

Non-dipper effect in hypertense patients after renal transplantation by 24-hour ambulatory blood pressure monitoring

Efecto non-dipper en pacientes hipertensos postrasplante renal por monitoreo ambulatorio de la presión arterial de 24 horas

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Abstract

Objective: Determine instant and after 1-month non-dipper effect in hypertense patients after renal transplantation by 24-hour ambulatory blood pressure monitoring in Hospital General de Zona No. 50, San Luis Potosí, Mexico. **Method:** Descriptive, longitudinal and prospective cohort study of a non-probability convenience sampling in post-transplant patients with hypertension. We collected data from MAPA and includes age, sex, cardiovascular risk factors in variables. Use of central tendency and dispersion measures for descriptive analysis and t Student for inferential analysis. **Results:** 19 patients were included, 11 male (57.9%) and 8 females (42.1%), with age range 20 to 49 years (median of 30.2 years $\pm$ 7.7). Where the non-dipper effect in the first take was 89.5% and in the second take 84.2%. **Conclusions:** There is a high frequency of the non-dipper pattern in patients at one month of kidney transplant, the persistence of this hypertension may be, among others, by the use of immunosuppressants. A new category for non-dipper classification is described.

Keywords: Renal transplantation. Hypertension. Chronic renal insufficiency. Kidney diseases. Nephropathy.

Resumen

Objetivo: Determinar el efecto non-dipper inmediato y posterior a 1 mes en pacientes adultos hipertensos postrasplante renal con monitoreo continuo de la presión arterial de 24 horas, en el Hospital General de Zona No. 50 de San Luis Potosí, México. **Método:** Estudio de tipo cohorte, longitudinal, prospectivo, con muestreo no probabilístico por conveniencia de casos consecutivos en pacientes receptores de trasplante renal con hipertensión arterial. Se recogieron los siguientes datos: edad, sexo, factores de riesgo cardiovascular, uso de antihipertensivos o inmunosupresores, y monitoreo ambulatorio de la presión arterial de 24 horas. Se aplicaron medidas de tendencia central y de dispersión para análisis descriptivo, y prueba t de Student para análisis inferencial. **Resultados:** Se incluyeron 11 hombres (57.9%) y 8 mujeres (42.1%), con una edad de 20 a 49 años (media 30.2 $\pm$ 7.7), en los que el efecto non-dipper inmediato fue del 89.5% y posterior a 1 mes fue del 84.2%. **Conclusiones:** Existe una alta frecuencia del patrón non-dipper en pacientes a 1 mes del trasplante renal. La persistencia de la hipertensión puede ser, entre otras causas, por el uso de inmunosupresores. Se describe una nueva categoría para la clasificación non-dipper.

Palabras clave: Trasplante renal. Hipertensión. Insuficiencia renal crónica. Enfermedades renales. Nefropatía.

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Introduction

On December 23, 1954, in the city of Boston (USA) the first successful organ transplant was performed, kidney and between identical twins. This modified the natural history of the disease and was classified as one of the most important achievements of modern medicine^{1,2}. In 1966, the first kidney transplant was carried out in Mexico, in a patient with tubulointerstitial nephritis who died 14 days later due to septic shock³; the second kidney transplant was performed in 1967, in a patient who survived the transplant for 15 years^{4,5}. Renal rejection is one of the main problems, since the generation of antibodies caused by immunity plays an important role in graft rejection; however, the change in intrarenal hemodynamics is mainly of vascular origin and due to hyperfiltration of the remaining nephrons^{6,7}.

Within the vascular factors, it is considered that arterial hypertension associated with immunosuppressive therapy is the most affected^{8,9}; these factors cause the graft to have a shorter life, since if uncontrolled hypertension is maintained, the same endothelial damage can be generated as in a hypertensive patient without kidney disease. On the other hand, if the patient has rejection of the kidney graft due to immune or infectious reasons, arterial hypertension can be generated due to fluid overload^{10,11}.

renal transplantation is indicated in patients with end-stage chronic renal failure, the main causes being chronic glomerulonephritis, diabetic nephropathy and nephroangiosclerosis^{12,13}, which must be taken into account to assess the evolution of arterial hypertension^{14,15}.

Blood pressure is inversely associated with glomerular filtration rate after transplantation; 50% of patients experience significant improvement in blood pressure control, with reduced medication use in the months after transplant^{16,17}. Immunosuppressive agents can affect glomerular filtration rate and hemodynamic status, leading to arterial hypertension by a variety of mechanisms, including endothelin-induced vasoconstriction, abrogation of nitric oxide-induced vasodilation, and sodium retention^{18,19}. After kidney transplantation, 67-90% of patients treated with immunosuppressants, especially cyclosporine, develop arterial hypertension^{20,21}.

Other causes of post-transplant hypertension are renal artery stenosis and sequelae of antibody-mediated rejection²². Calcium channel blockers may be the most useful drugs to mitigate calcineurin inhibitor-induced

Table 1. Blood pressure scales

WHO	JNC 8	Systolic and diastolic blood pressure (mmHg)	ISH	P-NOM-030
Optimal	Normal	< 120 and < 80	Normal	Optimal
Normal		120-129 and/or 80-84		Suboptimal
Normal high	Normal high	130-139 and/or 85-89	Normal high	Bordering high
Grade I	Grade I	140-159 and/or 90-99	Grade 1	Grade I
	Grade II	160-179 and/or 100-109	Grade II	Grade II
Grade II		> 180 and/or > 110		Grade III

ISH: International Society of Hypertension; JNC: Joint National Committee; WHO: World Health Organization; P-NOM: Official Mexican Standard Project.

vasoconstriction and are associated with improved glomerular filtration rate^{23,24}. However, the use of renin-angiotensin inhibitors remains an attractive management strategy in transplant recipients^{25,26}.

Arterial pressure is maintained by a balance between cardiac output and peripheral vascular resistance, regulated by small-caliber arteries that work through smooth muscle. There are hypotheses that the increase in blood pressure is a consequence of the increase in minute volume in relation to the increase in the sympathetic system, so that the increase in peripheral resistance would be a compensatory mechanism that affects cellular homeostasis²⁷⁻³² (Table 1).

The KDIGO guides (*Kidney Disease Improving Global Outcome*) include kidney transplant recipients and propose treatment strategies with the goal of achieving blood pressure < 130/80 mmHg in kidney patients³³.

To measure blood pressure according to the circadian rhythm, the technique of ambulatory blood pressure monitoring (ABPM) is useful, a non-invasive method of monitoring for 24 hours that allows offering different parameters of blood pressure. It is generally used as an aid in the diagnosis of patients with refractory, nocturnal, white coat hypertension, pulse pressure, and hourly drug dosing^{34,35}.

The aforementioned data on the unfavorable association of arterial hypertension, vascular injury and chronic kidney disease allow us to clarify the epidemiological panorama of the disease. Complications of high blood pressure cause 9.4 million deaths, being the cause of 45% of deaths from heart disease and

Table 2. Classification of blood pressure according to the circadian rhythm

Classification	BP value at night versus day	Night/day ratio
<i>Dipper</i>	BP decrease at night 10-20% of the day	0.90-0.80
<i>Non-dipper</i>	Absence of nocturnal BP fall of 10% or < 10% of that of the day	0.91-1.00
<i>Dipper extreme</i>	Night BP decrease > 20% of the day	< 0.80
<i>Non-dipper mixed</i>	Fall and rise in a value (systolic or diastolic) of nocturnal BP	NA

NA: not applicable; PA: blood pressure.
Modified from ref. 43.

51% from stroke³⁶. The prevalence of hypertension observed in Mexico is 18.4% in adults 20 to 49 years old and 26.7% in adults 70 to 79 years old, according to the 2018 National Health and Nutrition Survey³⁷. It is estimated that 450,000 new cases are diagnosed annually in Mexico³⁸. According to data obtained by the Mexican Social Security Institute on disease burden, 27% of total mortality was secondary to cardiovascular disease³⁹.

During sleep onset, blood pressure normally decreases, reaching a maximum when slow-wave sleep is entered, and blood pressure rises on awakening^{40,41}. There are average values of systolic and diastolic pressure in the daytime and nighttime periods, which allows a classification of the patient depending on the circadian rhythm and through the night/day ratio^{42,43}. The determinations make it possible to provide preventive action and guide the detection of patients who, despite having a *non-dipper* pattern, have not yet developed any complications⁴³ (Table 2).

The authors found criteria that O'Brien⁴⁴ did not mention when performing the circadian classification of arterial hypertension. We added a fifth criterion to the classification, called the mixed *dipper* (Table 2), defined as the decrease in one value and the increase in the other value (systolic or diastolic) of nighttime blood pressure compared to daytime blood pressure.

The aim of this study was to determine the immediate and 1-month *non-dipper* effect of renal transplantation in hypertensive patients, as measured by continuous 24-h blood pressure monitoring.

Method

The study was carried out in the renal transplantation Unit of the General Hospital of Zone No. 50 of San Luis Potosí, belonging to the Mexican Institute of Social Security, during the period from August 2019 to April 2020, with a longitudinal cohort design. and prospective, non-probabilistic sampling for convenience of consecutive cases, of the entire natural population of renal transplantation recipients with arterial hypertension. The study was approved by the Local Health Research Committee 2402 with institutional registration number R-2019-2402-040.

The inclusion criterion was to be an adult over 18 years of age who received a renal transplantation with a diagnosis of arterial hypertension who agreed to participate in the protocol; the exclusion criteria were being a minor or not accepting the monitoring. All those patients who lost the graft before completing ABPM, after one month, or who completed said measurement in the same period of time due to study desertion, were eliminated from the study. Overweight, obesity, dyslipidemia and smoking were considered independent variables, while the presence of diabetes *mellitus*, arterial hypertension prior to the transplant and the etiology of chronic renal disease were control variables.

The age in years and the sex of the patients were taken into account, as well as the operational definition of the *non-dipper* effect in patients with arterial hypertension: two or more measurements with blood pressure figures > 140/90 mmHg or with the use of antihypertensive drugs without less than a 10% decrease in blood pressure from the diurnal average. Additionally, the existence of comorbidity or lifestyles that could aggravate cardiovascular disease was studied.

Once the patient's participation was authorized after the explanation of the study, the placement of the ABPM (Ambulatory Blood Pressure Monitor Space Labs Inc., Model No. 90207, Serial No. 207-042057) was performed, which was personalized with the data of each patient. patient with programmable parameters established by the investigator using standardized measurements such as daytime (6:00 a.m. to 9:00 p.m., every 30 minutes) and night (10:00 p.m. to 5:00 am, every 60 minutes). The procedure lasted 24 hours after the transplant and 24 hours after the first month after the transplant. Data from the observation sheet of each patient and the ABPM record were collected.

The concentrated data was used to perform a descriptive statistical analysis with measures of central tendency (mean) and dispersion (standard deviation); Student's t-test was used for the inferential analysis, with the SPSS version 23 program.

Results

57.9% of the patients were men and 42.1% were women, with an age range of 20 to 49 years (mean 30.2 years and standard deviation ± 7.7). The body mass index was 16.9 to 32.3 kg/m², with an average of 24.3 (± 5.2) kg/m², obtaining a categorical distribution with low weight of 5.3%, normal weight of 68.4% and grade 1 obesity of 26.3%. Among the etiologies documented by the medical history, diabetes *mellitus* was found in 5.3%, hypertension in 78.9%, tuberculosis in 5.3%, glomerulonephritis in 5.3%, and lupus erythematosus in 5.3%. Etiologies were also documented in only 5 patients by renal biopsy, in which glomerulonephritis was found in 5.3%, lupus nephritis in 5.3%, tuberculosis in 5.3% and for the association of diabetes *mellitus* and hypertension it is 10.5%. 58.5% of the patients did not undergo a pre-transplant biopsy.

Regarding the values obtained in the blood pressure measurements, a statistically significant difference was observed in the immediate morning systolic values, which ranged from 118.5 to 163.0 mmHg, with a mean of 142.1 ± 12.7 mmHg, and from 105.2 to 147.7 mmHg, with a mean of 131.8 ± 11.6 mmHg, after 1 month ($p < 0.05$ [0.003]). Immediate morning diastolic values ranged from 78.6 to 115.9 mmHg, with a mean of 95.8 ± 10.9 mmHg, and from 71.8 to 87.2 mmHg, with a mean of 85.1 ± 8.1 mmHg, after 1 month ($p < 0.05$ [0.002]).

Immediate nocturnal systolic values ranged from 114.4 to 179.8 mmHg, with a mean of 138.9 ± 16.8 mmHg, and from 105.7 to 160.5 mmHg, with a mean of 131.6 ± 13.9 mmHg, after 1 month ($p < 0.05$ [0.036]), while in the nocturnal values an immediate diastolic value was found with a range of 72.5 to 129.5 mmHg, with a mean of 95 ± 14.9 mmHg, and from 68.0 to 101.6 mmHg, with a mean of 82.5 ± 9.4 mmHg, after 1 month $p < 0.05$ [0.003]). The immediate *non-dipper* effect was found in 89.5% and after 1 month in 84.2%. Table 3 shows the results of mean arterial pressure (MAP) and heart rate.

According to the etiologies, the following results were obtained, in order of greatest change in MAP, observing that there is a significant decrease between morning and night MAP: in lupus nephritis (immediate

Table 3. Descriptive statistics of mean arterial pressure and heart rate

n = 19	Immediate intake		Take after 1 month	
	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
Morning PAM	92-131	111.1 $\pm$ 10.7	82.9-115.1	100.9 $\pm$ 9.1 0.002*
Morning FC	72.9-117.3	92.4 $\pm$ 11.2	59.3-99.7	86.2 $\pm$ 11.1 0.128
Night MAP	77-126	100.1 $\pm$ 12.6	80.6-121.3	98.9 $\pm$ 10.4 0.772
Night HR	70-110	89.3 $\pm$ 12.2	46.75-97.3	77.3 $\pm$ 10.9 0.004*

SD: standard deviation; HR: heart rate; MAP: mean arterial pressure.

morning MAP of 100 mmHg, immediate night MAP of 109 mmHg, morning MAP after 1 month of 83 mmHg, night MAP after one month of 82 mmHg) decreased to a greater degree than in glomerulonephritis (immediate morning MAP of 126 mmHg, immediate night MAP of 121 mmHg, morning MAP after 1 month of 107 mmHg, night MAP after 1 month of 96 mmHg) and diabetes *mellitus* (immediate morning MAP of 111 mmHg, immediate night MAP of 94 mmHg, morning MAP after 1 month of 87 mmHg, night MAP after 1 month of 99 mmHg).

Unlike the previous etiologies, tuberculosis (Immediate morning MAP of 102 mmHg, immediate night MAP of 97 mmHg, morning MAP after 1 month of 92 mmHg, night MAP after 1 month of 98 mmHg) presented a lower decrease in MAP than hypertension (mean immediate morning MAP of 112 mmHg, immediate night MAP of 100 mmHg, mean morning MAP after 1 month of 103 mmHg, night MAP after 1 month of 100 mmHg). The difference in percentage of the MAP immediately and after 1 month is shown in table 4.

Significance was found in the morning MAP ($p < 0.05$ [0.002]), unlike the night ($p < 0.05$ [0.772]), while it was the other way around for heart rate, finding significance at night ($p < 0.05$ [0.004]) and not in the morning ($p < 0.05$ [0.128]). In addition, a positive and significant Pearson correlation was observed between the mean nocturnal MAP and the number of years that the patient smoked ($r = 0.459$; $p = 0.048$) and the number of years of having arterial hypertension ($r = 0.65$; $p = 0.045$), but not with the average nocturnal systolic or diastolic blood pressure.

An echocardiogram was performed on all patients and left ventricular hypertrophy was found in 32%; no association was found between left ventricular hypertrophy and the *non-dipper* effect when performing Fisher's exact test ($p > 0.05$ [0.70]).

Table 4. Percentage difference in mean arterial pressure at 1 month post-renal transplantation

Etiology	Morning PAM	Night MAP
Diabetes <i>mellitus</i>	22% decrease	5% increase
Arterial hypertension	8% decrease	Without changes
Glomerulonephritis	15% decrease	21% decrease
Tuberculosis	10% decrease	1% increase
Lupus nephritis	17% decrease	25% decrease

MAP: mean arterial pressure.

A decrease in the use of calcium channel antagonist antihypertensives was observed after transplantation, as well as an increase in the use of alpha and beta blockers. Regarding immunosuppressive drugs, an increase in the use of tacrolimus was observed after 1 month with respect to immediate intake, and the use of others such as cyclosporine and sirolimus was added.

Discussion

Chronobiology is the study of biological rhythms and their underlying mechanisms⁴⁵. Blood pressure follows a circadian pattern, with higher numbers during the day and lower ones at night, but in many hypertensive patients the night drop (*non-dipper*) does not occur and therefore they have a higher cardiovascular risk. This is more important in renal transplantation recipients, since nocturnal pressure drop and pulse pressure are prognostic markers^{46,47}. performed monitoring using ABPM in 70 patients diagnosed with essential hypertension and with adequate control after pharmacological treatment, and found that 75% were *dipper*. If we compare these results with those obtained in our study, only 10.5% were *dipper*, that is, an inverted relationship in post-transplant patients.

Chronic renal disease causes different types of morphological alterations, mainly of a cardiovascular nature. Some studies mention that, despite the use of replacement therapy or transplantation, the presence of factors that increase risk persists⁴⁸. This study found a significant difference in morning compared to night MAP, and a similar difference in night compared to morning heart rate. We believe that this is related to a change in homocysteine, common in renal patients, along with the use of immunosuppressants⁴⁹. On the other hand, it has been shown that in these types of patients there is an alteration

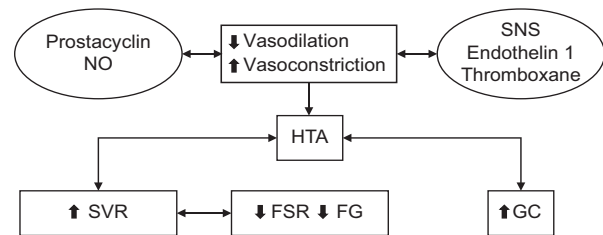


Figure 1. Mechanisms involved in cyclosporine-induced arterial hypertension. GFR: glomerular filtration rate; RBB: renal blood flow; CO: cardiac output; HTA: arterial hypertension; NO: nitric oxide; SVR: systemic vascular resistance; SNS: sympathetic nervous system.

in the autonomic nervous system that causes a slight increase in sympathetic activity⁵⁰.

It is confirmed that elevated MAP and a higher stage of hypertension are associated with a history of smoking, so there would be more endothelial damage in these patients⁵¹. The study by Suhaila et al.⁵² in a population of hypertensive patients shows that ambulatory blood pressure more accurately reflects a patient's actual blood pressure than office blood pressure. In their results, the ambulatory pressure measured in 24 hours was normal, but the daytime mean and nighttime diastolic were above the normal value. Like us, they observed that most of the patients were categorized as *non-dipper*.

The non-association between left ventricular hypertrophy and the *non-dipper* effect may be due to the size of the sample, so it cannot be concluded as definitive and more studies should be carried out in this regard.

The response to night arterial hypertension may be associated with the use of immunosuppressants, which would explain this finding, as described in Figure 1. Guidelines are needed to individualize the treatment of these patients.

Conclusions

We found a different pattern that is not classified by O'Brien, which we consider as an additional variable, and it will have to be confirmed if it can predict risk, so we consider that this category, called mixed *non-dipper*, should be evaluated in a sample larger to assess its significance. This study supports that the frequency of the *non-dipper* effect presented by hypertensive patients after renal transplantation is greater than that observed in other populations. There is no evidence available to recommend an antihypertensive treatment based on the management of an altered circadian profile, nor can a

specific treatment be recommended for the *non-dipper* pattern in post-transplant patients, but we must assess the possibility that this classification allows stratifying the risk of the patient, as well as prevent damage to the transplanted target organ. We recommend continuing this line of research in larger series of patients and in longer-term cohorts.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of people and animals. The authors declare that the procedures followed complied with the ethical standards of the responsible human experimentation committee and in accordance with the World Medical Association and the Declaration of Helsinki.

Data confidentiality. The authors declare that they have followed the protocols of their work center regarding the publication of patient data.

Right to privacy and informed consent. The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

References

- Veliz DH, Landeira JD, Pérez JEA, Betancourt I, Álvarez NE, Sánchez AF. Importance of blood pressure variability. *Rev Cuba Cardiol Cir Cardiovasc.* 2016;10:54 PM-61.
- Hernández-Ibarra LE, Mercado-Martínez FJ, Martínez-Castañeda A. Organ donation and transplantation in Mexico. A transplantation health professionals' perspective. *Mexican Public Health* 2017;59:53-8.

- Baptista González HA. Kidney transplant. Regarding the first cases. *Rev Invest Med Sur Mex.* 2011;6:32 PM-4.
- Murray JE. Ronald Lee Herrick Memorial. *Am J Transplant.* 2011;11:419.
- Social Communication U. IMSS Bulletin 376. Mexico City: IMSS; 2019.
- Peña JC. History of renal transplantation at the INCMNSZ. *Rev Invest Clin.* 2005;57:120-3.
- Sejia M, Nim M, Astesiano R, Coitiño R, Santiago J, Ferrari S et al. Acute rejection of renal transplantation; diagnosis and therapeutic alternatives. *Nefrol Latinoam.* 1996;4:31 PM-8.
- Wagner-Grau P. Pathophysiology of arterial hypertension. *An Fac Med.* 2010;71:225-9.
- Midtvedt K, Hartmann A. Hypertension after renal transplantation: are treatment guidelines emerging? *Nephrol Dial Transplant.* 2002;17:1166-9.
- Martín Dávila P, Blanes M, Fortún J. Immunosuppression and infection in the transplant patient. *Enferm Infecc Microbiol Clin.* 2007;25:143-54.
- Milla García E, Gómez Tijero N, Giménez Poderós T. Renal transplantation in the immediate postoperative period. In: Bermejo Vicedo T, editor. *Hospital Pharmacy Resident's Manual.* Madrid: Gráficas Marte; 2007. p. 1-64.
- Aziz F, Clark D, Garg N, Mandelbrot D, Djamali A. Hypertension guidelines: how do they apply to kidney transplant recipients. *Transpl Rev.* 2018;32:225-33.
- UNC Health Care Interpreter Services. Chronic Kidney Disease. UNC School of Medicine. Chapel Hill: National Kidney Disease Educational Program; 2012. Available at: <https://uncrenalcenter.org/renalhealthlibrary/chronic-renal-disease-1>
- Chew-Wong A, Alberú-Gómez J, Abasta-Jiménez M, Márquez-Díaz F, Correa-Rotter R. Post-renal transplantation arterial hypertension: associated risk factors and influence on renal graft survival. *Gac Med Mex.* 2005;141:461-8.
- López-Montenegro Soria MA, Porta Oltra B, Jiménez Torres NV, Pallardó Mateu L. Prediction of risk of acute rejection in patients with renal transplantation. *Farm Hosp.* 2009;33:194-201.
- Santamaría-Olmo R, Gorostidi-Pérez M. Blood pressure and progression of chronic renal disease. *NefroPlus.* 2013;5:4-11.
- Pérez Tamajón L. Early medical complications after renal transplantation. *Spanish Society of Nephrology;* 2016. Available at: <https://www.nefrologiaaia.org/es-articulo-complicaciones-medicas-precoces-tras-el-140>
- Dominguez-Gil B, Espejo B, Muñoz MA, Rodicio JL, Morales JM. Arterial hypertension after renal transplantation. *Hypertension and Vascular Risk.* 2002;19:80-90.
- Morales JM, Domínguez-Gil B. Renal transplantation: evidence-based medicine. Immunosuppression in organ transplantation. Sharp rejection. In: *Classroom on solid organ transplants.* Madrid: Drug Farma; 2001. p. 79-100. Available at: <https://www.yumpu.com/es/document/view/44442498/aula-sobre-trasplantes-de-organos-solidos-roche-trasplantes>
- Orias M, Díaz CH. Pathophysiology of arterial hypertension in renal transplantation. In: *Arterial hypertension, epidemiology, physiology, pathophysiology, diagnosis and therapy.* Argentina: Inter-Médica; 2013. p. 277-81. Available at: <http://www.saha.org.ar/formacion/libro>
- Robert N, Wong GW, Wright JM. Effect of cyclosporine on blood pressure. *Cochrane Database Syst Rev.* 2010;(1):CD007893.
- Radhakrishnan J. Nephrotoxicity and post-transplant arterial hypertension. *Medwave.* 2001;1(3). Available at: <http://www.medwave.cl/link.cgi/Medwave/PuestaDia/Congresos/1334>
- Casola PD. Arterial hypertension after renal-hepatic-cardiac solid organ transplantation. *Insuf Card.* 2011;6:80-91.
- Rengel M. Effects of antihypertensive treatment with calcium channel blockers in renal transplantation patients. *Nephrology.* 2000;20:71-2.
- Martín P, Errasti P. Kidney transplant. *An Sist Sanit Navarr.* 2006;29:79-92.
- Hernández AA, Bayés B, Cabello V, Cofan F, Crespo M, Franco A, et al. Treatment of arterial hypertension after renal transplantation. *Nephrology.* 2009;29:16-23.
- Maicas Bellindo C, Lázaro Fernández E, Alcalá López J, Hernández Simón P, Rodríguez Padial L. Etiology and pathophysiology of essential arterial hypertension. *Monocordium.* 2003;5:141-60.
- Ferreira R. Pathophysiology of arterial hypertension. *IntraMed.* 2001. Available at: <https://www.intramed.net/contenido.asp?contenido=14532>
- Hernández Hernández M. Clinical review: systemic arterial hypertension. Medical attention. Available at: <http://www.facmed.unam.mx/deptos/familiar/atfm106/revisionclinica.html>
- Rubio-Guerra AF, Francisco A, Guerra R. New American College of Cardiology/American Heart Association Hypertension guidelines for the treatment of hypertension. A leap in the right direction? *Med Int Mex.* 2018;34:299-303.
- Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D et al. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension.* 2020;75:1334-57.
- Government of Mexico. Draft Official Mexican Standard PROY-NOM-030-SSA2-2017, for the prevention, detection, diagnosis, treatment and control of systemic arterial hypertension. 030 México; 2017.

33. World Health Organization. Global atlas on cardiovascular disease prevention and control. WHO; 2011. 164 p. Available at: https://www.who.int/cardiovascular_diseases/publications/atlas_cvd/en
34. Zúñiga EC, Martínez SXZ. Ambulatory blood pressure monitoring. *Rev Mex Cardiol*. 2010;9:25 PM-30.
35. Álvarez Batard G, Ruso R, Pérez Caballero MD, Fernández Arias MA. Clinical manual of ambulatory blood pressure monitoring. *Rev Cubana Med*. 2006;45(4).
36. World Health Organization. General information on hypertension in the world. WHO; 2013.
37. INSP, INEGI. National Health and Nutrition Survey. Public Health Magazine of Mexico. Mexico; 2018.
38. Zamorano González B, Parra Sierra V, Vargas Martínez JI, Peña Cardenas F, Velázquez Narvaez Y, Ruiz Ramos L et al. Risk of arterial hypertension in the adult population in Matamoros, Tamaulipas, Mexico. *J Heal NPEPS*. 2018;3:368-79.
39. Ramírez-Arias E, Santos-Martínez E, Díaz-Díaz E, Rodríguez M, Pérez-Ruiz CE, Raúl L. Consensus on systemic arterial hypertension in Mexico. Mexico City; 2016. p. 506-51.
40. Hernandes Fernandes E, Coelho D, Missel Correa JR, Kumpinski D. Circadian disturbances of the cardiovascular system. *Rev Esp Cardiol*. 2000;53:117-22.
41. Campo Sien C. Adequate fall in blood pressure during sleep: clinical significance. *Hypertension and Vascular Risk*. 2002;19:101-3.
42. Ocón J, Ibeas J. Nictameral rhythm of blood pressure. *Nephrol*. 2002;10:27 PM-38.
43. Doménech Fera-Carot M, Sobrino Martínez J. Night hypertension. *Hypertension and Vascular Risk*. 2011;28:143-8.
44. O'Brien E, Sheridan J, O'Malley K. DIPPERS AND NON-DIPPERS. *Lancet* [Internet]. 1988 Aug 13 [cited 2021 Oct 12];332(8607):397. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S014067368892867X>.
45. Ángeles-Castellanos M, Rodríguez K, Salgado R, Escobar C. Medical chronobiology. Physiology and pathophysiology of biological rhythms. *Rev Fac Med UNAM*. 2009;50:238-41.
46. Vinyoles E. Pulse pressure or non dipper pattern, which better predicts risk in resistant hypertension? *Hypertension and Vascular Risk*. 2008;25:221-2.
47. Villalba Alcalá F, Espino Montoro A, Álvarez Lacayo C, Cayuela Domínguez A, González Fernández MC, López Chozas JM. Behavior of nocturnal drop in blood pressure after controlled withdrawal of antihypertensive medication. *Primary Care*. 2003;31(5):301-6.
48. López Gómez JM, Jofré R, Cases A. Cardiovascular risk factors in chronic renal disease. *Nephrology*. 2002;10:45 PM-7.
49. Pascual J, Marcén R. Cardiovascular diseases in renal transplantation. *Nephrology*. 2001;21:104-14.
50. Contreras Ríos R, Hurtado Arestegui A. Evaluation of autonomic dysfunction in patients with chronic renal failure on a hemodialysis program. *Rev Med Hered*. 2013;9:98.
51. Pardell Alenta H, Armario García P, Hernández del Rey R. Tobacco, blood pressure and cardiovascular risk. *Hypertension and Vascular Risk*. 2003;20:226-33.
52. Suhaila S, Juwita S, My H, Alina T. Circadian blood pressure profile and associated cardiovascular risk factors in non-dippers. *International Medical Journal Malaysia*. 2013;12:23 PM-31.