MEDS Clinical Medicine (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/medsc.2024.050510
ISSN 2616-1907 Vol. 5 Num. 5

The predictive value of cardiac ultrasound for adverse events in acute heart failure AHF

Ren Haohan[1], Ren Jianxing[2]

[1]*Gansu University of Traditional Chinese Medicine, Lanzhou, Gansu, 730000, China*
[2]*Tianshui First People's Hospital, Tianshui, Gansu, 741000, China*

Keywords: Acute heart failure (AHF); cardiac ultrasound; prognosis evaluation

Abstract: To investigate the predictive value of echocardiography for adverse events in patients with acute heart failure AHF, the study selected 100 AHF patients treated at a hospital from November 2022 to December 2023. Based on the occurrence of endpoint events during follow-up, the patients were divided into an event group 36cases and a non-event group 64cases. All patients underwent echocardiographic examinations upon admission, with measurements including left ventricular ejection fraction LVEF, E/A ratio, and Tei index. Logistic regression analysis was used to evaluate their impact on adverse events. The results indicated that the E/A ratio and LVEF were significantly lower in the event group compared to the non-event group, while the Tei index was significantly higher P<0.01. Logistic regression analysis revealed that the E/A ratio and LVEF were independent protective factors, whereas the Tei index and age were independent risk factors P<0.05orP<0.01. Receiver operating characteristic ROC curve analysis showed that the combined detection of the E/A ratio, LVEF, and Tei index yielded an area under the curve AUC of 0.903, which was higher than any single indicator. The combined detection demonstrated a sensitivity of 86.11% and specificity of 92.19%.These findings suggest that the E/A ratio, LVEF, and Tei index are effective in predicting the risk of adverse events in AHF patients, and their combined detection provides significantly greater predictive value compared to individual indicators. This offers valuable guidance for early risk stratification, clinical decision-making, and personalized treatment in AHF patients.

1. Introduction

Acute heart failure (AHF) is a severe emergency of the cardiovascular system with high morbidity and mortality, involved in the pathogenesis of various factors, such as structural and functional cardiac abnormalities and systemic disorders. The disease course development and clinical prognosis of AHF patients are significantly heterogeneous, which poses great challenges for disease management. Therefore, identifying high-risk patients and predicting the occurrence of adverse events is essential to optimize treatment strategies. Recently, cardiac ultrasound, as a non-invasive, rapid and accurate imaging tool, has been widely used to evaluate cardiac function and guide the clinical treatment of [1]. Left ventricular ejection fraction LVEF, early-to-late mitral relaxation peak flow rate ratio E/A, and Ti index as cardiac function assessment indicators reflecting contraction, relaxation, and comprehensive function of the heart. However, the combined

value of these indicators in the prognosis evaluation of AHF patients is still poorly systematically. [2]This study aims to explore the role of LVEF, E/A and Tei index in predicting prognosis adverse events in AHF patients through single-center data analysis, and to provide a scientific basis for clinical decision-making.

2. Data and methods

2.1 General information

A total of 100 patients with acute heart failure (AHF) treated from November 2022 to December 2023 were selected for this study. There were 58 males with age range of 45 to 71 years, mean (58.96 ± 6.15) and 42 females with age range of 45 to 72 years, mean (57.29 ± 6.32). There was no statistical difference in age comparison between gender (P=0.188). The physical mass index (BMI) ranged from 19 to 26 kg/m², with a mean (23.46 ± 2.33) kg/m². Among the included population, 51 patients had a history of drinking and 35 patients had a history of smoking. This study was reviewed and approved by the medical ethics committee of our hospital and was studied.

2.2 Inclusion criteria for exclusion

Inclusion criteria: ① met the diagnostic criteria of AHF in the Chinese Guidelines for the Diagnosis and Treatment of Heart Failure 2018; the specific diagnosis is based on the comprehensive indicators of acute cardiac dysfunction, laboratory tests and imaging examination; ② patients were between 18 and 80 years, covering the typical onset age range; ③ All study subjects and their families knew the study content and signed informed consent to ensure the ethical compliance of the study.

Exclusion criteria: ① Patients with a previous history of acute myocardial infarction, which may have significant and irreversible effects on cardiac function; patients with ② and chronic obstructive pulmonary disease may affect the cardiopulmonary function evaluation; ③ women in pregnancy or lactation, fluctuations in hormone levels may interfere with the interpretation of the study data; ④ patients with severe functional decline of kidney, lung and other important organs;

2.2.1 Cardiac ultrasound examination

All enrolled patients underwent cardiac ultrasound after admission to assess their cardiac function status and record key indicators. Color Doppler cardiac ultrasound instrument (Shenzhen Mindray, model: resona7) was used for detection. Operated by an experienced specialist, the patient was instructed to take a supine position to expose the chest cavity, and set the frame frequency and frequency of the probe at 65 fps and 2.5 MHz, respectively. If the initial test image clarity is poor, the operator will repeat multiple tests according to the specific situation until satisfactory image quality is obtained. The main cardiac functions recorded by ultrasound measurements include left ventricular ejection fraction (LVEF), myocardial work (Te index), late mitral relaxation (peak A wave) and early diastole (peak E wave), and further calculated the E / A ratio. These indicators comprehensively reflect the cardiac function status of the patients, laying a foundation for the subsequent analysis of their predictive value for adverse events.

2.2.2 Treatment measures

All patients received standardized treatment and monitoring during hospitalization, including blood glucose detection, ultrasound and electrocardiogram, hematuria routine, liver and kidney

function and other indicators, to ensure a comprehensive grasp of the patient's physiological condition.[3] The treatment plan is mainly expanded drugs, and personalized drug treatment strategies are formulated based on the patients' condition and individual differences. The specific treatment period is 7 days, and all patients receive continuous vital signs monitoring and condition evaluation during the treatment period. In the process of drug treatment, medical staff pay close attention to the remission of patients' symptoms and the changes of laboratory indicators, and adjust the treatment plan in time to maximize the treatment effect and reduce the occurrence of complications.

2.2.3 Follow-up strategy

After discharge, all patients were followed up for 6 months, and the course development and endpoint events during the follow-up period were recorded by WeChat, telephone or outpatient review. Endpoint events were defined as a repeat admission for heart failure, myocardial infarction, stroke, or all-cause death. At the end of follow-up, the study subjects were divided into event group (n=36) and no event group (n=64) based on whether the patient had an endpoint event. Standardized follow-up forms were used to record patient clinical data and quality of life scores to ensure the integrity and accuracy of the data. The follow-up work is in the charge of the professional medical team, and the suspected events are confirmed and diagnosed in multiple ways, so as to ensure the objective and fair judgment of the endpoint events and provide high-quality data support for the verification of the prediction model.

2.3 Observing indicators

Focus on key indicators obtained during cardiac ultrasound, including left ventricular ejection fraction (LVEF), Tei index, early peak mitral valve relaxation flow velocity (peak wave E) and late peak flow velocity (peak wave A), and calculate the E / A ratio. LVEF is used to evaluate the systolic function of the left ventricle and the Te index reflects overall cardiac function (systolic and diastolic function). The E / A ratio was then used to assess the left ventricular diastolic function. The above indexes were measured by color Doppler ultrasound instrument and used to analyze the predictive value of prognosis adverse events.

2.4 Statistical analysis

Data analysis was performed using the SPSS 26.0 software. Measurement data are expressed as mean ± standard deviation ($\bar{x} \pm s$), and independent sample t-test was used for comparison between two groups. Categorical variables were expressed as frequency and percentage, and comparisons between groups were performed using the chi-square test. The factors affecting adverse events in acute heart failure patients were analyzed by Logistic regression, and the hazard ratio (OR value) and 95% confidence interval (CI) were calculated. The predictive value of E / A, LVEF and Tei index for adverse events was analyzed by ROC curve to determine the optimal cut-off value, sensitivity and specificity. A $P < 0.05$ was considered as a statistically significant difference.

3. Results

3.1 Comparison of E / A, LVEF and Tei index between the two groups

Event group E/A and LVEF were significantly decreased and Tei index was significantly increased with statistically significant differences, as shown in Table 1.

Table 1: Comparison of E / A, LVEF and Tei index

group	E/A	LVEF	Tei index number
No event group	0.98±0.10	42.63±4.89	0.44±0.27
Event group	0.79±0.16△	37.86±4.41△	0.58±0.21△
t	7.309	4.847	-2.686
P	0.001	0.001	0.009

Note: E / A: MERDS early peak flow rate / late peak flow rate, LVEF: LV ejection fraction.△ P <0.01, the same below.

3.2 Logistic regression analyzed the factors affecting prognosis adverse events in patients with AHF

The prognosis adverse events in AHF patients were included as dependent variables (none =0, occurrence =0), and E / A, LVEF and Tei index (measured values) were included as independent variables; the Logistic regression analysis showed that age and Tei index were independent risk factors for adverse events in AHF patients (OR = 3.728 and 6.878, respectively, P <0.01). E/A and LVEF were independent protective factors (OR = 0.519 and 0.350, P <0.05 or <0.01, respectively), as shown in Table 2.

Table 2: Logistic regression analysis of the factors affecting the prognosis adverse events of patients with AHF

variable	β	S.E.	Waldχ^2	OR	95%CI	P
age	1.316	0.296	19.709	3.728	2.085~6.665	0.001
E/A	-0.657	0.275	5.690	0.519	0.302~0.889	0.017
LVEF	-1.050	0.297	12.453	0.350	0.195~0.627	0.001
Tei index number	1.928	0.304	40.305	6.878	3.793~12.475	0.001

3.3 Predictive value of E / A and LVEF combined Ti index for prognosis adverse events in AHF

According to the ROC curve analysis, the predictive value of E / A, LVEF and Tei index is better than the adverse events in AHF patients. The best cut-off values were: E / A 0.89, LVEF 38.77%, and Tei index> 0.36. The AUC for the combined test was 0.903, higher than any single test (AUC 0.808 for E/A alone, AUC 0.782 for LVEF alone and AUC 0.814 for Ti alone). The sensitivity and specificity of the combined test were 86.11% and 92.19%, respectively, showing a very high predictive power, as shown in Table 3.

Table 3: E/A, LVEF and Tei Index were combined to test for the predictive value of prognostic adverse events in AHF

index	AUC	95%CI	sensitivity	specificity	cutoff value
E/A	0.808	0.717~0.880	80.56 29/36	76.56 49/64	≤0.89
LVEF	0.782	0.689~0.859	77.78 28/36	81.25 52/64	≤38.77%
Tei index number	0.814	0.724~0.885	83.33 30/36	73.44 47/64	>0.36
Joint detection	0.903	0.827~0.953	86.11 31/36	92.19 59/64	-

4. Discussions

Acute heart failure (AHF) is a cardiovascular emergency with high morbidity and mortality, and its complex pathogenesis involves multidimensional abnormalities of cardiac structure, function, and systemic factors [4]. The development of disease development and clinical prognosis of AHF patients are high, so accurate prediction of the risk of adverse events is crucial to optimize treatment strategies and improve survival. Recently, cardiac ultrasound has been widely used to evaluate cardiac function and predict clinical outcomes due to its non-invasive, fast and precise characteristics. Among them, left ventricular ejection fraction (LVEF), early and late mitral valve relaxation peak flow rate ratio (E/A) and Tei index are important indicators reflecting the cardiac function status, but the value of the combined analysis in predicting adverse events in AHF patients is not explored [5].

The analysis of the data in this study found that E/A and LVEF were significantly lower in the event group than in the no-event group, while the Tei index was significantly increased ($P < 0.01$). Logistic Regression analysis indicated that E/A and LVEF were independent protective factors, and the Tei index and age were independent risk factors ($P < 0.05$ or $P < 0.01$). Further ROC curve analysis showed that the AUC of E/A, LVEF and Tei index was 0.903, sensitivity of 86.11% and specificity of 92.19%, which was significantly better than the single index [6]. This indicates that the combined analysis of cardiac function indices can more comprehensively reflect the pathophysiological state of the patient and improve the prediction accuracy. The best cut-off value for E/A, LVEF, and Tei index (0.89, 38.77%, > 0.36) was also identified, providing an actionable clinical basis for the early identification of high-risk patients [7].

In conclusion, E/A, LVEF and Tei index have important value in predicting the prognosis of AHF patients, and the combined test can significantly improve the prediction accuracy. This study not only verified the clinical advantages of multi-index combined analysis, but also provided a clear reference of the cutoff value, which laid a foundation for further multi-center promotion, especially for patients with complex conditions, which can significantly optimize the timing of intervention, and reduce the incidence of adverse events.

References

[1] Zhang Chengjia, Jing Haiyun, Wang Dan. Predictive value of GA and HbA 1 c levels for mortality risk in patients with acute heart failure [J]. Journal of WMedicine, 2024, 22 (12): 2224-2227.

[2] Luo Dongdong, Zhou Wanbao, Wu Hui. The application value of volume management in the treatment of patients with acute heart failure [J]. Contemporary Medicine, 2023, 29 (20): 95-98.

[3] Wang Xinya, Wang Qian, Chen Yiyi, etc. The value of gamcholate combined with serum FT3 / FT4, IGFBP7, NT-proBNP in predicting poor prognosis in patients with acute heart failure [J]. Chinese Journal of Emergency Recovery and Disaster Medicine, 2023, 18 (11): 1404-1408.

[4] Jing Jiaoying, Zhu Jianfa, Zhang Xiao. Predictive value of serum RDW, NT-proBNP level for combined detection of MACE in elderly patients with acute heart failure [J]. Huaihai Medicine, 2024, 42 (2): 142-146.

[5] Wang Zhenlei, Mou Weifeng, Cui Peng. Predictive value of type B brain sodium peptide levels at admission for poor outcome in acute heart failure [J]. Contemporary Medicine, 2023, 29 (26): 134-136.

[6] Xue Zhongwen, Lu Songhui, Wang Shuang. Construction of risk factors and risk prediction model for diuretic resistance in patients with acute heart failure [J]. Hebei Medicine, 2024, 46 (8): 1156-1160.

[7] Bi Jiancheng, Liu Qunying, Feng Junling, et al. Prediction model construction and risk stratification study of unplanned readmission in elderly patients with acute heart failure [J]. Journal of Integrated TCM and Western Medicine in Cardiovascular and cerebrovascular Diseases, 2023, 21 (10): 1860-1864.