Research Article / Araştırma Makalesi

The Prognostic Value of Bendopnea In-Hospital Mortality In Patients With Acute Coronary Syndrome

Bendopnenin Akut Koroner Sendromlu Hastalarda Hastane İçi Mortalitesindeki Öngördürücü Değeri

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Abstract

Background: Bendopnea, also known as flexi-dyspnea, has recently been defined as the development of shortness of breath within 30 seconds by bending forward in patients with systolic and decompensated heart failure. There is no clear data in the literature regarding acute coronary syndrome (ACS) patients and in-hospital mortality. This study investigated the effect of the presence of bendopnea on in-hospital mortality in ACS patients.
Materials and Methods: A cross-sectional analysis was conducted on patients admitted with ACS (unstable angina and non-ST elevation myocardial infarction (NSTEMI)) between March 2023 and January 2024. The presence of orthopnea, bendopnea, paroxysmal nocturnal dyspnea PND and venous jugular distention (VJD) recorded. Coronary angiography was performed in all patients. A total of 395 patients were enrolled in this study.
Results: The patients were divided into 2 groups as living and deceased. The deceased group was significantly older. Bendopnea, PND, and orthopnea were statistically higher in the deceased group. left ventricular ejection fraction(LVEF) was statistically lower, syntax score was statistically higher in the deceased group. Age (%95 CI:1.254-1.627 , OR: 1.411 p:0.001), uric acid (%95 CI: 1.151-1.394 OR: 1.278 p:0.001), bendopnea (%95 CI: 1.285-1.611 OR: 1.452 p: 0.001), syntax score (%95 CI: 1.103-1.358 OR: 1.258 p:0.001) were shown to be independent risk factors for mortality.
Conclusions: The presence of bendopnea in patients with ACS may be closely associated with in-hospital mortality.

Keywords: Acute coronary syndrome, Bendopnea, Mortality

Öz

Amaç: Flexi-dispne olarak da bilinen bendopne, son zamanlarda sistolik ve dekompanse kalp yetmezliği olan hastalarda öne doğru eğilerek 30 saniye içinde nefes darlığı gelişmesi olarak tanımlanmıştır. Bu çalışmada AKS hastalarında bendopne varlığının hastane içi mortalite üzerine etkisi araştırıldı.
Materyal ve Metod: Mart 2023 ile Ocak 2024 arasında AKS (kararsız anjina ve ST yükselmesiz miyokard enfarktüsü (NSTEMI)) ile başvuran hastalar üzerinde kesitsel bir analiz yapıldı. Bendopne varlığı kaydedildi. Tüm hastalara koroner anjiyografi yapıldı. Bu çalışmaya toplam 395 hasta dahil edildi.
Bulgular: Hastalar yaşayanlar ve ölenler olarak 2 gruba ayrıldı. Ölen grup istatistiksel olarak daha yaşlıydı. Bendopne, paroksismal nokturnal dispne (PND) ve ortopne, ölen grupta istatistiksel olarak daha yüksekti. Ölen grupta sol ventrikül ejeksiyon fraksiyonu istatistiksel olarak daha düşük, syntax skoru ise istatistiksel olarak daha yüksekti. Yaş ((%95 CI:1.254-1.627 , OR: 1.411 p:0.001), ürik asit (%95 CI: 1.151-1.394 OR: 1.278 p:0.001), bendopne (%95 CI: 1.285-1.611 OR: 1.452 p: 0.001), syntax skoru ((%95 CI: 1.103-1.358 OR: 1.258 p:0.001), mortalite için bağımsız risk faktörleri olduğu gösterilmiştir.
Sonuç: AKS'li hastalarda bendopnenin varlığı hastane içi mortalite ile yakından ilişkili olabilir.

Anahtar Kelimeler: Akut koroner sendrom, Bendopne, Mortalite

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Introduction

Despite advanced diagnosis and treatment, coronary artery disease is the main cause of death in developed and developing countries. The most serious and common form of coronary artery disease is acute coronary syndromes (ACS). ACS includes unstable angina pectoris, non-ST-elevated myocardial infarction and ST-elevated myocardial infarction (1). Emergency percutaneous coronary intervention (PCI) and revascularization is the most effective treatment after ACS, limiting the infarct area, the development of heart failure and complications. Despite advanced PCI approaches, heart failure is very common and is the most important short- and long-term prognostic indicator (2). In observational studies, heart failure after ACS is observed between 7-38%. Many symptoms may occur as a result of heart failure depending on the type and severity of the disease(3).

Dyspnea and its subtypes (orthopnea, paroxysmal nocturnal dyspnea(PND), exercise dyspnea) are the main symptoms of acute heart failure(4). Bendopnea, also known as flexi-dyspnea, has recently been defined as the development of shortness of breath within 30 seconds by bending forward in patients with systolic and decompensated heart failure(5). Although the exact etiopathogenesis is not known, it is thought to be caused by increased ventricular pressure as a result of increased abdominal and intrathoracic pressure caused by bending forward. In addition, a close relationship with poor cardiac index, increased pulmonary capillary wedge pressure (PCWP), right heart pressure and pulmonary artery pressure has been shown. In patients with systolic heart failure, the presence of bendopnea has been shown to be a poor prognostic indicator for poor quality of life and poor long-term prognosis(6). In addition, it has been shown to be closely related to many cardiovascular diseases such as the prevalence of coronary artery disease and surgical outcomes(7-8). However, there is no clear data in the literature regarding acute coronary syndrome patients and in-hospital mortality.

This study investigated the effect of the presence of bendopnea on in-hospital mortality in ACS patients.

Materials and Methods

Patient population

A cross-sectional analysis was conducted on patients admitted with ACS (unstable angina and non-ST elevation myocardial infarction (NSTEMI)) between March 2023 and January 2024. All patients underwent coronary angiography (CA). The necessary permissions for the study were obtained from the local ethics committee (The Clinical Research Ethics Committee of Adana City Training and Research Hospital date: 28.03.2024 number: 3259) and the study was conducted in accordance with the Declaration of Helsinki.

NSTEMI and unstable angina were defined as ST-segment depression, T-wave inversion or transient ST-segment elevation, and elevated CK-MB and/or troponin T above the upper limit of normal) in addition to the presence of chest symptoms. All patients received medications recommended by current guidelines.(9) After diagnosis of ACS, all patients received a loading dose of 300 mg of acetylsalicylic acid. Clopidogrel (300 mg or 600 mg loading dose) or ticagrelor (180 mg loading dose) was also administered according to the physician's preference. Unfractionated heparin or low-molecular-weight heparin was administered according to the patient's weight. In addition, statin therapy was started in all patients. The decision to perform coronary angiography and the timing and type of revascularization procedure were determined by the patient's cardiologist.

Patients under the age of 18, patients with ST-elevation myocardial infarction, cardiogenic shock, Killip score >2, severe valvular heart disease, steroid therapy, chronic renal or hepatic failure, systemic inflammatory disease, cancer, previous coronary artery bypass surgery, previous percutaneous coronary intervention for any reason, and patients with abnormal serum electrolyte values were excluded from the study. Following the application of the exclusion criteria, 395 patients were included in the study.

All patients were questioned in detail about hyperlipidemia, diabetes mellitus, smoking, asthma, and COPD (chronic obstructive pulmonary disease). All medical treatments used by the patients were recorded. The presence of orthopnea, bendopnea, PND and
venous jugular dıstensıon(VJD), was questioned and recorded.

Laboratory measurement

Serum levels of fasting blood glucose, hemoglobin, C-reactive protein(CRP), and a lipid panel including low-density lipoprotein cholesterol and high-density lipoprotein cholesterol were assessed and recorded within the first 24 hours.

Echocardiographic Evaluation

Echocardiographic examination of all patients included in the study was performed using an iE33 cardiac ultrasound system (Phillips Healthcare) and a 2.5 to 5 MHz probe system. Left ventricular ejection fraction (LV EF) was quantified using the modified Simpson method. Pulmonary artery pressure (PAB) was estimated by means of the Bernoulli equation (P =4[TRmax]2), with continuous wave (CW) Doppler over the tricuspid regurgitation (TR) flow.

Coronary Angiography

The access site for CA (femoral or radial) was determined by the attending physician. CA was performed using the Judkins technique. Two experienced interventional cardiologists evaluated the CA images. Nonionic low-osmolar contrast medium was used as the contrast medium during CA. Anticoagulation and antiplatelet therapies were administered according to current coronary artery disease guideline recommendations. After percutaneous coronary intervention (PCI), all patients were hospitalized in the coronary

care unit. Aspirin 100 mg, clopidogrel 75 mg or ticagrelor 90 mg, and statin therapy was continued in all patients. The SYNTAX Score (SS) was calculated by including vessels with a diameter greater than 1.5 mm and stenosis greater than 50% from CA images. (http://www.Syntaxscore.com).

Statistical Analysis

The study data were evaluated using the SPSS version 21.0 statistical software. Normality distribution of continuous variables was investigated using visual (histogram and probability charts) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). The descriptive statistics of the study were presented as mean and standard deviation for normally distributed data and as median, minimum, and maximum for non-normally distributed data. The chi-square test was used to show whether there was a difference between categorical variables. The Student's t-test was used to compare the continuous variables with parametric properties in independent groups, while the MannWhitney U test was used to compare continuous variables with non-parametric properties in independent groups. The level of statistical significance was set at a p-value less than 0.05. The variables for which the unadjusted p-value was <0.05 in the logistic regression model were identified as potential risk markers and included in the full multivariate model. Backward elimination multivariate logistic regression analyses using a likehood ratio test to eliminate variables were utilized.

Results

A total of 395 patients were enrolled in this study. The patients were divided into 2 groups as living and deceased. 326 patients (mean age: 65.2±14.2 years, 25.9% male) were in the living group and 69 patients (mean age: 74.1±12.9 years, 29.5% male) were in the deceased group. When comparing the demographic data, the deceased group was significantly older (p<0.001), other findings were similar (Table 1). Medical treatments were similar (Table 1). When comparing symptoms, bendopnea, paroxysmal PND, and orthopnea were statistically higher in the deceased group (p=0.001 for each, Table 1).

Table 1. Comparison of demographic data, medacitions and symptoms

	Living n:326	**Deceased** n:69	p
Demographic and risk factors			
Age, year	65.2±14.2	74.1± 12.9	<0.001
Gender, male n (%)	212 (65.0)	44 (63.7)	0.121
Smoking, n (%)	119 (36.5)	25 (36.2)	0.627
COPD n (%)	50 (15.3)	10 (14.4)	0.123
Diabetes mellitus, n (%)	201 (61.6)	45 (65.2)	0.341
hypertension, n (%)	115 (35.2)	24 (34.7)	0.681
hyperlipidemia, n (%)	45 (13.8)	11 (15.9)	0.607
Medical treatments			
ACE inh (n, %)	158 (48.4)	32 (46.4)	0.232
ARB inh (n, %)	95 (29.1)	22 (31.8)	0.345
Beta blockers (n, %)	65 (19.9)	15 (21.7)	0.226
Statin (n, %)	50 (15.3)	10 (14.4)	0.426
Acetylsalicylic acid (n, %)	45 (13.8)	11 (15.9)	0.369
Oral antidiabetic drugs (n, %)	66 (20.2)	15 (21.7)	0.638
Insulin (n, %)	45 (13.8)	11 (15.9)	0.494
Symptom			
Bendopnea	53 (16.2)	31(44.9)	0.001
Orthopnea	41 (12.6)	34 (49.2)	0.001
PND	26 (8.0)	22 (31.8)	0.001
VJD	19 (5.8)	7 (10.2)	0.075

COPD: *Chronic obstructive pulmonary disease,* ***ACE:*** *Angiotensin-converting enzyme inhibitor,* ***ARB:*** *Angiotensin receptor blockers,* ***PND:*** *paroxysmal nocturnal dyspnea,* ***VJD:*** *venous jugular distention*

When laboratory values were compared between the two groups, uric acid (7.8±3.21 vs. 4.5±1.21 p:0.001), CRP (3.33±1.82 vs. 1.98±0.79 p:0.001), basal troponin (5.12±1.12 vs. 3.65±2. 51 p:0.001) and NT- proBNP (1245±521 vs. 751± 252 p:0.001) were found to be higher in the deceased group. (Table 2) When echocardiographic characteristics were compared, LVEF (39.6±9.1 vs. 48±1.8 p:0.001) was statistically lower in the deceased group. When electrocardiographic features were compared, heart rate(p:0.001) was statistically higher in the deceased group. When angiographic characteristics were compared, syntax score (p=0.001) was statistically higher in the deceased group (Table 3).

The results of the univariate and multivariate regression analyses showed that, age (OR: 1.411 95% CI: 1.254-1.627 p: 0.001), uric acid (OR: 1.278 95% CI: 1.151-1.394 p: 0. 001), bendopnea (OR: 1.452 95% CI: 1.258-1. 611 p: 0.001), syntax score (OR: 1.258 95% CI: 1.103-1.358 p:0.001) were shown to be independent risk factors for mortality (Table 4).

Table 2. Comparison of laboratory parameters

	Living n:326	**Deceased** n:69	P
Laboratory measurements			
Glucose (mg/dl)	159.6±47.6	145.9±61.8	0.589
BMI kg/m2	31.5±2.1	32.3±2.9	0.064
BKH (uL)	11.7±4.12	12.1±6.11	0.321
Hb (mg/dl)	14.2±2.15	14.5±1.58	0.256
Cr (mg/dL)	0.75 ± 0.28	0.95±0.14	0.412
Na (mmol/L)	141.5±8.2	143.1±4.51	0.541
K (mmol/L)	4.75±1.25	4.2±0.9	0.789
Uric acid (mg/dL)	4.5±1.21	7.8±3.21	0.001
Total protein (g/dL)	7.41±1.11	6.59±1.48	0.168
Calcium(mg/dL)	9.52±1.8	9.4±1.51	0.207
CRP (mg/L)	1.98 ±0.79	3.33±1.82	0.251
Baseline Troponin (ng/mL)	3.65 ± 2.51	5.12 ±1.12	0.001
NT-proBNP	751±252	1245±521	0.001
LDL	151±42.2	142±40.8	0.888
HDL	47±12.8	46±11.5	0.133
TOTAL CHOLESTEROL	189.5±55.8	178±51.2	0.432

***Hb:** Hemoglobin, **WBC:** White blood cells, **BUN:** Blood urea nitrogen, **Cr:** Creatinine, **Na:** Sodium, **K:** Potassium, **CRP:** C-reactive protein, **LDH:** Lactate dehydrogenase, **LDL:** low density lipoprotein cholesterol, **HDL:** High-density lipoprotein cholesterol, **LV EF**: Left ventricular ejection fraction*

Table 3. Comparison of angiographic, electrocardiographic, and echocardiographic findings

	Living n:326	**Deceased** n:69	P
Echocardiographic features			
LA diameter	35±4.2	36±4.5	0.574
LV diastolic diameter	55.1±5.9	61.4±6.1	0.411
LV systolic diameter	42±10	43±11	0.124
LV EF	48±1.8	39.6±9.1	0.001
sPAP	44±10	44±12	0.235
Electrocardiographic features			
Heart Rate (beats/min)	78 ± 14	84 ± 18	0.001
QRS duration	112±21	115±19	0.078
Angiographic Features			
SYNTAX score	14.8 ± 5.5	20.1±3.3	0.001
Culprit artery, n (%)			
LAD	146 (%45.1)	33 (%48.1)	0.236
CX	97 (%30.5)	14 (%19.9)	
RCA	83 (%24.4)	22 (%32.0)	
Treatment methods	10 (% 3)	3 (%4)	
Medical treatment	289 (%88.6)	60 (%86.9)	0.254
Percutaneous coronary artery intervention			
Coronary artery bypass graft op.	27 (%8.4)	6 (%10.1)	

***LA:**left atrium, **LV:**left ventricle, **sPAP:**pulmonary artery systolic pressure, **LAD:**left anterior descending, CX:circumflex, RCA: right coronary artery*

Table 4. Independent predictors for mortalitiy

	OR	**95% CI**	**p**	**OR**	**%95 CI**	**p**
Age	1,321	1.115-1.455	0.001	1.411	1.254-1.627	0.001
Uric acid	1.356	0.224-1.584	0.001	1.278	1.151-1.394	0.001
Bendopnea	1.257	0.202-1.495	0.001	1.452	1.285-1.611	0.001
Syntax score	1.125	0.103-1.194	0.001	1.258	1.103-1.358	0.001
Orthopnea	1.102	0.914-1.021	0.301			
LV EF %	1.083	0.951-1.245	0.245			
NT-proBNP	1.120	0.958-1.251	0.301			
Troponin	1.211	0.954-1.321	0.211			
Heart rate	1.110	0.945-1.141	0.541			
PND	1.321	0.987-1.586	0.987			
NT-proBNP	1.236	0.954-1.358	0.147			

LVEF: left ventricular ejection fraction, CRP: c-reactive protein, PND: paroxysmal nocturnal dyspnea

Discussion

This study represents the first investigation into the relationship between the presence of bendopnea and in-hospital mortality in patients with ACS. At the conclusion of the study, the presence of bendopnea was demonstrated to be an independent risk factor for in-hospital mortality in ACS patients.

Similar to previous studies, age, uric acid, Syntax score and were observed as independent risk factors for in-hospital mortality in ACS patients. Many studies have shown that advanced age is an important indicator of in-hospital mortality and poor clinical outcomes in ACS patients. In addition to the increased prevalence of coronary artery disease and calcification with advancing age, prolonged procedure time and increased complications constitute the basic pathophysiology(10). Epidemiologic studies have observed in-hospital mortality >50% in ACS patients aged >75 years(11). The relationship between serum uric acid levels and cardiovascular disease has long been recognized. Increased oxidative stress, systemic and local inflammation, and endothelial dysfunction are the basic pathophysiology due to serum uric acid levels(12). Magnoni M. et al. showed in their study of ACS patients that mortality was 2.9 times higher in patients with uric acid levels higher than 6. 0 mg/dl(13). In addition, Zhang S. et al. showed that 1-year mortality was 2.6 times higher in individuals with high serum uric acid levels in ACS patients (14). Syntax score is an objective method to assess the prevalence and severity of coronary artery disease. In many studies, a high Syntax score has been observed as an independent risk factor for in-hospital mortality after ACS. In prospective studies by Akboğa et al. and Schherf et al. high Syntax score was observed as an independent risk factor for in-hospital mortality in ACS patients (15-16).

Dyspnea is the most important symptom in heart failure patients, and exercise dyspnea, orthopnea, and PND are the most important symptoms in heart failure patients (17). Bendopnea is a recently described symptom in heart failure patients and is accepted as the occurrence of shortness of breath within 30 seconds by bending forward in advanced heart failure patients (18). Although the etiology of this phenomenon is not fully understood, it is believed to be related to the increase in intraabdominal and intra-aortic pressure that occurs with forward bending. In 2014, Thibodeu et al. observed bendopnea, which was introduced to the clinical literature, 29 (28%) of 102 patients. In 102 patients, 29% exhibited bendopnea, which was observed in the intracardiac catheter measurements. Increased left ventricular intraventricular pressure, PCWP, and right atrial pressure were observed in the presence of bendopnea. Conversely, an increase in PCWP and right atrial pressure was observed in all patients when tilted. Notably, no change in cardiac index was observed in patients without bendopnea. However, a statistically significant decrease was observed in patients with bendopnea. Furthermore, bendopnea was three times higher in patients with increased PCWP and decreased cardiac index. However, no relation was found between bendopnea in individuals with high PCWP and normal cardiac index (19). Tirinidad et al. found that the presence of bendopnea was closely associated with increased PND, orthopnea, and VJB in their study. Additionally, they observed that short-term mortality was 2.3 times more likely in patients with these symptoms (20). Pranata B. et al. In a meta-analysis of 6 studies on heart failure, it was observed that the risk of orthopnea caused by bendopnea was 3.02 times higher, PND was 2.76 times higher, abdominal fullness was 7.5 times higher, advanced stage heart failure was 7.5 times higher, and short- and long-term mortality was 2.21 times higher. Furthermore, the presence of bendopnea did not differ between lower extremity edema and pulmonary edema/renal (21).

Rodriguez et al. observed that the presence of bendopnea in patients with severe aortic stenosis was an independent risk factor for the need for postoperative mechanical ventilation and prolonged hospitalization (22). Şaylık F. et al. observed that in patients with ischemic heart failure, the presence of bendopnea was associated with the presence of bendopnea was identified as an independent risk factor for the prevalence of coronary artery disease (CAD) (23). In the study by Rostamzadeh et al. although the presence of bendopnea was observed as an independent risk factor for long-term mortality, but no association with orthopnea was observed (24).

As a result of our study, while benopnea was observed as an independent risk factor for death, although a statistical difference was detected in terms of orthopnea and PND, no difference was observed in the regression analysis. We hypothesize that this difference is related to the patient population and clinical characteristics. In our study, patients with Killip score >2 and ST elevation myocardial infarction, which are high-risk patients in terms of patient population, were excluded. Furthermore, no difference was observed between the groups in terms of peripheral edema, VJD, and PND, as well as pulmonary congestion findings. This suggests that bendopnea may be a more reliable marker than orthopnea in patients with ACS.

Discussion

This study determined that AKI development in critically ill patients with variant B.1.1.7 infection followed in the intensive care unit was less than in other patients. In addition, it was determined that the need for IMV in variant B.1.1.7 patients and the mortality rates in variant B.1.1.7 patients not developing AKI were both higher. This suggested that the increase in mortality due to the longer duration of variant B.1.1.7 infection in the respiratory tract occurred independently of the AKI development.

Conclusion

In this study, for the first time, the presence of bendopnea was observed as an independent risk factor for in-hospital

mortality in ACS patients. This study suggests that the presence of bendopnea should not be overlooked in identifying high-risk patients with ACS and that appropriate treatments should be initiated earlier. Further comprehensive and prospective studies may help us to understand the relationship between ACS and bendopnea and to determine diagnostic and therapeutic values.

Limitations

This study is subject to a number of limitations. Primarily, it was conducted at a single center with a relatively small number of patients. Furthermore, cardiac catheterization was not performed, and long-term follow-up of discharged patients was not conducted.

Ethical Approval: *The necessary permissions for the study were obtained from the local ethics committee (The Clinical Research Ethics Committee of Adana City Training and Research Hospital date: 28.03.2024 number: 3259) and the study was conducted in accordance with the Declaration of Helsinki.*

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References

1. Bhatt DL, Lopes RD, Harrington RA. Diagnosis and Treatment of Acute Coronary Syndromes: A Review. JAMA. 2022 Feb 15;327(7):662-675.
2. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr. et al. 2014 AHA/ACC Guideline for the Management of Patients with Non-ST-Elevation Acute Coronary Syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014 Dec 23;64(24):e139-e228.
3. Harrington J, Jones WS, Udell JA, Hannan K, Bhatt DL, Anker SD. Et al. Acute Decompensated Heart Failure in the Setting of Acute Coronary Syndrome. JACC Heart Fail. 2022 Jun;10(6):404-414.
4. Marcus G, Shimony S, Stein GY, Matezky S, Iakobishvili Z, Minha S, et al. Incidence, predictors and prognostic implications of dyspnea at admission among acute coronary syndrome patients without heart failure. Int J Cardiol. 2020 Feb 15:301:29-33.
5. Nakade T, Maeda D, Matsue Y, Fujimoto Y, Kagiyama N, Sunayama T, et al.Bendopnea prevalence and prognostic value in older patients with heart failure: FRAGILE-HF-SONIC-HF post hoc analysis. Eur J Prev Cardiol. 2024 Aug 22;31(11):1363-1369.
6. Thibodeau JT, Jenny BE, Maduka JO, Divanji PH, Ayers CR, Araj F. et al. Bendopnea and risk of adverse clinical outcomes in ambulatory patients with systolic heart failure. Am Heart J. 2017 Jan;183:102-107.
7. Timóteo AT. Bendopnea: A new symptom for the differential diagnosis of chronic cardiopulmonary disease? Rev Port Cardiol. 2017 Mar;36(3):187-188.
8. Larina VN, Bart BY, Chukaeva II, Karpenko DG, Zacharova MI, Kulbachinskaya OM. Bendopnea: Association With Echocardiographic Features and Clinical Outcomes in Elderly Patients With Chronic Heart Failure. Kardiologiia. 2018 Dec 25;58(12):36-44.
9. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A 2023 ESC Guidelines for the management of acute coronary syndromes. Eur Heart J. 2023 Oct 12;44(38):3720-3826
10. Veerasamy M, Edwards R, Ford G, Kirkwood T, Newton J, Jones D et al. Acute coronary syndrome among older patients: a review. Cardiol Rev. 2015 Jan-Feb;23(1):26-32.
11. Pogorevici A, Citu IM, Bordejevic DA, Caruntu F, Tomescu MC Canada acute coronary syndrome score was a stronger baseline predictor than age ≥75 years of in-hospital mortality in acute coronary syndrome patients in western Romania. Clin Interv Aging. 2016 Apr 26:11:481-8.
12. Nakahashi T, Tada H, Sakata K, Yoshida T, Tanaka Y, Nomura A,. et al. The Association Between Serum Uric Acid and Mortality in Patients with Acute Coronary Syndrome After Percutaneous Coronary Intervention. Int Heart J. 2022 May 31;63(3):447-453.
13. Magnoni M, Berteotti M, Ceriotti F, Mallia V, Vergani V, Peretto G, et al. Serum uric acid on admission predicts in-hospital mortality in patients with acute coronary syndrome Int J Cardiol. 2017 Aug 1;240:25-29.
14. Zhang S, Liu X, Song B, Yu H, Zhang X, Shao Y.. Impact of serum uric acid levels on the clinical prognosis and severity of coronary artery disease in patients with acute coronary syndrome and hypertension after percutaneous coronary intervention: a prospective cohort study. BMJ Open. 2022 Jan 12;12(1):e052031.
15. Akboga MK, Inanc IH, Sabanoglu C, Akdi A, Yakut I, Yuksekkaya B et al. Systemic Immune-Inflammation Index and C-Reactive Protein/Albumin Ratio Could Predict Acute Stent Thrombosis and High SYNTAX Score in Acute Coronary Syndrome. Angiology. 2023 Aug;74(7):693-701.
16. Scherff F, Vassalli G, Sürder D, Mantovani A, Corbacelli C, Pasotti E et al. The SYNTAX score predicts early mortality risk in the elderly with acute coronary syndrome having primary PCI. J Invasive Cardiol. 2011. Dec;23(12):505-10.
17. West RL, Hernandez AF, O'Connor CM, Starling RC, Califf RM. A review of dyspnea in acute heart failure syndromes. Am Heart J. 2010 Aug;160(2):209-14.
18. Yılmaz Öztekin GM, Genç A, Şahin A, çağırcı G, Arslan Ş. Effect of Bendopnea on Achievement Medical Treatment Target Doses in Heart Failure. Arch Iran Med. 2023 Jan 1;26(1):36-42.
19. Thibodeau JT, Turer AT, Gualano SK, Ayers CR, Martinez VM, Mishkin DJ et al. Characterization of a novel symptom of advanced heart failure: bendopnea. JACC Heart Fail. 2014 Feb;2(1):24-31.
20. Baeza-Trinidad R, Mosquera-Lozano JD. Bendopnea related to poor prognosis. Acta Cardiol. 2021 Dec;76(10):1166.
21. Pranata R, Yonas E, Chintya V, alkatiri AZ, Siswanto BB. Clinical significance of bendopnea in heart failure-Systematic review and meta-analysis. Indian Heart J. 2019 May-Jun;71(3):277-283.

22. Dominguez-Rodriguez A, Thibodeau JT, Ayers CR, Sosa AJ, Garrido P, Montoto J et al. Impact of bendopnea on post-operative outcomes in patients with severe aortic stenosis undergoing aortic valve replacement. Interact Cardiovasc Thorac Surg. 2018 Dec 1;27(6):808-812.
23. Şaylık F, Kümet Ö, Sarıkaya R, Akbulut T. Bendopnea Predicts High SYNTAX Score in Patients With Coronary Artery Disease: A Bayesian Approach. Angiology. 2024 Feb 22:33197241235957.
24. Rostamzadeh A, Khademvatani K, Salehi S, Seyyed Mohammadzad MH, Khani M, Hajahmadipour Rafsanjani M, et al. Echocardiographic Parameters Associated with Bendopnea in Patients with Systolic Heart Failure. J Tehran Heart Cent. 2022 Oct;17(4):223-229.