

Usefulness of 24-h ambulatory blood pressure monitoring in a population with high cardiovascular risk

Utilidad del monitoreo ambulatorio de la presión arterial de 24 horas en una población con alto riesgo cardiovascular

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Abstract

Background: High blood pressure is considered a disease and at the same time a cardiovascular risk factor, mainly involved in ischemic heart disease, cerebrovascular disease, and kidney failure, causing high mortality worldwide. **Objective:** The objective was to follow-up with 24-h ambulatory blood pressure monitoring in patients with high blood pressure belonging to a population with high cardiovascular risk. **Methods:** This study was descriptive, observational, and retrospective study, which analyzes 24-h outpatient pressure controls of 1858 patients, in Cartagena, Colombia. **Results:** One thousand one hundred and seventy-three examinations were validated and included in the study. The median age was 66 years. 66.8% (783) were women and 33.2% (390) were men. The main changes occurred during the night, when 79.1% of the patients had high systolic pressure loads, 65.6% recorded diastolic pressure averages, and 83.7% had abnormal circadian patterns. Only 11% of the studies were normal in all parameters. **Conclusions:** Twenty-three-hour ambulatory blood pressure monitoring proved to be a useful tool to identify uncontrolled hypertensive patients, detect nocturnal hypertension and abnormal circadian patterns, which are risk markers for cardiovascular morbidity and mortality.

Keywords: Cardiology. Diagnosis. Cardiovascular diseases. Vascular diseases. Hypertension. Blood pressure.

Resumen

Antecedentes: La hipertensión arterial es considerada una enfermedad y al mismo tiempo un factor de riesgo cardiovascular, involucrada principalmente en la cardiopatía isquémica, la enfermedad cerebrovascular y la insuficiencia renal, causando una elevada mortalidad. **Objetivo:** Realizar seguimiento con monitoreo ambulatorio de la presión arterial de 24 horas en pacientes con hipertensión arterial pertenecientes a una población con alto riesgo cardiovascular. **Método:** Estudio descriptivo, observacional, retrospectivo, en el que se analizaron los monitoreos ambulatorios de presión de 24 horas de 1858 pacientes, en Cartagena, Colombia. **Resultados:** Se incluyeron 1173 registros. La mediana de edad fue de 66 años. El 66.8% (783) fueron mujeres y el 33.2% (390) fueron hombres. Las principales alteraciones ocurrieron durante la noche, cuando el 79.1% de los pacientes tuvieron cargas elevadas de presión sistólica, el 65.6% registraron promedios elevados de presión diastólica y el 83.7% tuvieron patrones circadianos anormales. Solo el 11% de los estudios fueron normales en todos los parámetros. **Conclusiones:** El monitoreo ambulatorio de la presión arterial de 24 horas demostró ser una herramienta útil para

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Date of reception: 15-09-2019
Date of acceptance: 14-05-2020
DOI: 10.24875/CIRUE.M22000173

Cir Cir (Eng). 2020;88(5):604-610
Contents available at PubMed
www.cirugiaycirujanos.com

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identificar a los pacientes hipertensos no controlados, detectando hipertensión nocturna y patrones circadianos anormales, los cuales son marcadores de riesgo para morbilidad y mortalidad cardiovascular.

Palabras clave: Cardiología. Diagnóstico. Enfermedades cardiovasculares. Enfermedades vasculares. Hipertensión. Presión sanguínea.

Introduction

Cardiovascular diseases are the leading cause of mortality in the world with 17.3 million annual deaths and a trend toward an increase that has been calculated will reach a figure of 23.6 million by 2030¹. In 2013, cardiovascular pathology caused 31% of global mortality, with 80% of these deaths occurring in developing countries¹.

Worldwide prevalence of stroke in 2010 was 33 million, with 16.9 million subjects suffering a first event during that year, and in 2013, strokes were the second leading cause of death, behind heart diseases¹. Among the people who have a first stroke, 77% have a history of high blood pressure, which is favored by unhealthy lifestyles, especially in low-income countries².

Cardiovascular risk factors are classified as causal, major, or independent, when a direct causal relationship with cardiovascular diseases has been demonstrated and include high blood pressure, diabetes mellitus, hypercholesterolemia, smoking, and age, accounting for 75% of fatal and non-fatal events³.

Other risk factors are those that are predisposing and conditional. The former acts through other intermediate risk factors or have a clear association with them, and the latter are observed during the development of the disease, but show no evidence of a direct causal relationship³.

Hypertension is a disease and also a cardiovascular risk factor and is a causative principle for ischemic heart disease, heart failure, cerebrovascular disease, peripheral arterial disease, chronic kidney failure, atrial fibrillation, and mortality worldwide⁴. It is the third leading cause of disease-induced disability, behind undernutrition, and sexually transmitted diseases². High blood pressure is estimated to affect 40% of the population older than 25 years⁵.

Control of modifiable major risk factors (high blood pressure, diabetes, hypercholesterolemia, and smoking) decreases the risk for developing cardiovascular diseases (primary prevention) and reduces the risk of new events and premature deaths (secondary prevention)³.

Blood pressure control has also been shown to reduce coronary heart disease-related mortality by 20% and cerebrovascular disease-associated mortality by 24%³. Nocturnal hypertension has even been identified as the best predictor of cardiovascular morbidity and mortality, and its control is related to a life free of cardiovascular events and complications⁴⁻⁸.

A meta-analysis of 17,312 hypertensive patients from three continents established the relationship of different “non-dipper” and “riser” circadian patterns (inappropriate decrease and increase of blood pressure during sleep) with morbidity and mortality⁷. However, although there are studies that show that high blood pressure control improves patient quality of life, mean global control with high blood pressure treatment is only 32.5%⁵.

In Canada, 23% of the adult population is hypertensive, and control improvement should be highlighted, which went from 13.2% in 1992 to 68.2% in 2012-2013. Among diabetic Canadians, the prevalence of high blood pressure is 67.1%, with 60.1% of them being controlled^{5,9}.

In the USA, 33% of adults have high blood pressure, which corresponds to 80 million people, and although 77% are receiving antihypertensive treatment, only 54% of them are controlled and 46% have blood pressure values higher than 140/90 mmHg. Among the African-American population, high blood pressure is more common and reaches a rate of 46%, while among Hispanics (men and women), it is 30%¹.

In Latin America, a study that included 11 countries showed that the prevalence of high blood pressure was 40.7%; among these individuals, 40.6% were on pharmacological treatment, but only 13.1% were controlled with blood pressure figures < 140/90 mmHg².

Four South American countries were included in the PURE trial: Argentina, Brazil, Colombia, and Chile. Among hypertensive patients, 57% were aware of their condition, but only 52.8% of them received treatment and only 18.3% were controlled^{2,10}.

In Colombia, the prevalence of high blood pressure revealed by a systematic review carried out in 2014 was 31.33% (25.95% in 2010), with a mortality rate of 12.71% (13.88% in 2010) in women, and a prevalence

of 28.73% (23.85% in 2010), with a mortality rate of 13.73% (14.81% in 2010) in men¹¹.

Ambulatory blood pressure monitoring has been shown to be a useful tool for diagnosis and follow-up of the disease. Patients with “white coat” hypertension, masked, resistant, and pseudo-resistant hypertension can be identified with this diagnostic method¹². A multicenter cross-sectional study carried out at primary care units in the Valencian Community (Spain), which included 1028 hypertensive patients older than 65 years of age, showed that ambulatory blood pressure monitoring was superior to clinical measurements for controlled patients to be identified^{13,14}.

Blood pressure measurements with ambulatory monitoring have been shown to be more closely related to target organ damage, whereas elevated pulse pressure during sleep, blood pressure abnormal circadian behavior, and especially mean nocturnal blood pressure, have been observed to be predictors of cardiovascular disease-associated morbidity and mortality¹⁵.

Therefore, determining these parameters by ambulatory blood pressure monitoring in all hypertensive patients is crucial, especially if they have high cardiovascular risk, to make the necessary adjustments in antihypertensive treatment, and thus generate a net benefit that will be reflected on a longer life with better quality.

The purpose of this study was to carry out a follow-up with 24-h ambulatory blood pressure monitoring in patients with high blood pressure belonging to a population with high cardiovascular risk.

Methods

Descriptive, observational, cross-sectional, and retrospective study carried out in 1858 patients from the high cardiovascular risk program referred to the cardiovascular dynamics laboratory from September 29, 2014, to December 31, 2015, who were listed and described in a database, and who were characterized by their cardiovascular prevention physicians as high-risk patients with the previous cardiovascular events, such as myocardial infarction, coronary artery bypass graft surgery, stroke, heart failure, chronic kidney disease, or diabetes mellitus.

The patients underwent 24-h ambulatory blood pressure monitoring to detect those with figures above the following thresholds: 130/85 mmHg on average for 24 h, 135/90 mmHg for the daytime or wakefulness period, 120/70 mmHg for the nighttime or sleep

period, 25% for systolic and diastolic pressure loads or percentages above the thresholds, and 50 mmHg for pulse pressure. Systolic and diastolic blood pressure should decrease by 10-20% during sleep with regard to daytime average. Patients with normal circadian cycles were regarded as having a “dipper” pattern or profile, those with an attenuated decrease (< 10%) were referred to as “non-dippers,” and those with a decrease > 20% were rated as “extreme dippers.” Patients with any pressure increase during sleep or inverted circadian cycle were rated as “risers.”

All ambulatory blood pressure monitoring studies were performed with newly-acquired SunTech Medical Bravo monitors, with AccuWinProSE ABPM Software, which has the ANSI/AAMI SP10:2002 validations.

The inclusion criteria were as follows: (a) patients enrolled in the high cardiovascular risk program; (b) admission blood pressure monitoring; and (c) only studies that met the Canadian Cardiovascular Society validation criteria, which include pressure monitoring for at least 24 h, measured every 20-30 min at daytime and every 30-60 min at night, with success criteria being at least 70% of valid measurements, at least 20 daytime measurements, and at least 7 at nighttime. Considering bedtime and wake-up hours of most patients in the geographical area and socioeconomic stratum, the periods were adjusted by default for daytime or wakefulness from 05:00 h to 21:00 h, and for nighttime or sleep, from 21:00 h to 05:00 h of next day. Some patients had their period schedules customized.

The exclusion criteria were (a) patients not enrolled in the high cardiovascular risk program; (b) repeated monitoring measurements; and (c) monitoring measurements that failed to meet the validation requirements.

Permanent atrial fibrillation, extremely weak or imperceptible brachial pulses, senile dementia or severe cognitive disorders, and severe Parkinson’s disease or Parkinson’s disease with abnormal movements or dyskinesia were the main reasons that prevented 24-h blood pressure monitoring or its completion.

Data from monitoring measurements that did meet the criteria were loaded into MS Office Excel 2013 software. Statistical analysis was carried out using the EpiInfo software, version 7.2.

This project was developed in accordance with resolution 008430 of the Ministry of Social Protection of Colombia, which regulates research on human subjects, with the project constituting a risk-free study since the employed methods do not modify or alter

Table 1. 24-h blood pressure ambulatory monitoring measurements

Variable	24 h		Daytime		Nighttime		Night-day difference
	Median (IQR)	Increase* n (%)	Median (IQR)	Increase* n (%)	Median (IQR)	Increase* n (%)	Median (IQR)
Heart rate (bpm)	72 [65-80]	59 (5.0)	-	-	-	-	-
Pulse pressure (mmHg)	56 [49-76]	823 (70.2)	56 [49-66]	810 (69.0)	57 [49-68]	821 (70.0)	1 [-3-6]
SBP (mmHg)	130 [118-142]	602 (51.3)	130 [118-144]	453 (38.6)	128 [115-143]	770 (65.6)	-2 [-9-5]
SBP load (%)	38 [14-69]	734 (62.6)	24 [6-58]	584 (49.8)	75 [33-100]	928 (79.1)	-1.6 [-7.2-4.1]
DBP (mmHg)	71 [64-80]	184 (15.7)	72 [65-81]	107 (9.1)	69 [62-77]	538 (45.9)	-3 [-8-1]
DBP load (%)	11 [2-30]	357 (30.4)	6 [0-24]	290 (24.7)	20 [0-55]	544 (46.4)	-4.5 [-10.6-1.2]

bpm: beats per minute; DBP: diastolic blood pressure IQR: interquartile range; SBP: systolic blood pressure.

*Number of patients with elevation in values and percentage of the sample they represent.

patients' biological, psychological, or social variables, which are in accordance with the Declaration of Helsinki and with the Council for International Organizations of Medical Sciences (CIOMS) guidelines for research involving human subjects.

In all cases, patient informed consent was obtained, and protection of identification data was guaranteed.

Results

The high cardiovascular risk program included 1858 patients, but after an initial review, 1352 cases were regarded as meeting the requirement of having 24-h ambulatory monitoring, out of whom 179 were excluded due to incorrect data on 24-h diastolic blood pressure records, errors in daytime systolic pressure records, or duplication. Finally, 1173 24-h blood pressure monitoring procedures that met the inclusion requirements were analyzed.

Average age was 66 years, with an interquartile range (IQR) of 56-76 years and a standard deviation (SD) of ± 13.7 years. As for distribution by gender, 66.8% (n = 783) were women and 33.2% (n = 390) were men.

The analysis of results showed a median heart rate of 72 beats/per min, pulse pressure of 56 mmHg, systolic blood pressure of 130 mmHg with a load of 38%, and average diastolic pressure of 71 mmHg with a load of 11%. As for daytime and nighttime periods, median values for pulse pressure were found to be 56 and 57 mmHg, respectively; for systolic pressure, 130 and 128 mmHg, with loads of 24% and 75%; and for diastolic pressure, 72 and 69 mmHg, with loads of 5% and 20%. During the 24-h period, pulse pressure elevation was recorded in 70.2% of patients, systolic

hypertension in 51.3% and diastolic hypertension in 15.7%. A detailed discrimination of 24-h pressure monitoring findings is shown in table 1.

The percentage of patients with pulse pressure elevation, increased systolic and diastolic blood pressure, as well as the percentage of subjects with systolic and diastolic load increase, is depicted in figure 1.

Finally, when systolic and diastolic blood pressure circadian patterns were evaluated, the results were as follows: for systolic blood pressure, the non-dipper pattern was observed in 43.2% of patients (n = 507); the riser pattern, in 40.5% (n = 475); only 15.6% of patients (n = 183) had a normal or dipper pattern, and 0.7% (n = 8) were extreme dippers. Thus, 84% of patients had abnormal circadian patterns.

Circadian profiles for diastolic blood pressure were as follows: non-dipper pattern in 47.6% of patients (n = 558), riser in 28.6% (n = 336), normal profile or dipper in 22.2% (n = 260), and extreme dipper in 1.7% (n = 20).

Discussion

In this group of patients classified with high cardiovascular risk coming from a cardiovascular risk control program who were receiving antihypertensive treatment, ambulatory blood pressure monitoring provided evidence of inadequate control in 79.1%. Nighttime systolic blood pressure load was the most altered marker, followed by nighttime pulse pressure in 70% and nocturnal systolic hypertension in 65.6%. In addition, 83.7% of patients (n = 982) had systolic pressure abnormal circadian patterns, with 43.2% being non-dippers (n = 507), and 40.5%, risers (n = 475).

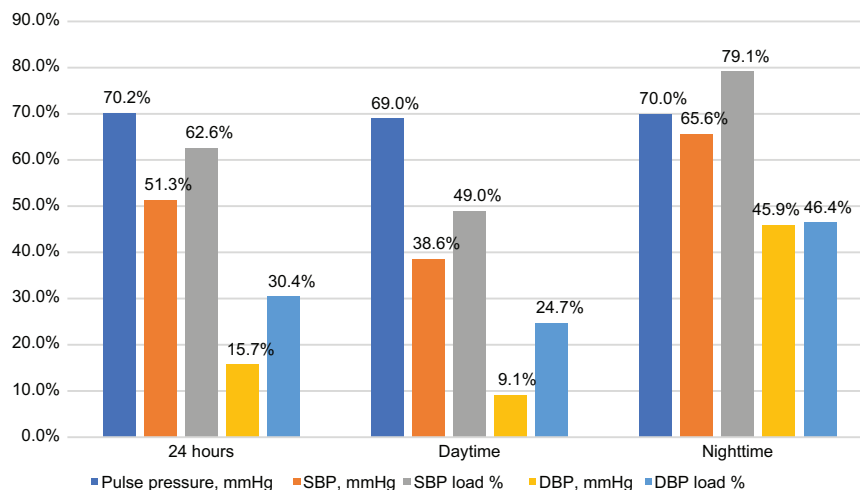


Figure 1. Percentage of patients with pulse pressure elevation, increased systolic and diastolic blood pressure, and pressure loads. DBP, diastolic blood pressure; SBP: systolic blood pressure.

Only 16.3% of patients could be regarded as being controlled, which is unacceptable for the others, due to their high cardiovascular risk condition and for having multiple cardiovascular risk factors associated with high blood pressure, such as diabetes mellitus and dyslipidemia or for having a history of cardiovascular or cerebrovascular events, heart failure, or kidney disease.

The relationship between nocturnal hypertension and cardiovascular events in a cohort of 2115 hypertensive high-risk treated-patients was established when systolic blood pressure > 130 mmHg was shown to increase the risk of non-fatal infarctions, strokes, hospitalization for heart failure and cardiovascular death in 52%, in comparison with those with systolic blood pressure values < 115 mmHg⁸.

Several publications have established that average blood pressure during the nighttime or sleep period and the riser and non-dipper patterns are directly related to mortality and cardiovascular events⁴⁻⁸. In this study, we observed that 65.6% of patients had nocturnal hypertension, 79.1% had systolic blood pressure elevated loads, 40.5% showed a riser circadian pattern and 43.2% had a non-dipper pattern.

Studies have found that nocturnal hypertension is related to subclinical injury to target organs, such as ventricular mass increase and carotid intima-media layer thickening, and some authors have even reported cognitive impairment in these patients¹⁵⁻¹⁷.

In 2015, Androulakis et al.¹⁶ compared central systolic blood pressure with ambulatory blood pressure

monitoring-obtained pressures for predicting target organ subclinical damage in case of nocturnal hypertension, determined by urinary protein excretion rate and left ventricular mechanical dysfunction. The results of their study indicate that mean nocturnal blood pressure showed a significant correlation with central and peripheral systolic blood pressure and was significantly associated with increased proteinuria. The authors conclude that nocturnal systolic blood pressure correlates better with left ventricular mechanical function and urinary albumin/creatinine ratio than central systolic blood pressure.

Ambulatory blood pressure monitoring is one of the most recent approaches to heart examination and is increasingly being consolidated as a useful and efficient tool, due to its cost-benefit ratio, for improving the diagnosis and follow-up of hypertensive patients, optimizing antihypertensive treatment and establishing individual prognosis. It is also useful in when masked hypertension is suspected in the presence of normal blood pressure at the office, but with data consistent with target organ damage, which is of vital importance in women, given that the relationship between cardiovascular or renal events and nocturnal hypertension is more common in them, and if they are pregnant, it contributes precisely characterize maternal-fetal risk¹⁸⁻²⁰. In patients who require complex antihypertensive regimens, it helps to adjust medication schedule and doses, clearly reflecting patient autonomic function, which is closely linked to prognosis and cardiovascular event-free survival²¹.

We are then facing the premise of carrying out 24-h blood pressure ambulatory monitoring in all hypertensive patients, regardless of age and comorbidity, to ensure comprehensive and effective blood pressure control. Having nocturnal hypertension or an abnormal circadian pattern can be corrected by shifting some antihypertensive medications other than diuretics to the nighttime schedule, but without forgetting the possibility of concurrent pathologies, such as obstructive sleep apnea, different sleep disorders, and diabetic neuropathy/dysautonomia.

In this group of patients with high cardiovascular risk, ambulatory blood pressure monitoring has been shown to be a highly useful tool for identifying uncontrolled hypertensive patients, especially those with nocturnal hypertension, abnormal circadian patterns, or elevated pulse pressure.

The importance of the information provided by this study and the benefits deriving from high blood pressure appropriate control, such as reducing cardiovascular mortality, reversing cognitive alterations that affect patient quality of life and preventing or stopping the progression of heart failure or renal failure, make ambulatory blood pressure monitoring essential for the management of hypertensive patients, and even more so if they are at high cardiovascular risk. In addition to the social benefit, the economic benefit for the health system would be highly significant, not only in terms of the value of medicines but also in the saving of days of disability leave, visits to emergency services, and hospital stays.

In the “polypill” era, combined antihypertensive drugs and the tendency to indicate patients to take all medications at wake up time, it will be necessary to instruct patients with nocturnal hypertension in order for them not to allow, without justification, having the treatment regimen and schedule that controlled said alteration modified.

As doctors, we must offer better information to patients in general and especially to hypertensive patients, to motivate them to lead a healthy lifestyle by increasing physical activity, aerobic exercise, varied and balanced diet, as well as to drink more pure water and do without sugary drinks, improve their social, family, and spiritual life, and all that aimed at improving their internal ecosystem and enjoying good health and happiness.

Conclusions

It is important to clarify that, to achieve a good hypertension control, patients should undergo

follow-up, preferably with 24-h ambulatory blood pressure monitoring, since it has been shown that, despite receiving medication for being considered high cardiovascular risk patients, the percentage with monitoring-reported abnormal patterns is extremely high, which continues to be a risk factor for fatal outcomes.

One of the priorities in the control of blood pressure figures should be nighttime control since world medical literature has emphasized that not achieving this is associated with higher mortality from cardiovascular causes.

We dare to invite our readers to carry out periodic controls in the follow-up of hypertensive patients with comorbidity by 24-h ambulatory blood pressure monitoring to have a real assessment of the behavior of the pathology and take the necessary measures for reducing the appearance of serious cardiovascular events that may determine and limit patient functionality.

Acknowledgment

The authors would like special thanks to Mary Vergara de Navarro, María Carolina Sánchez, Ramón Fortich, Juan Camilo Ulloa and Enrique Ramos.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures that were followed adhered to the ethical standards of the responsible committee for experimentation on human subjects and were in agreement with the World Medical Association and the Declaration of Helsinki.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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