

# A Model to Predict in-Hospital Death in Patients with Type B Acute Aortic Dissection: A Single-Center Retrospective Observational Study

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## ABSTRACT

**Background:** Acute type B aortic dissection (BAAD), as a catastrophic disease, is linked to high morbidity and mortality. The current research is to create a simple risk model to predict in-hospital mortality in BAAD patients based on laboratory results.

**Methods:** Patients with BAAD were included from April 1, 2017, to November 30, 2019, in the hospital. Clinical features and laboratory results were collected. Logistic regression analyses and ROC were applied to the evaluation.

**Results:** Hemoglobin (HB) ( $114.88 \pm 28.42$  (nonsurvivor) vs.  $134.95 \pm 17.88$  (survivor),  $P < 0.001$ ) and UREA ( $10.93 \pm 7.02$  (nonsurvivor) vs.  $7.17 \pm 3.77$  (survivor),  $P = 0.001$ ) were significantly different. In multivariate analysis, HB (hazard ratio (HR): 0.124; 95% confidence interval (CI) 0.025 – 0.627;  $P = 0.012$ ) and UREA (HR: 8.765; 95% CI 2.022 – 37.993;  $P = 0.004$ ) were independent predictors of in-hospital death. Then, a model with good performance (AUC 0.761 (0.677 – 0.832)) was developed.

**Conclusion:** A simple model with good prediction value was developed. With this model, physicians quickly can identify high-risk patients, determine the best treatment strategies, and improve prognosis.

## INTRODUCTION

Acute type B aortic dissection (BAAD), as a catastrophic disease, was first reported in two centuries ago; it is associated with high morbidity and mortality rates [Zhang 2019]. In-hospital death rate of BAAD patients was 10.6% [Tolenaar 2014]. Despite the early diagnostic and advanced therapeutic techniques aid in improving the prognosis, the mortality rate for BAAD patients at an early stage remains high. In addition, some BAAD patients

suffer from certain complications, such as pneumonia and lung injury, which would lead a worse prognosis than those without complications [Cook 1998; Brunkwall 2012].

As the performance of BAAD is various, the diagnosis of this disease and the identification of high-risk patients are difficult, and prognosis of each patient is unpredictable [Tolenaar 2013; Wilkinson 2013]. Old age, abnormal kidney function, female sex, and low albumin have been considered as risk prognostic markers [Tolenaar 2014; Ko 2015; Zeng 2016]. Novel biomarkers or models based on easy-to-obtain parameters are recommended to guide the monitoring of efficacy and prognosis of diseases. We conducted this work to develop a simple risk model to predict in-hospital mortality in BAAD patients based on laboratory results.

## METHODS

**Patients and data:** Patients with BAAD (confirmed with multi-detector computed tomography scanning) were retrospective and included those treated from April 1, 2017, to November 30, 2019, in the First Affiliated Hospital of Nanjing Medical University. Patients with traumatic dissection, respiratory disease, infectious disease, incomplete information, and cardiac hypofunction were out of our scope in the research. At last, 126 patients were enrolled. Data containing the patient's age, sex, hypertension, diabetes, admission laboratory results, and in-hospital outcomes within 30 days were collected. This research was approved by the ethics committee of the hospital and kept in line with the Declaration of Helsinki. Informed consent was waived by the committee because of the retrospective nature of the study.

**Statistical analysis:** Variables were presented as mean  $\pm$  standard deviation or number (percentages). Continuous variables were compared using the t-test and categorical data were compared using the Fisher exact or Chi-square tests. Variables with a marginal association with mortality ( $P < 0.10$ ) were entered in a stepwise multivariable logistic regression model (forward) for in-hospital mortality. Multivariate binary logistic regression analyses (forward) were carried out to identify the predictors of in-hospital mortality. ROC was brought in to evaluate the performance of the model. A value of  $P < 0.05$  was considered significant. Data analysis was done with SPSS 21 statistical analysis software.

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## RESULTS

**Patient characteristics:** Patients were divided into survivor and nonsurvivor groups, according to the in-hospital mortality. There were 101 males, and the mortality of BAAD patients in this study was 12.7%. Baseline characteristics of the two groups are displayed in Table 1. (Table 1) There was a significant difference between the groups in the number of patients with hypertension ( $P = 0.006$ ) or renal dysfunction ( $P < 0.001$ ). Hemoglobin (HB) ( $114.88 \pm 28.42$  (nonsurvivor) vs.  $134.95 \pm 17.88$  (survivor),  $P < 0.001$ ), prothrombin time (PT), international normalized ratio (INR), activated partial thromboplastin time (APTT), UREA ( $10.93 \pm 7.02$  (nonsurvivor) vs.  $7.17 \pm 3.77$  (survivor),  $P = 0.001$ ), and creatinine (CREA) also were significantly different. The discrepancy between variables such as fibrinogen (FIB), lymphocyte, and D-dimer is not obvious (Table 1).

Independent predictors of in-hospital death: ROC was first applied to confirm the optimal value of each variable. Then, the following variables with  $P < 0.10$  in Table 1 were turned into categorical variables. At last, in multivariate analysis, HB (hazard ratio (HR): 0.124; 95% confidence interval (CI) 0.025 – 0.627;  $P = 0.012$ ), and UREA (HR: 8.765; 95% CI 2.022 – 37.993;  $P = 0.004$ ) were independent predictors of in-hospital

death. (Table 2) A model was built as follows:  $\text{Logit } P = 2.171 \times \text{UREA} - 2.086 \times \text{HB} - 0.180$

**Performance of the model:** ROC was utilized to check the performance of the model, the results suggested that AUC was 0.761 (0.677 – 0.832). (Figure 1). When 0.1638 was selected as the best cutoff value, the sensitivity and specificity were 43.75% and 97.27%, respectively.

## DISCUSSION

The research suggested that HB and UREA were independent factors for BAAD patients' in-hospital death. And a model with good performance was built based on these factors.

HB could combine with oxygen to transport oxygen, and there is a relationship between hypoxia in skeletal muscle [Tseng 2021]. Previous researchers have reported that admission HB was related to many diseases, such as acute ischemic stroke, cyanotic congenital heart disease, and gestational diabetes [Liu 2022; Zhou 2021; Sissala 2022]. In this study, a significant difference also was found between survivors and nonsurvivors.

Research on UREA and mortality has been reported.

Table 1. Characteristics of patients according to outcome

Characteristics	Nonsurvivors (N = 16)	Survivors (N = 110)	P-value
Age (years)	62 (30-82)	56 (26-84)	0.112
Male, n (%)	13 (81.25%)	88 (80.00%)	0.908
Hypertension, n (%)	11	101	0.006
Diabetes mellitus, n (%)	2	6	0.284
Renal dysfunction (%)	2	0	<0.001
WBC ( $\times 10^9/L$ )	$9.82 \pm 2.38$	$10.35 \pm 3.69$	0.581
Lymphocyte ( $\times 10^9/L$ )	$1.26 \pm 0.91$	$1.22 \pm 0.55$	0.837
Neutrophil ( $\times 10^9/L$ )	$7.80 \pm 2.63$	$8.23 \pm 3.54$	0.648
HB (g/L)	$114.88 \pm 28.42$	$134.95 \pm 17.88$	<0.001
PLT ( $\times 10^9/L$ )	$156.81 \pm 92.35$	$174.05 \pm 51.55$	0.269
PT (s)	13.0 (11.6 – 30.7)	12.4 (10.4 – 23.9)	0.006
INR	1.13 (1.01 – 2.75)	1.08 (0.90 – 2.12)	0.006
APTT (s)	30.1 (26.2 – 46.0)	28.3 (21.9 – 42.1)	0.015
FIB (g/L)	$3.40 \pm 0.36$	$3.64 \pm 0.16$	0.600
D-dimer (mg/L)	$4.63 \pm 1.02$	$3.59 \pm 0.32$	0.273
ALT (U/L)	20.4 (0.4 – 217.9)	17.9 (5.0 – 3485)	0.936
AST (U/L)	24.2 (6.9 – 540.3)	19.2 (10.5 – 4728)	0.752
UREA (mmol/L)	$10.93 \pm 7.02$	$7.17 \pm 3.77$	0.001
CREA ( $\mu\text{mol/L}$ )	122.4 (52 – 1172.1)	75.5 (35.6 – 696.5)	<0.001

APTT, activated partial thromboplastin time; ALT, alanine aminotransferase; AST, aspartate aminotransferase; CREA: creatinine; FIB, fibrinogen; HB, hemoglobin; INR, international normalized ratio; PLT, platelet; PT, prothrombin time; UREA: urea nitrogen; WBC; white blood cell count

Elevated UREA was a risk factor for poor prognosis in patients with acute decompensated heart failure, acute myocardial infarction, or pulmonary disease [Ren 2018; Horiuchi 2018; Tatlisu 2017]. In addition, for patients with acute aortic dissection, UREA also was employed to predict in-hospital death [Liu 2018]. In our study, we confirmed this conclusion.

Models are commonly used in the diagnosis, treatment, and prognosis of diseases. A model based on independent factors (MRI and Ultrasound Signs) was established for the diagnosis of ovarian cancer [Guo 2022]. Based on four biomarkers (capillary oxygen saturation, albumin, D-dimer, and age), a new score, named as SAD-60 score, was built with a good predictive capacity for mortality in hospitalized COVID-19 patients [Surme 2022]. Based on the above reports, we speculate that the model also can significantly improve predictive performance and be used in this research. Thus, we aim to build a model with good performance to predict in-hospital death. We retrospectively analyzed the results of BAAD patients. Univariate and multivariate results suggested that HB and UREA were independent indexes, and based on these results, a model was built. Further, predicting the value of the model was better than that of each individual alone.

**Limitations:** Selection bias cannot be avoided, and some biomarkers may not be included as this investigation was a retrospective and a single-center study. The sample size was small, and some potential risk indicators may go undetected. In addition, we did not explore if the model has a predicted value in long-term mortality. Finally, we did not validate the model with internal and external cohorts.

**CONCLUSIONS**

In conclusion, HB and UREA were independent factors in predicting in-hospital mortality for BAAD patients. A simple model with good prediction value was developed.

With this model, physicians quickly can identify high-risk patients, determine the best treatment strategies, and improve prognosis.

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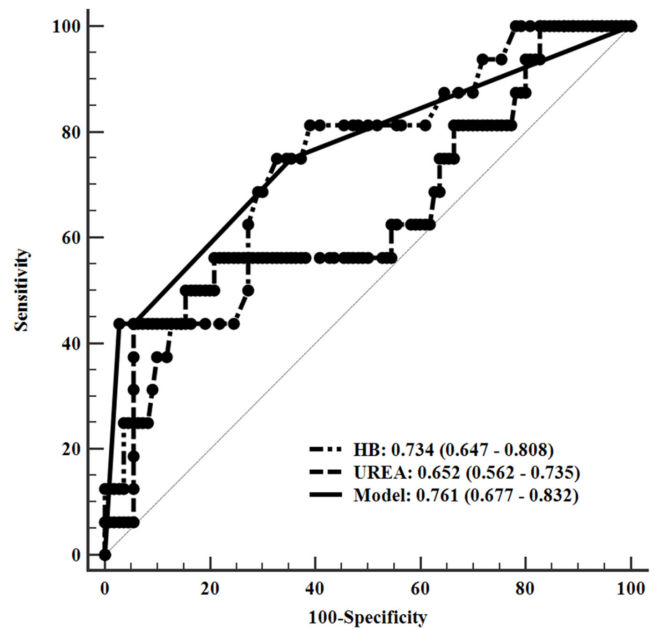


Figure 1. The performance of the model

Table 2. Logistic regression of in-hospital mortality for patients with BAAD

Variables	Univariate analysis			Multivariate analysis			
	HR	95% CI	P-value	$\beta$	HR	95% CI	P-value
Age	3.583	1.218 -10.545	0.028				
HB	0.162	0.049 - 0.538	0.002	-2.086	0.124	0.025 - 0.627	0.012
PT	5.056	1.516-16.862	0.008				
INR	4.132	1.250 - 13.694	0.024				
APTT	5.510	1.615 - 18.800	0.009				
UREA	13.481	3.727 - 48.076	<0.001	2.171	8.765	2.022 - 37.993	0.004
CREA	5.875	1.928 - 17.901	0.003				
AUC	-	0.761	-				

APTT, activated partial thromboplastin time; AUC: area under the curve; CI: confidence interval; HR: hazard ratio; CREA, creatinine; HB, hemoglobin; INR, international normalized ratio; PT, prothrombin time; UREA: urea nitrogen;  $\beta$ : regression coefficient

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