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Evaluation of The Effect of Ambulatory Blood Pressure and Heart Rate on in-Hospital Mortality and Long-Term Functional Outcomes in Ischemic Stroke

İskemik İnmede Ambulatuvar Kan Basıncı ve Kalp Hızının Hastane İçi Mortalite ve Uzun Dönem Fonksiyonel Sonlanım Üzerine Etkisinin Değerlendirilmesi

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ABSTRACT

Background: This study investigates the effect of ambulatory blood pressure (ABP) and ambulatory heart rate (AHR) measurements on in-hospital mortality and long-term outcomes in patients with acute ischemic stroke (AIS).

Methods: ABP and AHR were recorded by Holter monitoring at nighttime (21.00-07.00) and daytime (07.00-21.00). Patients were divided into survived and deceased groups, and into favourable and unfavourable outcome groups according to long-term functional outcomes. The 24-hour, daytime and nighttime ABP and AHR measurements were compared.

Results: Nighttime, daytime and 24-hour mean heart rate (MHR) values were found to be higher in deceased group. In the discrimination according to the in-hospital mortality, the cut-off value of daytime MHR was 89.7 with 90.0% sensitivity and 82.4% specificity (P<.05). Similarly, the cut-off value of nocturnal MHR was 83.6 with 90.0% sensitivity and 76.5% specificity (P<.05). With a 1-unit increase in daytime MHR, the risk of developing mortality will increase 1.120 times [12% increase] (OR=1.120; 95% CI=1.047-1.198).

Conclusion: AHR measurements may be more helpful for clinicians to predict in-hospital mortality and long-term functional outcomes in patients with AIS than ABP measurements.

Keywords: Acute ischemic stroke, ambulatory blood pressure, mean heart rate, in-hospital mortality, long-term functional outcome.

ÖZ

Amaç: Bu çalışmada akut iskemik inmeli (Aİİ) hastalarda ambulatuvar kan basıncı (AKB) ve ambulatuvar kalp hızı (AKH) ölçümlerinin hastane içi mortalite ve uzun dönem sonuçlar üzerindeki etkisinin araştırılması amaçlanmıştır.

Yöntemler: AKB ve AKH, Holter monitörizasyonu ile gece (21.00-07.00) ve gündüz (07.00-21.00) kaydedildi. Hastalar hastane-içi mortaliteye göre sağ kalan ve ölen, uzun dönem fonksiyonel sonuçlara göre de iyi ve kötü sonlanım şeklinde gruplara ayrıldı. Gruplar arasında yirmi dört saatlik, gündüz ve gece AKB ve AKH ölçümleri ve kan basıncı karşılaştırıldı.

Bulgular: Gece, gündüz ve 24 saatlik ortalama kalp hızı (OKH) değerleri ölen hasta grubunda daha yüksek bulundu. Hastane içi mortaliteye göre ayırımda, gündüz OKH'nin kesim değeri %90.0 duyarlılık ve %82.4 özgüllük ile 89.7 idi (P<.05). Benzer şekilde, gece OKH'nin kesim değeri %90,0 duyarlılık ve %76,5 özgüllük ile 83,6 idi (P<.05). Gündüz OKH'da 1 birimlik artış ile hastane içi mortalite riski 1.12 kat [%12 artış] artacaktır (OR=1.120; %95 CI=1.047-1.198).

Sonuç: AKH ölçümleri, Aİİ'li hastalarda hastane içi mortaliteyi ve uzun dönem fonksiyonel sonuçları öngörmede klinisyenlere AKB ölçümlerinden daha fazla yardımcı olabilir.

Anahtar Kelimeler: Akut iskemik inme, ambulatuvar kan basıncı, ortalama kalp hızı, hastane içi mortalite, uzun dönem fonksiyonel sonlanım.

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INTRODUCTION

Acute ischemic stroke (AIS) stands among the most prevalent causes of mortality and prolonged disability all over the world.[1] To date, the outcomes of stroke have been associated with numerous factors. Stroke severity and patient age are both major predictors of outcomes in the acute phase of stroke.[2]

The circadian rhythm plays a crucial function in maintaining homeostasis in the body. Blood pressure (BP) also has a circadian pattern. Nocturnal BP exhibits a decrease in both systolic and diastolic values, which is subsequently followed by higher diurnal values.[3] During the early stage of AIS, there is an increase in BP that gradually returns to normal within a few days. High BP might be beneficial during AIS by improving cerebral perfusion or it might be detrimental by aggravating and hemorrhagic transformation of the ischemic tissue.[4]

Despite the efficacy of instantaneous measurements repeated in the clinic and at home, ambulatory measurements increase the reliability of daily measurements and make night-time measurements possible. Ambulatory measurements allow us to obtain a large number of measurements. When we obtain these measurements, we can compare day and night values. It is known that BP normally decreases by 10% to 20% during sleep at night compared to daytime. A decrease between 10% to 20% is called dipper pattern, decrease of less than 10% is called a non-dipper pattern.[5] AIS has been associated to a disturbed autonomic nervous system function, particularly in severe strokes, and this might be realted with a higher risk of poor functional outcome and mortality.[6,7]

Also, during the recording period, 24-hour Holter monitoring can record mean heart rate (MHR) values, which may provide a more valuable prognostic contribution than an instantaneous electrocardiogram (ECG).[8] The relationship between stroke and various heart rate (HR) parameters, including baseline HR, MHR, and HR variability has been assessed in previous studies.[9,18] The role of HR variability on disease outcomes remains a subject of controversy.[14,16,18,19] Some studies employed HR parameters within one week of onset.[18] and in others within 24 hours of admission.[9,13,16] Whereas other studies utilized HR parameters during the patient's first admission.[11,12,20] However, the relationship between the HR parameter and recording periods with in-hospital mortality and long-term outcomes is still imprecise.

The purpose of this study was to evaluate the impact of ambulatory BP (ABP) and ambulatory HR (AHR) measurements on the long-term outcomes and in-hospital mortality of patients with AIS.

MAIN POINTS

- In terms of long-term functional outcomes, all blood pressure and heart rate parameters were higher in the UO group compared to the FO group. However, only the daytime and nighttime MAP and MHR, as well as the 24-hour MAP and MHR values, demonstrated statistically significant increases in the UO group.
- As a result of logistic regression analysis based on in-hospital mortality, it was determined that daytime MHR was a significant variable in terms of the risk of mortality.opment of stroke.
- In the discrimination according to the in-hospital mortality, the cut-off value of daytime MHR was 89.7 with 90.0% sensitivity and 82.4% specificity. Similarly, the cut-off value of nocturnal MHR was 83.6 with 90.0% sensitivity and 76.5% specificity

MATERIAL AND METHODS

Study Design and Ethical Considerations

This prospective observational single-center cohort study included patients who presented to the emergency department with acute stroke symptoms within the first 6 hours of symptom onset between September 1, 2018 and June 1, 2019. Ischemic stroke was diagnosed by clinical findings, brain computerized tomography (CT) and/or diffusion magnetic resonance imaging (MRI).

The inclusion criteria were as follow: (a) diagnosis of AIS; (b) admission during the first 6 hours of symptom onset; (c) National Institute of Health Stroke Scale (NIHSS) score of 6 and above (d) lack of prior stroke; (e) determination that modified Rankin Scale (mRS) score was 0 prior to current stroke.

The exclusion criteria were; (a) admission after the first 6 hours of symptom onset; (b) NIHSS score of 5 and below; (c) having cardiac arrhythmia; (d) currently taking antiarrhythmic medication; (e) patients with inaccurate BP and heart rate (HR) monitoring; (f) patients with a hypertensive crisis (>220/120 mmHg) who had received immediate antihypertensive treatment; (g) severe dementia; (h) severe psychiatric disease. Ethics committee approval was received for this study from the Çukurova University Non-Interventional Clinical Studies Ethics Committee. (Date: March 3, 2018; Decision No: 23). Written informed consent was obtained from patients who participated in this study. All procedures were performed in accordance with the ethical standards of the revised 2008 Declaration of Helsinki.

Data Collection and Assessment

The clinical evaluation findings performed on each patient upon admission, detailed medical history and neurological examination. Time of symptom onset, smoking and alcohol consumption, diabetes mellitus (DM) and hypertension (HT), valvular heart disease history were all collected. Complete blood count, blood biochemistry, lipid profile, if neccessary vasculitic tests and causes of thrombophilia were all examined. The results, as well as demographic and clinical data, were recorded. ECG, carotid-vertebral color doppler ultrasonography, brain and diffusion MRI, cerebral and cervical MR/CT angiography, transthoracic echocardiography.

The primary endpoint of the study was in-hospital mortality. Long-term outcomes were evaluated according to the mRS scores at the end of the first year of AIS. The patients with mRS 0-2 constituted the favourable outcome (FO) group, while those with mRS 3 and above constituted the unfavourable outcome (UO) group.

Procedures

In this study, the Microlife® Watch BP Analyzer O3 (Microlife Corporation, Clearwater, USA) was used to take hourly readings of BP and HR throughout the day and night. Within the first 6 hours of admission, an ambulatory holter device was attached to each patient's non-paralized brachial arm. BP and HR measurements, which were performed every 60 minutes in the first 24 hours of admission, were recorded at night (21.00-07.00) and daytime (07.00-21.00). By adding up all the recorded HR readings and divided by the total number of readings, the MHR was found to be the average of the HRs taken within 24 hours of admission.

All patients had measurements recorded of mean arterial pressure (MAP), mean systolic blood pressure (MSBP), mean diastolic blood pressure (MDBP), nighttime and daytime MSBP, MDBP, and MABP, and nighttime and daytime MHR over the course of a 24-hour period.

Patients were divided into two groups according to nocturnal blood pressure and heart rate fall. Patients with a fall of 10% to 20% in MSBP, MDBP, MAP and MHR values at night compared to daytime were evaluated as dipper; those with a decrease of less than 10% were evaluated as non-dipper.

Statistical Analysis

The Statistical Package for Social Sciences version 24.0 sofware (IBM Corp.; Armonk, NY, USA) was used for statistical analysis. Frequency tables and descriptive statistics were used to interpret the findings.

In-hospital mortality and mRS score at the end of the first year of AIS were the independent variables. BP and HR (MAP, MSBP, MDBP, MHR for 24-hours, daytime and nighttime) are the dependent variables.

Continuous data were expressed as mean±SD while categorical data were expressed as numbers or percentages. The normal distribution of continuous variables was evaluated by Shapiro-Wilk test. Student's t-test was used to compare the normally distributed continuous variables while the Mann-Whitney U test was used to compare the non-parametric continuous variables.

Chi-square tables were used to examine the relationship between two qualitative variables. A binary logistic regression model was used to determine risk levels when the dependent variable was at two group levels. ROC curves were used to determine the cut-off. The statistical significance set at the level of P<.05.

RESULTS

A total of 191 consecutive acute stroke patients admitted to the emergency department were assessed for eligibility to participate. The study included 61 patients who met the inclusion and exclusion criteria (Figure 1).

The mean age of the deceased group was 70±8.7 years, while the mean age of the survived group was 64.2±12.5 years. The patients in the UO group also had a mean age higher than those in the FO group (P<.05). Cardiovascular diseases were higher in the deceased group (P<.05). The median NIHSS score was 10.[6,25] Admission NIHSS score and the number of patients with mild to moderate and moderate stroke were higher in the FO group (P<.05). The demographical and clinical characteristics of the patients are listed in Table 1.

Daytime, nighttime and 24-h MSBP, MDBP, MAP and MHR values were compared in the survived and deceased groups. Nighttime, daytime and 24-h MHR values were found to be higher in the deceased group (P<.001) (Table 2).

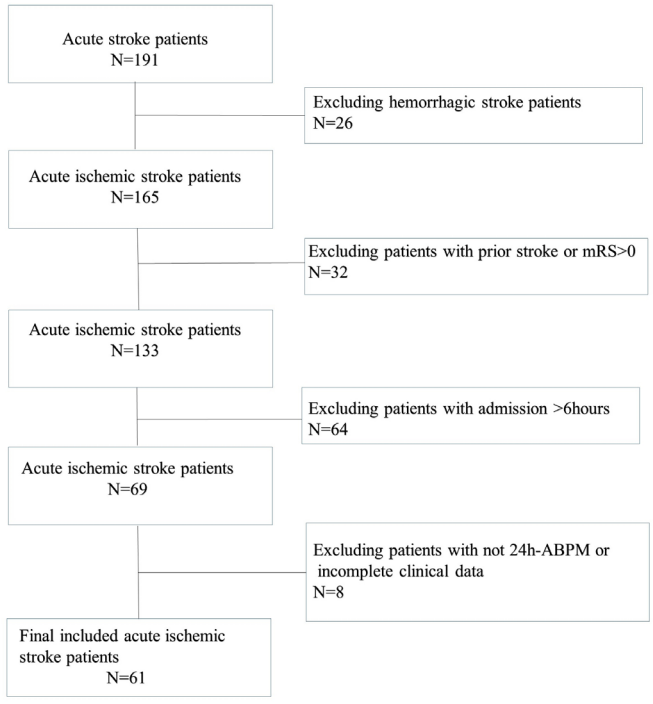

Figure 1. Flow chart of patients included in the study. ABPM, ambulatory blood pressure monitoring.

Table 1. Comparison of clinical and demographic data related to mortality and long-term outcomes

Variables	n	%	Deceased	Survived	P	FO group	UO group	P
Age (year) (mean±SD)	65±12		70±9	64±12	.166	62±13	70±8	.009
Gender Female	23	62.3	30%	39.2%	.577	33.3%	45.5%	.348
Smoking	34	55.7	60.0%	54.9%	.364	45.4%	51.2%	.414
Hypertension	30	49.2	50.0%	49.0%	.948	45.4%	51.2%	.414
Diabetes mellitus	24	40.0	50.0%	37.2%	.214	40.9%	38.4%	.866
Cardiovascular diseases	27	44.3	70.0%	33.3%	<.001	45.4%	51.2%	.414
Antithrombotic use	30	49.2	50.0%	49.0%	.948	40.9%	38.4%	.866
Admission NIHSS (mean±SD)	9±5		11±5	9±5	.209	7±4	13±5	<.001
Stroke severity NIHSS 6 to 20 NIHSS≥21	53 8	86.9 13.1	70.0% 30.0%	90.2% 9.8%	.086	100% 0%	63.6% 36.4%	<.001
Iv r-tPA	36	59.0	70.0%	56.9%	.444	56.4%	63.6%	.582
tPA administered within 3 hours 3 to 4.5 hours	11 25	18.0 41.0	20.0% 50.0%	17.0% 39.2%	.449	13.6% 50.0%	20.5% 35.9%	.540
MT	11	18.0	40.0%	13.7%	.05	12.8%	27.5%	.166

FO, Favourable outcome; Iv, Intravenous; MT, Mechanical thrombectomy; NIHSS, National Institute of Health Stroke Scale; SD, Standard deviation; r-tPA,recombinant tissue plasminogen activator; UO, Unfavourable outcome.

Table 2. Comparison of ambulatory blood pressure and heart rate measurements of survived and deceased group

	Survived (n = 51) (mean ± SD)	Deceased (n = 10) (mean ± SD)	P
Daytime			
MSBP (mmHg)	139.2 ± 18.37	143.32 ± 23.07	.537
MDBP (mmHg)	81.29 ± 11.42	89.01 ± 15.01	.069
MAP (mmHg)	100.56 ± 12.66	107.13 ± 16.58	.160
MHR (bpm)	76.53 ± 12.74	103.22 ± 20.45	< .001
Nighttime			
MSBP (mmHg)	141.45 ± 19.18	138.42 ± 20.55	.652
MDBP (mmHg)	82.36 ± 12.40	85.01 ± 12.44	.540
MAP (mmHg)	102.02 ± 13.54	102.78 ± 13.07	.872
MHR (bpm)	76.42 ± 12.53	95.29 ± 18.28	< .001
24-hour			
MAP (mmHg)	101.24 ± 11.97	104.93 ± 14.68	.395
MHR (bpm)	75.96 ± 12.53	99.24 ± 18.80	< .001

bpm, beats per minute; MAP, Mean arterial pressure; MDBP, Mean diastolic. blood pressure, MHR, Mean heart rate; MSBP, Mean sistolic blood pressure; SD, standard deviation. Data are mean ± SD.

The dipping and non-dipping status of the patients were compared according to survived and deceased groups. It was found that SBP dipping status was statistically higher in the deceased group (P < .05) (Table 3).

In terms of long-term functional outcomes, all BP and HR parameters were higher in the UO group compared to the FO group. However, only the daytime and nighttime MAP and MHR, as well as the 24-hour MAP and MHR values, demonstrated statistically significant increases in the UO group (P < .05) (Table 4).

As a result of logistic regression analysis based on in-hospital mortality, it was determined that daytime MHR was a significant variable in terms of the risk of mortality in the current model (P<.05). With a 1-unit increase in daytime MHR, the risk of developing mortality will increase 1.120 times [12% increase] (OR=1.120; 95% CI=1.047-1.198) (Table 5).

As a result of logistic regression analysis based on long-term functional outcome, it was determined that age and admission NIHSS was significant variables in terms of the status of long-term functional outcome in the current model (P<.05). With a 1-unit increase in age MHR, the risk of developing poor outcome will increase 1.08 times (8% increase) (OR=0.920; 95% CI=0.851-0.994) and with 1-unit increase in NIHSS score, the risk of developing poor outcome will increase 1.24 times (24% increase) (Table 6).

Table 3. Comparison of dipper/non-dipper pattern status of survivor and mortality group

Variables	Dipper pattern		Non-dipper pattern		P
	Survived	Deceased	Survived	Deceased	
SBP	23 (45.1)	8 (25.8)	28 (54.9)	2 (6.7)	.044
DBP	26 (78.8)	7 (21.2)	25 (89.3)	3 (10.7)	.270
HR	31 (81.6)	7 (18.4)	20 (87.0)	3 (13.0)	.582

DBP: Diastolic blood pressure, HR: Heart rate, SBP: Sistolic blood pressure. Data are n (%).

Table 4. Comparison of ambulatory blood pressure and heart rate measurements of long-term functional outcome groups

Variables	FO group (n = 39)	UO group (n = 22)	P
Daytime			
MSBP (mmHg)	136.86 ± 17.72	145.22 ± 20.56	.100
MDBP (mmHg)	80.84 ± 10.30	85.60 ± 14.94	.147
MAP (mmHg)	99.48 ± 11.57	105.46 ± 15.82	.096
MHR (bpm)	75.50 ± 11.52	90.49 ± 21.42	.001
Nighttime			
MSBP (mmHg)	137.55 ± 17.56	147.00 ± 21.04	..065
MDBP (mmHg)	80.73 ± 11.93	86.44 ± 12.48	.083
MAP (mmHg)	99.64 ± 12.54	106.59 ± 13.90	.050
MHR (bpm)	74.77 ± 11.75	87.91 ± 17.13	.003
24-hour			
MAP (mmHg)	99.50 ± 11.01	106.00 ± 13.83	.049
MHR (bpm)	74.47 ± 11.67	89.18 ± 13.83	< .001

BPM, beats per minute; MAP, Mean arterial pressure; MDBP, Mean diastolic blood pressure; FO, Favourable outcome; MHR, Mean heart rate; MSBP, Mean sistolic blood pressure; SD, Standard deviation; UO, unfavourable outcome. Data are mean ± SD.

Table 5. Logistic regression model based on in-hospital mortality risk status

Variable	B	SE	Wald χ2	P	OR	95% CI
Age	0.055	0.053	1.093	.296	1.057	0.953, 1.173
Gender A	0.104	1.125	0.009	.926	1.110	0.122, 10.061
Stroke severity	0.072	0.111	0.424	.515	1.075	0.865, 1.335
Iv r-tPA application B	-2.354	1.574	2.236	.135	0.095	0.004, 2.077
MAP (daytime)	0.112	0.093	1.438	.230	1.118	0.931, 1.343
MAP (nighttime)	-0.164	0.111	2.195	.138	0.848	0.683, 1.055
MHR (daytime)	0.113	0.034	10.890	.001	1.120	1.047, 1.198
MHR (nighttime)	-0.055	0.088	0.385	.535	0.947	0.796, 1.126
Constant	-11.279	6.255	3.252	.071	0.000	
Reference category: A:Male, B:Applied	CCR=90.2%		χ 2 (8) =3.711, P=.882			

Iv: Intravenous, MAP: Mean arterial pressure, MHR: Mean heart rate, r-tPA: Recombinant tissue plasminogen activator.

The receiver operating characteristics (ROC) curve analysis indicated significant predictors for differentiating daytime and nighttime values of MHR in relation to in-hospital mortality. In the discrimination according to the in-hospital mortality, the cut-off value of daytime MHR was 89.7 with 90.0% sensitivity and 82.4% specificity (P<.001). Similarly, the cut-off value of nocturnal MHR was 83.6 with 90.0% sensitivity and 76.5% specificity (P<.001). The AUC values of MHR-daytime and MHR-night time for evaluating the risk of in-hospital mortality for AIS were 0.873 (95% CI=0.701-1.000) and 0.825 (95% CI=0.643-1.000) (Figure 2, Table 7)

Table 6. Logistic regression model based on long-term functional outcome status

Variable	B	SE	Wald χ^2	P	OR	95% CI
Age	-0.084	0.040	4.418	.034	0.920	0.851, 0.994
Gender[A]	1.119	0.968	1.335	.248	1.551	0.459, 20.416
Admission NIHSS	-0.329	0.122	7.260	.007	0.763	0.566, 0.914
Treatment group[B]	-2.926	2.230	1.721	.190	0.054	0.001, 4.244
r-TPA[C]	-2.241	1.900	1.390	.238	0.106	0.003, 4.406
MT[C]	-0.039	1.135	1.911	.973	2.550	0.104, 8.891
MAP (daytime)	-0.045	0.058	0.609	.435	1.118	0.853, 1.071
MAP (nighttime)	0.038	0.060	0.390	.532	0.848	0.923, 1.168
MHR (daytime)	-0.042	0.063	0.450	.502	0.946	0.848, 1.084
MHR (nighttime)	0.038	0.078	0.390	.794	0.945	0.841, 1.141
Constant	17.545	6.105	8.259	.004	0.000	
Reference category: A:Male B:Reperfusion C:Applied	CCR=77.0%		$\chi^2_{(8)}$ =4.920, P=.766			

MAP, Mean arterial pressure; MHR, Mean heart rate; MT, Mechanical thrombectomy; NIHSS, National Institute of Health Stroke Scale; r-TPA, recombinant tissue plasminogen activator

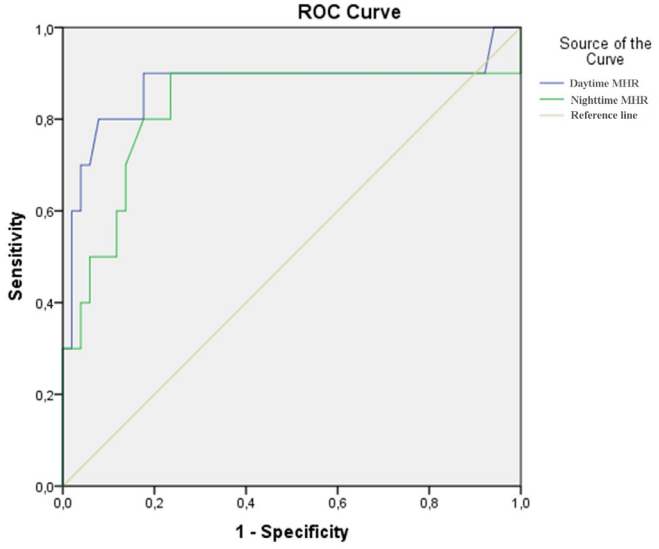

Figure 2. Receiver operating characteristic (ROC) curve analysis showing the predictive ability of daytime and nighttime MHR for in-hospital mortality.

Table 7. Area under the curve (ROC)

	Area	Standard Error	P	Asymptotic 95% CI		Cut-off
				Lower bound	Upper bound	
MHR - daytime	0.873	0.088	< .001	0.701	1.000	83.6
MHR - nighttime	0.825	0.093	< .001	0.643	1.000	89.7

MHR, Mean heart rate.

DISCUSSION

This study showed that in ambulatory measurements, HR monitoring may be more useful than BP monitoring for evaluating in-hospital mortality and long-term functional outcomes. There is no consensus on which HR parameter is most useful in terms of in-hospital mortality and outcomes in AIS patients. It is still not known which HR parameter is more useful in terms of outcome in which period of acute stroke. Some studies utilized HR parameters within the first week of onset,[8] while others assessed them within 24 hours of admission.[9,13,16,21]

The literature has demonstrated different results about the association between HR and mortality. Yao et al. examined the relationship between 30-day mortality and MHR in AIS patients with AF and found a significant relationship. They reported that a 1-unit increase in MHR value increased 30-day mortality by 2.4%.[22] In our study, AF was the exclusion criterion and we found that each 1 unit increase in MHR increased mortality by 12%.

In patients with AIS without AF, Han et al. reported no independent correlation between resting heart rate and in-hospital mortality. They found that a high resting HR (76 beats per minute) increased the risk of mortality by 1.63 times.[19] According to Ritter et al., patients with an HR > 100 beats per minute had a statistically significantly worse stroke prognosis at 3 months compared to patients with an HR of 100 beats per minute, but there was no statistically significant difference between the two groups in terms of 3-month mortality or length of hospitalization.[24] Lee KJ et al. reported in a retrospective study of 18093 patients, maximal HR between days 4 to 7th of AIS was found to be the most significant predictor of mortality.[18] Lee JD et al. found that the mean initial in-hospital HR was a predictor of cardiovascular and all-cause mortality in a retrospective analysis of 21655 patients.[24] However, day and night MHR levels were not assessed separately in these trials. Moreover, in most of these studies, the 3-month period was evaluated rather than the in-hospital mortality.

The mechanisms underlying cardiovascular autonomic dysfunction in ischemic stroke remain poorly understood. During the early stages of ischemic stroke, a decrease or increase in HR results in a reduction in cardiac output. This, in turn, leads to a reduction in perfusion in the ischemic area and poor outcome.[22]

Zhang et al. found no significant association between ABP variability in the first 24 h (measured every 2 h) and in-hospital mortality and 3-month outcome in a study of 542 patients.[25] As stated in the study by Kakaletsis et al., a reduction in systolic blood pressure (SBP) and diastolic BP (DBP), particularly at night, was associated with a favorable prognosis.[26] In the study by Staessen et al., it was found that high nocturnal ABP measurements were more effective than high daytime ABP measurements in predicting mortality and morbidity.[27] In a study of 1989 patients, Metoki et al. found that increased nocturnal ABP was associated with mortality in AIS, whereas increased. daytime ABP was associated with mortality in hemorrhagic stroke [28] In the study conducted by Kakaletsis et al., nocturnal MDBP was determined as an independent predictor of mortality, and 24-hour, daytime, and nighttime MSBP, low nighttime SBP, 24-hour MDBP, daytime MDBP, and nighttime MDBP values were identified as independent prognostic factors.[29] Weiss et al. reported that high SBP on admission

and high 24-h ABP were associated with poor short- and long-term outcomes.[30] Elevated admission SBP levels may indicate a response to the partial impairment of brain auto-regulation and the dependence of brain perfusion on systemic arterial pressure. The increase in SBP at the fisrt day of admission may correlate with the severity of brain injury. It is probable that the SBP levels at the first days and the changes observed in the first week are manifestations of the same underlying phenomenon, specifically the magnitude of the stroke. Feng et al. found an increased risk of unfavorable functional outcomes at 3 months in acute ischemic stroke patients exhibiting persistently elevated heart rates.[31] Lee K-J et al. found that heart rate parameters measured between the 4th and 7th day post-stroke onset correlated with significant clinical events in the first year following AIS.[32] An increased HR may indicate raised sympathetic activity, such as the stress response to a stroke, which can result in pathophysiological effects including endothelial dysfunction, cardiac remodeling, and activation of the renin-angiotensin-aldosterone system, potentially related to poor outcomes. High HR may lead to either hypoperfusion or hyperperfusion in ischemic brain regions where cerebral autoregulation is diminished or absent, potentially resulting in additional brain damage and poor outcomes. All these mechanisms may also affect long-term functional outcomes after stroke.[32] In the present study the daytime and nighttime MAP and MHR, 24-h MAP and MHR values were higher in UO group. Also the nighttime, daytime and 24-h MHR vales were higher in deceased group.

The main limitation of this study was the small sample size. The small sample size can be attributed to the inclusion criteria, which focused solely on mild-moderate and moderate to severe stroke patients, specifically those with a prestroke mRS of 0, while excluding individuals with a history of previous strokes. There is over-adjustment in the logistic regression model as the number of mortality group is 10 and the number of FO group is 39.

CONCLUSIONS

In conclusion, we can say that the daytime and nighttime MAP and MHR, 24-hour MAP and MHR values can help clinicians to predict in-hospital mortality and long-term functional outcome. It can be argued that ambulatory HR measurements rather than ABP measurements are more useful in predicting in-hospital mortality and long-term functional outcome in patients with AIS.

Ethics Committee Approval: Ethics committee approval was received for this study from the Çukurova University Non-Interventional Clinical Studies Ethics Committee (Date: March 3, 2018; Decision No: 23). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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