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Original Research

CHARACTERISTICS OF AMBULATORY BLOOD PRESSURE MONITORING IN PATIENTS WITH ACUTE HEART FAILURE

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ABSTRACT: The use of ambulatory blood pressure monitoring (ABPM) has been established in the evaluation of the 24-hour blood pressure (BP) pattern. Most studies have examined the nighttime blood pressure fall (NBPF) pattern in patients with chronic heart failure (CHF). However, little clinical information is available to understand the pattern of NBPF in patients with acute heart failure (AHF). Objective: to investigate the pattern of ABPM in patients with AHF. We included 69 patients with HFrEF who were hospitalised for AHF at Department of Cardiology, Thong Nhat Hospital from March 2020 to December 2021. After haemodynamic stabilisation, we monitored the patients ambulatory BP. The patients mean age was 66.2±14.77 years, with 71.0% of men, and a mean heart failure duration of 2.8±1.9 years. Coronary artery disease was the most common cause of heart failure (79.7%), while dilated cardiomyopathy accounted for 20.3%. The comorbidities were: hypertension, dyslipidemia, diabetes, stroke, and atrial fibrillation; 97.1%, 91.7%, 31.9%, 10.1%, and 31.9%, respectively. The New York Heart Association functional classification was: II, III, and IV; 17.4%, 63.8%, and 18.8%, respectively. The therapeutic regimens were as follows: angiotensin receptor neprilysin inhibitor, angiotensin converting enzyme inhibitor/angiotensin receptor antagonist, beta-blockers, spironolactone, and digoxin; 20.3%, 69.6%, 68.1%, 85.5%, and 34.8%, respectively. Four patients (5.8%) had normal BP dipping pattern (NBPF ≥10%), 35 (50.7%) had a non-dipping pattern (0% ≤NBPF <10%), and 30 (43.5%) had a riser pattern (NBPF <0%). Our findings highlight the haemodynamic pattern of patients with AHF with most of them showing an NBPF below 10%.

Keywords: ambulatory blood pressure monitoring; heart failure; nighttime blood pressure fall

1. INTRODUCTION

Acute heart failure (AHF) is a clinical syndrome characterized by the rapid onset or worsening of signs and symptoms of heart failure, necessitating urgent medical attention. According to the 2016 European Society of Cardiology (ESC) guidelines, AHF is classified into four types based on the degree of congestion and peripheral hypoperfusion [1].

Many patients with progressive heart failure frequently experience fatigue and orthostatic hypotension, which may be associated with underlying coronary artery disease or cerebrovascular disease. Moreover, individuals with AHF often exhibit reduced perfusion to vital organs, attributable not only to pump failure but also to the hemodynamic effects of multiple heart failure therapies. Additionally, increased sympathetic nervous system activation and impaired baroreceptor sensitivity are common in AHF, contributing to blood pressure dysregulation.

The utility of ambulatory blood pressure monitoring (ABPM) in AHF has been documented in several prior studies [5–7]. However, in Vietnam, there remains a paucity of research specifically evaluating ABPM in patients with acute heart failure with reduced ejection fraction (HFrEF). Based on this context, the Department of Cardiology at Thong Nhat Hospital has initiated the application of ABPM in patients with HFrEF. ABPM findings are expected to provide valuable information for guiding treatment decisions, optimizing the selection and titration of antihypertensive and heart failure medications, and improving prognostic stratification.

1.1. Study Objectives:

+ To investigate the characteristics of ambulatory blood pressure monitoring in patients with acute heart failure with reduced ejection fraction admitted to the Department of Cardiology, Thong Nhat Hospital.

+ To describe the demographic and clinical characteristics of patients with acute heart failure with reduced ejection fraction at the Department of Cardiology, Thong Nhat Hospital.

2. SUBJECTS AND METHODS

2.1. Study design:

Case series report.

2.2. Location and time of study:

From March 2020 to December 2021.

2.3. Study location:

Department of Cardiology, Thong Nhat Hospital.

2.4. Study subjects

Study population: Patients with acute heart failure with reduced left ventricular ejection fraction treated as inpatients at the Department of Cardiology, Thong Nhat Hospital and monitored with ambulatory blood pressure monitoring from March 2020 to December 2021.

Target population: Patients with acute heart failure with reduced left ventricular ejection fraction treated as inpatients.

2.5. Patient selection criteria

Inclusion criteria

Acute heart failure with reduced left ventricular ejection fraction was defined based on the diagnostic criteria for acute heart failure according to ESC 2016 [1].

Patients agreed to participate in the study.

If patients were readmitted during the study period, ambulatory blood pressure results were taken from the first admission during the study period.

Exclusion criteria

Results of ambulatory blood pressure monitoring were insufficient for 24 hours or unclear.

Patients did not agree to participate in the study.

2.6. Variable definitions

Age: quantitative variable, calculated as study year minus birth year.

Gender: qualitative variable with two values: male and female.

Medical diseases: recorded based on medical records, including hypertension,

dyslipidemia, diabetes mellitus, stroke, atrial fibrillation, kidney failure, coronary intervention, implantable cardioverter defibrillator.

HFrEF diagnosis: patients with symptoms ± signs of heart failure and left ventricular ejection fraction < 40% on transthoracic echocardiography using Simpson's method [1].

Medications: binary variable, including two values: yes or no, including medications: ARNI, ACE inhibitors, ARB blockers, beta-blockers, spironolactone, furosemide, ivabradine, digoxin.

Duration of diagnosis: quantitative variable, calculated from when the patient was first diagnosed with heart failure with reduced ejection fraction until the time the patient was included in the study.

Etiology: nominal variable, including ischemic heart disease, dilated cardiomyopathy.

NYHA class: defined based on the classification of the American Heart Association, including values: class I, class II, class III, class IV.

NT-pro BNP: quantitative variable.

Echocardiography: quantitative variable, based on 2D echocardiography guidelines, including values: LVEF, LVIDd, LA.

Ambulatory blood pressure parameters to be recorded:

Mean daytime systolic blood pressure (mmHg)

Mean nighttime systolic blood pressure (mmHg)

Mean daytime diastolic blood pressure (mmHg)

Mean nighttime diastolic blood pressure (mmHg)

Lowest daytime systolic blood pressure (mmHg)

Lowest nighttime systolic blood pressure (mmHg)

Highest daytime systolic blood pressure (mmHg)

Highest nighttime systolic blood pressure (mmHg)

Nighttime blood pressure fall percentage (NBPF) = mean daytime systolic blood pressure minus mean nighttime systolic blood pressure (%)

Dipper pattern: when NBPF ≥ 10%

Non-dipper pattern: when NBPF from 0 to < 10%

Riser pattern: when NBPF < 0%

2.7. Monitoring procedure

All patients participating in the study were fitted with ambulatory blood pressure monitoring at the Department of Cardiology, Thong Nhat Hospital. The procedure for fitting, removing, and reading results follows the recommendations of the European Society of Hypertension 2014 .

Ambulatory blood pressure monitoring procedure at the Department of Cardiology:

Must have physician's indication

Instruct patient to bathe and dry themselves before fitting the device

Insert battery into device

Connect and enter patient information from the main system

Fit OSCAR 2 24hr ABPM device (Product no: HSP1289) for patient

Explain and instruct patient during monitoring period

Patient continues taking heart failure medications during monitoring

Set up device according to instructions: date, time of fitting

Outpatients: fit device and monitor BP for 24 hours at home

Inpatients: fit device and monitor BP for 24 hours in the department

Remove device from patient after 24 hours

Enter data into device according to instructions

Interpret 24-hour blood pressure results and return results to patient

2.8. Data processing

Data were processed using SPSS 22.0 software.

Qualitative variables were described using frequency (n) and percentage %.

Quantitative variables were described using mean ± standard deviation (SD).

ANOVA test was used to compare quantitative variables.

Statistical significance was considered when $P < 0.05$.

2.9. Research ethics

The study was purely observational, with no invasive intervention on patients. Research results were only for improving quality of care and treatment for patients. All personal information of patients was kept confidential and stored on the researcher's personal computer.

3. RESEARCH RESULTS

From March 2020 to December 2021, at the Department of Cardiology, Thong Nhat Hospital, 69 patients with acute heart failure with reduced ejection fraction met the inclusion criteria and were included in the study. Males comprised the majority (71%). The mean age of patients was 66.2 ± 14.7 years (highest: 92 years, lowest: 21 years).

3.1. Patient characteristics

Table 1. General characteristics of 69 patients

Characteristics	n = 69
Age, years	66.2 ± 14.7
≥ 60 years, n (%)	51 (73.9)
Male gender, n (%)	49 (71.0)
Medical history, n (%)	
Hypertension	67 (97.1)
Dyslipidemia	67 (97.1)
Diabetes mellitus	22 (31.9)
Stroke	7 (10.1)
Atrial fibrillation	22 (31.9)
eGFR < 60 ml/min	31 (44.9)
Coronary intervention	22 (33.3)
Implantable cardioverter defibrillator	5 (7.2)

In our study, elderly patients comprised a high proportion (73.9%), with males accounting for 71%. Dyslipidemia and hypertension were the two most common diseases (97.1%). Other medical diseases such as chronic kidney disease, coronary intervention, diabetes mellitus, atrial fibrillation, stroke, and implantable cardioverter defibrillator accounted for 44.9%, 33.3%, 31.9%, 31.9%, 10.1%, and 7.2%, respectively [Table 1].

3.2. Heart failure characteristics:

Table 2. Heart failure characteristics:

Characteristics	n = 69
Duration of diagnosis, years	2.8 ± 1.9
Etiology, n (%)	
Ischemic heart disease	55 (79.7)
Dilated cardiomyopathy	14 (20.3)
NYHA class, n (%)	
Class I	0 (0.0)
Class II	12 (17.4)
Class III	44 (63.8)
Class IV	13 (18.8)
NT-proBNP, pg/mL	7885 ± 8799
Echocardiography	
LVEF, %	29.2 ± 6.4
LVIDd, mm	61.2 ± 9.6
LA, mm	40.7 ± 7.3
Medical treatment, n (%)	
ARNI	14 (20.3)
ACE inhibitor	8 (11.6)
ARB	40 (58.0)
Beta-blocker	47 (68.1)
Spironolactone	59 (85.5)
Furosemide	56 (81.2)
Ivabradine	2 (2.9)
Digoxin	24 (34.8)

In our study, the mean duration of diagnosis was 2.8 years, with ischemic heart disease causing heart failure in 55 patients (79.7%), and dilated cardiomyopathy in 14 patients (20.3%). Most patients had severe heart failure: NYHA class III in 44 patients (63.8%), NYHA class IV in 13 patients (18.8%). Furosemide and spironolactone were the two most commonly used

medications in acute heart failure patients (81.2% and 85.5%, respectively) [Table 2].

3.3. 24-hour ambulatory blood pressure characteristics:

In this cohort, 5.8% of patients exhibited a dipping blood pressure pattern, 52.1% had a non-dipping pattern, and 42.1% demonstrated a reverse-dipping (nocturnal blood pressure rise) pattern. There were no statistically significant differences in daytime systolic or diastolic blood pressure among the three groups (dipping, non-dipping, and reverse-dipping), with p-values of 0.15 and 0.14, respectively. However, nighttime systolic and diastolic blood pressures differed significantly among the groups, with p-values of 0.001 for both. The lowest nighttime systolic and diastolic blood pressure values were observed in the dipping group, while the highest values were found in the reverse-dipping group.

Table 3. 24-hour ambulatory blood pressure characteristics

Values	Dipper (n = 4)	Non-dipper (n = 35)	Riser (n = 30)	P
Daytime systolic BP, mmHg	132.3 ± 21.8	116.3 ± 18.2	124.5 ± 22.8	0.15
Nighttime systolic BP, mmHg	115.3 ± 15.3	112.6 ± 17.2	131.7 ± 24.1	0.001
Daytime diastolic BP, mmHg	72.0 ± 6.6	67.5 ± 10.8	74.1 ± 15.9	0.14
Nighttime diastolic BP, mmHg	68.8 ± 5.5	65.1 ± 10.6	77.9 ± 14.6	0.001
NBPF, %	12.5 ± 3.6	3.1 ± 2.4	-5.9 ± 4.9	< 0.001

4. DISCUSSION:

Based on the 24-hour ambulatory blood pressure monitoring (ABPM) results of 69 patients with acute heart failure with reduced ejection fraction (HFrEF) at the Department of Cardiology, Thong Nhat Hospital, and in alignment with the two stated research objectives, the discussion is structured around the following two key points: (1) **Characteristics of 24-hour ambulatory blood pressure profiles**, and (2) **Clinical characteristics of patients with acute heart failure with reduced ejection fraction** admitted to the Department of Cardiology, Thong Nhat Hospital.

4.1. 24-hour ambulatory blood pressure characteristics:

In the study conducted by Tomoya Ueda et al., which monitored 124 patients with acute heart failure with reduced ejection fraction (HFrEF), the proportions of patients exhibiting dipping, non-dipping, and reverse-dipping blood pressure patterns were 33.1%, 50.7%, and 14.5%, respectively. The proportion of non-dipping patients in that study was comparable to ours (52.1%). However, the prevalence of reverse-dipping patients was notably lower than in our cohort (42.1%).

Similarly, in another study by Takahiro Komori et al., involving 297 patients with HFrEF, the reported rates of non-dipping and reverse-dipping patterns were 53.8% and 20.9%, respectively.

The higher prevalence of reverse-dipping patterns observed in our study compared to these previous studies may be attributed to suboptimal blood pressure control and incomplete optimization of

medical therapy in patients with acute heart failure at the time of monitoring.

4.2. Characteristics of patients with acute heart failure with reduced ejection fraction admitted to the Department of Cardiology, Thong Nhat Hospital

In our study, the majority of patients were over 60 years of age (73.9%) and presented with multiple comorbidities. The most common conditions were hypertension and dyslipidemia, both observed in 97.1% of patients. Other notable comorbidities included chronic kidney disease (44.9%), history of coronary intervention (33.3%), diabetes mellitus (31.9%), and atrial fibrillation (31.9%).

All patients were hospitalized due to acute heart failure with reduced ejection fraction (HFrEF), with ischemic heart disease identified as the predominant underlying etiology (79.7%). The study also collected data on medical therapy. A high proportion of patients received furosemide (81.2% during hospitalization and 85.5% at discharge), likely reflecting the severity of decompensation—NYHA class III and IV accounted for 63.8% and 18.8%, respectively, and the mean NT-proBNP level was 7885 ± 8799 pg/mL.

In contrast, the use of angiotensin receptor–neprilysin inhibitors (ARNIs) was relatively low (20.3%), especially when compared to the use of beta-blockers (68.1%) and spironolactone (85.5%).

5. CONCLUSION:

In our study, 24-hour ambulatory blood pressure monitoring (ABPM) revealed that only 5.8% of patients exhibited a dipping blood pressure pattern. The proportions of patients with non-dipping and reverse-dipping (rising nocturnal blood pressure) patterns were 52.1% and 42.1%, respectively. These findings highlight the critical importance of blood pressure monitoring and management in patients with acute heart failure with reduced ejection fraction (HFrEF), particularly given the high prevalence of abnormal circadian blood pressure patterns in this population.

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