensive treatment. Vascular hypertrophy and atherosclerosis could justify the apparent paradox of receiving a more intense treatment to obtain a poorer control rate of hypertension. Premature drug treatment when BP is in the high normal range, as recommended by the guidelines for management of hypertension,¹² should improve the chances of obtaining adequate goals by primary prevention of subclinical vascular damage.

One of the main indications for ABPM is the study of the 'white-coat' phenomenon.^{2,10-13} In our series the prevalence of 'white-coat' hypertension (isolated clinic hypertension in untreated patients or office resistant control when treated) was 33%. The prevalence of 'white-coat' hypertension in other studies dealing with diabetic patients ranged between 14 and 51%.¹⁶ Disparities between studies may be related to differences concerning sampling criteria and definition of 'white-coat' hypertension.

Studies about prognosis of 'white-coat' hypertension in diabetic patients offered conflicting results. Whereas a 4-year follow-up study did not find worse outcomes within cases of 'white-coat' hypertension than in normotensive patients,¹⁷ a cross-sectional analysis described diabetic patients with 'white-coat' hypertension as having an increased risk for diabetic retinopathy and nephropathy.¹⁶ Differences between studies probably reflect that 'white-coat' hypertension confers lower dangers than sustained hypertension but higher risks than true normotension.

The 'white-coat' phenomenon in diabetic patients must be interpreted with caution because the majority of studies used, as we did, the standard definition of an office BP ≥ 140/90 mm Hg and a daytime ambulatory BP < 135/85 mm Hg. Clinic BP goal in diabetes is < 130/80 mm Hg but a similar threshold for the ambulatory BP goal is lacking. Nevertheless, the 130/80-target has been recently questioned in the 2009 reappraisal of European guidelines on hypertension management.¹⁸ With respect to ambulatory BP, those levels defined as optimal by the American Heart Association Scientific Statement about BP measurement¹³ could serve as goals in diabetic patients whereas specific data are available.

Prevalence of masked hypertension was low in our series because the main inclusion criterion was a previous diagnosis of hypertension and an established indication for ABPM. Prevalence of masked hypertension in series evaluating normotensive patients with diabetes was 25–50%¹⁹⁻²² or > 40% in diabetic hypertensives showing adequate control of BP.²³ These studies have shown that masked hypertension conferred unfavorable outcomes, thus evaluation of ambulatory BP may be indicated in normotensive diabetic patients²¹ and in hypertensive cases with controlled office BP.

Table 2 Comparison between diabetic and non-diabetic patients. Clinic blood pressure and ambulatory blood pressure monitoring data

Variable	Patients with diabetes (n 12 600)	Patients without diabetes (n 55 445)	Significance ^a
Clinic systolic BP (mm Hg)	151.0 ± 20.8	147.7 ± 19.0	<0.001
Clinic diastolic BP (mm Hg)	84.4 ± 12.6	86.7 ± 12.4	<0.001
Daytime systolic BP (mm Hg)	135.4 ± 15.9	131.8 ± 14.6	<0.001
Daytime diastolic BP (mm Hg)	76.6 ± 10.4	79.0 ± 10.8	<0.001
Nighttime systolic BP (mm Hg)	126.0 ± 18.2	121.0 ± 15.9	<0.001
Nighttime diastolic BP (mm Hg)	67.4 ± 10.4	68.6 ± 10.4	<0.001
24-h systolic BP (mm Hg)	133.0 ± 15.7	129.0 ± 14.2	<0.001
24-h diastolic BP (mm Hg)	74.2 ± 9.9	76.3 ± 10.3	<0.001
Clinic BP ≥ 140/90 mm Hg (%)	79.7	76.7	<0.001
Mean daytime BP ≥ 135/85 mm Hg (%)	51.5	49.0	<0.001
Mean nighttime BP ≥ 120/70 mm Hg (%)	65.5	57.4	<0.001
Mean 24-h BP ≥ 130/80 mm Hg (%)	40.7	44.6	<0.001

Abbreviations: BP, blood pressure; BMI, body mass index.

Quantitative variables are expressed as mean ± s.d. Qualitative variables are expressed as percentages.

^aDifferences between groups were sought using Student's *t*-test for quantitative data and χ^2 test for qualitative variables. Numerical variables were age, sex, BMI and presence of cardiovascular disease adjusted by multivariate analysis of variance, and categorical variables were age, sex, BMI and presence of cardiovascular disease adjusted by multiple logistic regression.

Figure 1 Distribution of 12 600 hypertensive patients with diabetes according to clinic and ambulatory blood pressure (BP). The term 'white-coat' refers to isolated clinic hypertension in untreated patients and to office resistant control in treated patients. 'Concordant lack of control' should be interpreted as true hypertension in the case of untreated subjects and 'masked hypertension' should be interpreted as isolated office control in treated subjects.

Prevalence of abnormalities in circadian pattern was remarkably high in our series of diabetic hypertensives. Two of 3 cases were non-dippers and the extreme form of this pattern, the riser profile, was present in 21% of diabetic patients. The diabetes condition seemed to have a pivotal role in the circadian profile of BP. As showed in Table 3, diabetics suffered from the most unfavorable night-to-day ratios independently of obesity or cardiovascular disease status, two well-recognized figures of worsened circadian patterns. Furthermore, non-obese diabetics showed a higher night-to-day ratio than non-diabetic obese, and diabetics free of established cardiovascular disease also showed a higher ratio than non-diabetics with cardiovascular disease. Cases with diabetes also showed a worse conventional cardiovascular risk profile (Table 1) than that observed in non-diabetic patients. In our experience, the burden of cardiovascular risk was the main determinant for a blunted nocturnal BP decrease.^{24,25} The contribution of the absence of a nocturnal BP fall is controversial in patients with diabetes. Absolute BP levels, particularly at night, probably have a higher predictive value for vascular damage than the BP dipper/non-dipper status.^{26–28} Nevertheless, a recent article has reported that type

Figure 2 Prevalence of circadian patterns of blood pressure in hypertensive patients with and without diabetes.

2 diabetics with a riser profile of BP showed 88% mortality during a follow-up of 9 years meanwhile mortality in the non-risers was 45%.⁷

This study has some limitations that deserve discussion. First, the cross-sectional design precludes conclusions about prognosis but the large number of patients included makes our data valuable in estimating prevalences of abnormalities in ambulatory BP in hypertensive patients with diabetes. Second, only two BP readings from a unique visit were used to assess office BP. More readings of clinic BP lead to lower estimates because of habituation and regression to the mean. This procedure could only change results about 'white-coat' and masked hypertension. Data about lack of control in ambulatory BP levels and estimates of circadian patterns are not influenced by the methodology of clinic BP measurement. Third, we had no information about diabetes control, that is, hemoglobin A1c, and metabolic control could have a role in BP control. Fourth, a conventional indication of ABPM could lead to a selection bias, which produced

Table 3 Comparisons of night-to-day of systolic BP between diabetic and non-diabetic patients according BMI and cardiovascular disease status

	Diabetics	Non-diabetics	P
<i>Comparisons according BMI status</i>			
BMI $\geq 30.0 \text{ kg m}^{-2}$	0.936 ± 0.090	0.916 ± 0.083	<0.001
BMI $< 30.0 \text{ kg m}^{-2}$	0.933 ± 0.090	0.904 ± 0.087	<0.001
	<i>P</i> diabetics obese vs. non-obese=0.136	<i>P</i> non-diabetics obese vs. non-obese <0.001	
<i>Comparisons according the presence or absence of CV disease</i>			
With any CV disease	0.956 ± 0.094	0.924 ± 0.088	<0.001
Without CV disease	0.941 ± 0.094	0.904 ± 0.084	<0.001
	<i>P</i> diabetics with vs. without CV disease <0.001	<i>P</i> non-diabetics with vs. without CV disease <0.001	

Abbreviations: BMI, body mass index; CV cardiovascular.
Night-to-day ratio is presented as mean $\pm$ s.d. Differences between groups were sought using Student's *t*-test.

an overestimation of 'white-coat' hypertension and an underestimation of masked hypertension. Fifth, the limitations of reproducibility of a single 24-h ABPM, as performed in our study, are well known, but the application of repeated ABPM sessions or 48-h ABPM to improve the quality of data is not feasible in large-scale studies. Furthermore, studies demonstrating the relationship between ambulatory BP and cardiovascular outcomes have usually been based on a single 24-h ABPM. Despite these limitations, our data are of value for approaching to prevalences of abnormalities that hypertensive patients with diabetes show in ambulatory BP because the large sample size.

In conclusion, hypertensive patients with diabetes showed a remarkably high prevalence of alterations in ABPM. Abnormalities in systolic BP, particularly during the night, and in circadian BP pattern could be linked with the excess of BP-related cardiorenal risk of diabetes. These observations support the recommendation for a wider use of ABPM in diabetic patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

We thank all the investigators, members of the Spanish Society of Hypertension ABPM Registry. A list with their names is available at <http://www.cardiorisc.com>. The Spanish Society of Hypertension ABPM Registry is supported by an unrestricted scientific grant from LACER Spain. The funding body had no role in the study design, analysis and interpretation of data, writing the manuscript, or in the decision to submit the article for publication.

- American Diabetes Association. Standards of medical care in diabetes—2010 (Position Statement). *Diabetes Care* 2010; **33**(Suppl 1): S11–S61.
- Pickering TG, Shimbo D, Haas D. Ambulatory blood-pressure monitoring. *N Engl J Med* 2006; **354**: 2368–2374.
- Hansen TW, Kikuya M, Thijs L, Björklund-Bodegård K, Kuznetsova T, Ohkubo T, Richart T, Torp-Pedersen C, Lind L, Jeppesen J, Ibsen H, Imai Y, Staessen J. Prognostic superiority of daytime ambulatory over conventional blood pressure in four populations: a meta-analysis of 7030 individuals. *J Hypertens* 2007; **25**: 1554–1564.
- Moran A, Palmas W, Pickering TG, Schwartz JE, Field L, Weinstock RS, Shea S. Office and ambulatory blood pressure are independently associated with albuminuria in older subjects with type 2 diabetes. *Hypertension* 2006; **47**: 955–961.

- Leitão CB, Canani LH, Silveiro SP, Gross JL. Ambulatory blood pressure monitoring and type 2 diabetes mellitus. *Arq Bras Cardiol* 2007; **89**: 315–321.
- Lurbe E, Redon J, Kesani A, Pascual JM, Tacons J, Alvarez V, Batlle D. Increase in nocturnal blood pressure and progression to microalbuminuria in type 1 diabetes. *N Engl J Med* 2002; **347**: 797–805.
- Astrup AS, Nielsen FS, Rossing P, Ali S, Kastrup J, Smidt UM, Parving HH. Predictors of mortality in patients with type 2 diabetes with or without diabetic nephropathy: a follow-up study. *J Hypertens* 2007; **25**: 2479–2485.
- Banegas JR, Segura J, Sobrino J, Rodríguez-Artalejo F, de la Sierra A, de la Cruz JJ, Gorostidi M, Sarria A, Ruilope LM. Effectiveness of blood pressure control outside the medical setting. *Hypertension* 2007; **49**: 62–68.
- Gorostidi M, Sobrino J, Segura J, Sierra C, de la Sierra A, Hernández del Rey R, Vinyoles E, Galcerán JM, López-Eady MD, Marín R, Banegas JR, Sarria A, Coca A, Ruilope LM. Ambulatory blood pressure monitoring in hypertensive patients with high cardiovascular risk: a cross-sectional analysis of a 20000-patient database in Spain. *J Hypertens* 2007; **25**: 977–984.
- Ó'Brien E, Asmar R, Beilin L, Imai Y, Mallion JM, Mancia G, Mengden T, Myers M, Padfield P, Palatini P, Parati G, Pickering T, Redon J, Staessen J, Stergiou G, Verdecchia P. European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. *J Hypertens* 2003; **21**: 821–848.
- Marín R, de la Sierra A, Armario P, Campo C, Banegas JR, Gorostidi M. Guía sobre el diagnóstico y tratamiento de la hipertensión arterial en España 2005. *Med Clin (Barc)* 2005; **125**: 24–34 [in Spanish].
- Guidelines Committee. 2003 European Society of Hypertension—European Society of Cardiology guidelines for the management of arterial hypertension. *J Hypertens* 2003; **21**: 1011–1053.
- Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, Jones DW, Kurtz T, Sheps SG, Roccella EJ. Recommendations for blood pressure measurement in humans and experimental animals. Part 1: blood pressure measurement in humans. *Circulation* 2005; **111**: 697–716.
- Boggia J, Li Y, Thijs L, Hansen TW, Kikuya M, Björklund-Bodegård K, Richart T, Ohkubo T, Kuznetsova T, Torp-Pedersen C, Lind L, Ibsen H, Imai Y, Wang J, Sandoya E, O'Brien E, Staessen JA. Prognostic accuracy of day versus night ambulatory blood pressure: a cohort study. *Lancet* 2007; **370**: 1219–1229.
- Redón J, Roca-Cusachs A, Mora-Macia J. Uncontrolled early morning blood pressure in medicated patients: the ACAMPA study. Analysis of the control of blood pressure using ambulatory blood pressure monitoring. *Blood Press Monit* 2002; **7**: 111–116.
- Kramer CK, Leitão CB, Canani LH, Gross JL. Impact of white-coat hypertension on microvascular complications in type 2 diabetes mellitus. *Diabetes Care* 2008; **31**: 2233–2237.
- Eguchi K, Hoshide S, Ishikawa J, Ishikawa S, Pickering TG, Gerin W, Ogedegbe G, Schwartz JE, Shimada K, Kario K. Cardiovascular prognosis of sustained and white-coat hypertension in patients with type 2 diabetes mellitus. *Blood Press Monit* 2008; **13**: 15–20.
- Mancia G, Laurent S, Agabiti-Rosei E, Ambrosioni E, Burniere M, Caulfield MJ, Cifkova R, Clément D, Coca A, Dominiczak A, Erdine S, Fagard R, Farsang C, Grassi G, Haller H, Heagerty A, Kjeldsen SE, Kiowski W, Mallion JM, Manolis A, Narkiewicz K, Nilsson P, Olsen MH, Rahn KH, Redon J, Rodicio J, Ruilope L, Schmieder RE, Struijker-Boudier HAJ, van Zwieten PA, Viigimaa M, Zanchetti A. Reappraisal of European guidelines on hypertension management: a European Society of Hypertension Task Force document. *J Hypertens* 2009; **27**: 2121–2158.
- Marchesi C, Maresca AM, Solbiati F, Franzetti I, Laurita E, Nicolini E, Gianni M, Guasti L, Marnini P, Venco A, Grandi AM. Masked hypertension in type 2 diabetes mellitus. Relationship with left-ventricular structure and function. *Am J Hypertens* 2007; **20**: 1079–1084.
- Leitão CB, Canani LH, Kramer CK, Boza JC, Pinotti AF, Gross JL. Masked hypertension, urinary albumin excretion rate, and echocardiographic parameters in putative normotensive type 2 diabetic patients. *Diabetes Care* 2007; **30**: 1255–1260.
- Eguchi K, Ishikawa J, Hoshide S, Pickering TG, Shimada K, Kario K. Masked hypertension in diabetes mellitus: a potential risk. *J Clin Hypertens (Greenwich)* 2007; **9**: 601–607.
- Wijkman M, Länne T, Engvall J, Lindström T, Östgren CJ, Nystrom FH. Masked nocturnal hypertension—a novel marker of risk in type 2 diabetes. *Diabetologia* 2009; **52**: 1258–1264.
- Ben-Dov IZ, Ben-Ishay D, Mekler J, Ben-Arie L, Bursztyn M. Increased prevalence of masked blood pressure elevations in treated diabetic subjects. *Arch Intern Med* 2007; **167**: 2139–2142.
- De la Sierra A, Redon J, Banegas JR, Segura J, Gorostidi M, de la Cruz JJ, Sobrino J, Listerri JL, Alonso J, Vinyoles E, Pallarés V, Sarria A, Aranda P, Ruilope LM. Prevalence and factors associated with circadian blood pressures patterns in hypertensive patients. *Hypertension* 2009; **53**: 466–472.
- De la Sierra A, Segura J, Gorostidi M, Banegas JR, de la Cruz JJ, Ruilope LM. Diurnal blood pressure variation, risk categories and antihypertensive treatment. *Hypertens Res* 2010; **33**: 767–771.
- Nakano S, Ito T, Furuya K, Tsuda S, Konishi K, Nishizawa M, Nakagawa A, Kigoshi T, Uchida K. Ambulatory blood pressure level rather than dipper/nondipper status predicts vascular events in type 2 diabetic subjects. *Hypertens Res* 2004; **27**: 647–656.
- Leitão CB, Canani LH, Kramer CK, Moehlecke M, Pinto LC, Ricardo ED, Pinotti AF, Gross JL. Blood pressure means rather than nocturnal dipping pattern are related to complications in type 2 diabetic patients. *Diabet Med* 2008; **25**: 308–313.
- Palmas W, Pickering T, Teresi J, Schwartz JE, Eguchi K, Field L, Weinstock RS, Shea S. Nocturnal blood pressure elevation predicts progression of albuminuria in elderly people with type 2 diabetes. *J Clin Hypertens (Greenwich)* 2008; **10**: 12–20.