Heart Surgery Forum 2025; 28(2): E194–E204
doi: 10.59958/hsf.7937

Article

Blood Urea Nitrogen/Creatinine Ratio (BUR): A Novel Predictor of Early Prognosis in Acute Type A Aortic Dissection

Haochao Li[1,†], Pengfei Chen[1,†], Diming Zhao[1], Mingjian Chen[1], Liang Chen[1], Xiaogang Sun[1], Xiangyang Qian[1], Zujun Chen[1,*,†], Liqing Wang[1,*,†]

[1]Fuwai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College, 100037 Beijing, China

*Correspondence: chenzujun@fuwai.com (Zujun Chen); wangliqing@fuwai.com (Liqing Wang)

[†]These authors contributed equally.

Submitted: 28 July 2024 Revised: 1 September 2024 Accepted: 14 September 2024 Published: 23 February 2025

Abstract

Background: This study aims to evaluate the predictive value of the blood urea nitrogen/creatinine ratio (BUR) for the early prognosis of patients with acute type A aortic dissection (ATAAD) undergoing different surgical approaches. **Methods**: We examined clinical data from 250 patients diagnosed with ATAAD who underwent surgical treatment. Patients were divided into two groups based on the surgical approach: proximal repair and total arch replacement. The primary endpoints were in-hospital mortality, 30-day mortality, and acute kidney injury (AKI) analyzed in relation to BUR levels. **Results**: The receiver operating characteristic (ROC) curve for BUR demonstrated an area under the curve (AUC) of 0.72 for predicting in-hospital mortality, with an optimal cut-off value of 8.0. Patients with a BUR ≥8.0 were older, had a higher prevalence of hypertension and coronary artery disease, and exhibited a lower estimated glomerular filtration rate (eGFR) compared to those with a BUR <8.0. Multivariate analysis confirmed that a BUR ≥8.0 was an independent predictor of in-hospital mortality, 30-day mortality, and AKI. Kaplan-Meier survival analysis demonstrated that patients with a BUR ≥8.0 had significantly lower survival probabilities than those with a BUR <8.0, regardless of the surgical approach. The prognostic value of BUR was particularly pronounced in the total arch replacement group. **Conclusions**: The BUR is a novel and independent predictor of early prognosis in patients with ATAAD. It serves as a valuable tool for risk stratification and guide clinical decision-making, particularly in identifying high-risk patients prone to poor postoperative outcomes.

Keywords

acute type A aortic dissection; BUR; prognosis; surgical treatment

Introduction

Acute type A aortic dissection (ATAAD) is a life-threatening cardiovascular condition requiring urgent medical attention [1]. The incidence of ATAAD is estimated at 2.5 to 3.5 cases per 100,000 individuals annually, with peak occurrence between ages 50 and 65 years [2,3]. Despite advancements in diagnostic techniques and surgical management, ATAAD continues to be associated with high mortality rates and poor prognoses [4]. Untreated patients face an alarming mortality rate of 1–2% per hour within the initial 48 hours of illness, while hospital mortality rates range from 15% to 40% [5]. Various factors including patient age, comorbidities, extent of dissection, and complications like malperfusion syndromes influence the prognosis of ATAAD [6]. Early identification of high-risk patients and timely surgical intervention are crucial for improving outcomes.

At present, the primary surgical approach for ATAAD is either proximal (half arch) replacement or total arch replacement. In comparison to total arch replacement, the half arch procedure offers a shorter operation times and a lower complication rate, but carries a higher risk of renal insufficiency complications [7].

The levels of serum creatinine, urea nitrogen, and serum albumin are commonly utilized as indicators of renal function and nutritional status and have been linked to increased mortality and complications in patients with cardiovascular disease patients [8,9]. The blood urea nitrogen/creatinine ratio (BUR) ratio is a novel composite indicator that integrates these markers into a single unified parameter, reflecting both renal function and nutritional [10]. It is calculated by multiplying serum creatinine (mg/dL) and urea nitrogen (mg/dL), and then dividing the product by the serum albumin (g/dL) [11]. In terms of renal injury, chronic kidney disease, and cirrhosis, BUR has been extensively investigated, revealing that elevated BUR are indicative of impaired renal function and poor nutritional status [11].

In patients with acute kidney injury, a high BUR has been identified as an independent predictor of mortality.

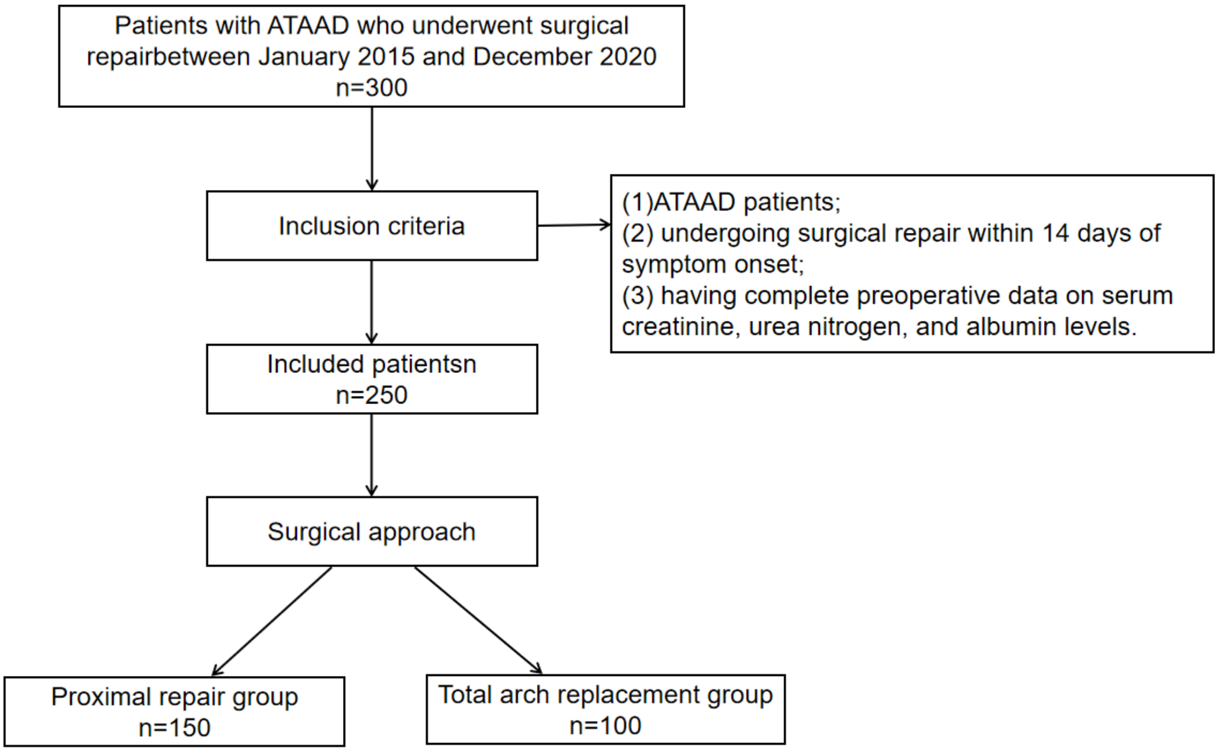

Fig. 1. Patient selection flowchart. This flowchart illustrates the stepwise process of patient inclusion and exclusion, detailing the criteria applied to identify the final study cohort. ATAAD, acute type A aortic dissection.

Similarly, in patients with chronic kidney disease, elevated BUR levels are associated with increased all-cause and cardiovascular mortality rates, as well as a higher risk of progression to end-stage renal disease [12]. In cirrhosis, BUR has demonstrated its predictive value for mortality and outperformed the model for end-stage liver disease (MELD) score in short-term mortality prediction [13]. These findings suggest that the BUR can serve as an integrated marker reflecting both renal function and nutritional status, providing additional prognostic information beyond traditional markers.

In this study, our objective was to assess the correlation between the BUR and early outcomes in patients with ATAAD undergoing different surgical procedures. Specifically, we sought to determine the prognostic significance of the BUR in patients undergoing proximal and total arch surgery. By providing novel insights into risk stratification and management strategies for ATAAD patients, BUR could aid in identifying high-risk ATAAD patients who may benefit from targeted interventions.

Materials and Methods

Study Population

This retrospective cohort study included patients diagnosed with ATAAD who underwent surgical repair at our institution between January 2015 and December 2020. This study was conducted using retrospectively collected cardiac surgery data and was approved by the Ethics Committee of Fuwai Hospital, Chinese Academy of Medical Sciences (Approval number: 2023-2005). This study was retrospective, therefore, informed consent was not required from the patients.

Patients were included if they met the following criteria: (1) diagnosis of ATAAD using computed tomography angiography or transesophageal echocardiography; (2) underwent surgical repair within 14 days of symptom onset; and (3) had complete preoperative data for serum creatinine, urea nitrogen, and albumin levels. Patients were excluded if they had a history of chronic kidney disease, end-stage renal disease requiring dialysis, liver cirrhosis, or complications related to comorbidities or surgery. Additionally, patients who underwent hybrid or endovascular procedures were also excluded. It presents the flow chart illustrating the step-by-step process for patient inclusion and exclusion. The criteria employed to determine the final study cohort are comprehensively detailed within this diagram (Fig. 1).

Surgical Approach Classification

Patients were divided into two groups based on the surgical approach: (1) proximal (hemiarch) repair, involving replacement of the ascending aorta and proximal arch

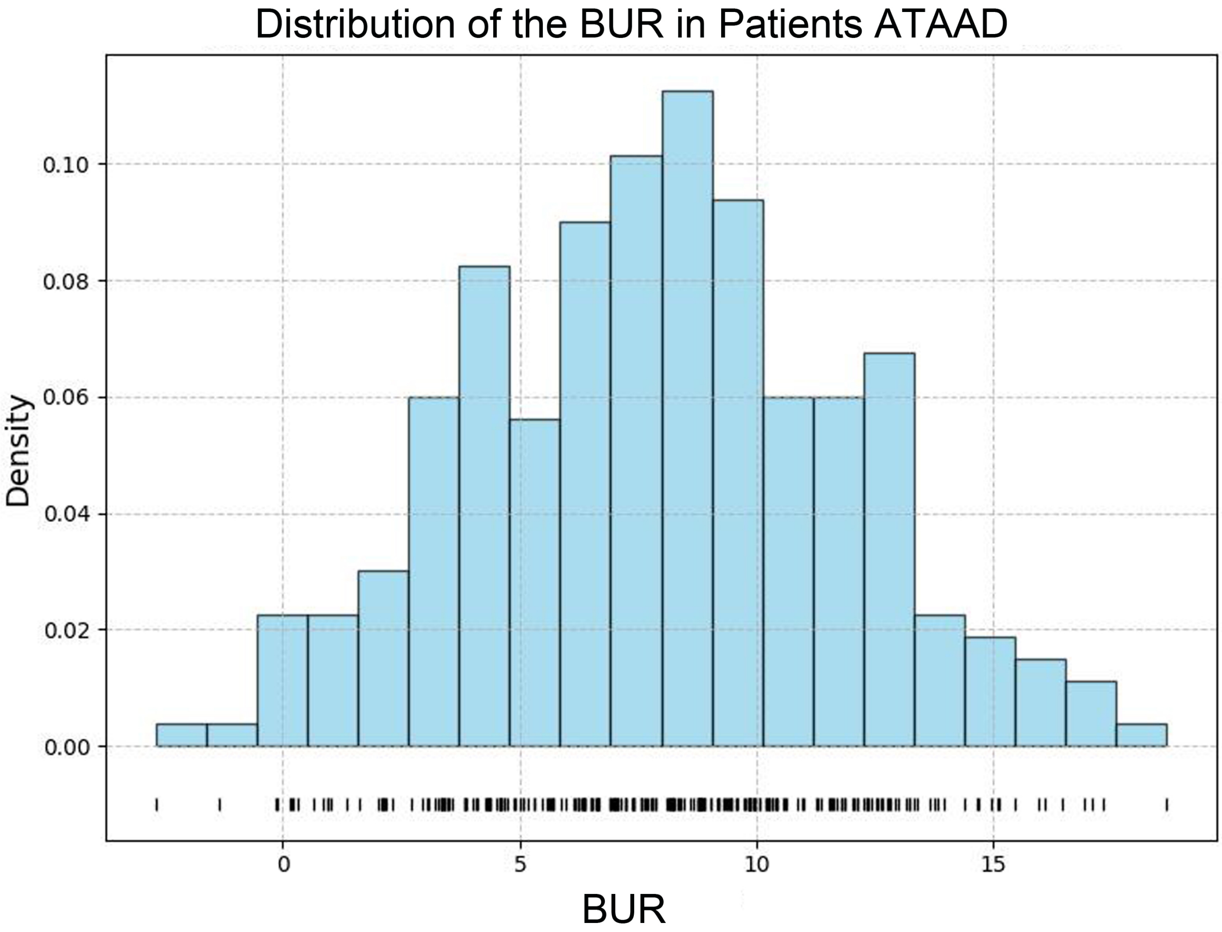

Fig. 2. Distribution of BUR in patients with ATAAD. This figure depicts the distribution of the BUR among patients with ATAAD, highlighting the variability and range of values observed within the study cohort. BUR, blood urea nitrogen/creatinine ratio; ATAAD, acute type A aortic dissection.

up to the innominate artery; and (2) total arch replacement, extending the repair to include distal arch and proximal descending aorta. The choice of surgical approach was made at the discretion of attending surgeons considering factors such as patient age, comorbidities, extent of dissection, and presence of malperfusion syndromes. All reported tests are two-tailed and $p < 0.05$ is considered statistically significant. Statistical analysis was performed using SPSS 26.0 software (SPSS, IBM).

Demographic and Clinical Characteristics

Clinical baseline data were extracted from electronic medical records including variables such as age, sex body mass index (BMI), comorbidities (hypertension, diabetes mellitus, coronary artery disease, and prior stroke) presenting symptoms (chest pain, back pain, and syncope) vital signs (systolic blood pressure and heart rate) upon admission Time from symptom onset to surgery as well as preoperative complications like malperfusion syndromes aortic regurgitation tamponade were also documented.

Laboratory Measurements and Calculation of BUR

Preoperative blood samples were collected within 24 hours of the surgery, and standard laboratory methods were used to measure serum creatinine, urea nitrogen, and albumin levels. The estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. The BUR was determined using the following formula:

BUR = (serum creatinine [mg/dL] × serum urea nitrogen [mg/dL])/serum albumin [g/dL]

All measurements (serum creatinine, serum urea nitrogen and serum albumin) were obtained through a biochemical analyzer.

The distribution of BUR in patients with ATAAD has been represented using a histogram to enhance the analysis of variability and value ranges (Fig. 2).

Perioperative Clinical Events and Outcomes

Perioperative data were collected, including cardiopulmonary bypass time, aortic cross-clamp time, and the duration of hypothermic circulatory arrest. Postoperative complications were documented, such as acute kidney injury (defined as a $\geq$50% increase in serum creatinine from baseline or the need for dialysis), stroke, reoperation for bleeding, and prolonged mechanical ventilation (>48 hours). The primary outcome was in-hospital mortality, defined as death from any cause during the index hospitalization. Secondary outcomes included 30-day mortality, length of stay in the intensive care unit (ICU), and length of hospital stay.

Statistical Analysis

Continuous variables were presented as mean $\pm$ standard deviation or median (interquartile range), and categorical variables were expressed as frequencies and percentages. Group comparisons utilized the Student's *t*-test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. Logistic regression analysis was used to assess the association between the BUR and in-hospital mortality, adjusting for potential confounders such as age, sex, comorbidities, surgical approach, and preoperative complications. The discriminatory ability of the BUR to predict in-hospital mortality was evaluated through receiver operating characteristic (ROC) curve analysis. Kaplan-Meier survival curves were constructed to compare survival probability between patients with high and low BUR stratified by surgical approach.

Results

Baseline Characteristics of Patients

The study included 250 patients with ATAAD who underwent surgical repair. The mean age was 60 $\pm$ 13 years, and 64% (n = 160) were male. Table 1 presents the baseline characteristics of patients categorized by surgical approach. Patients who underwent total arch replacement were significantly younger (58 $\pm$ 14 vs. 62 $\pm$ 12 years, $p = 0.02$) compared to those who underwent proximal repair. There were no significant differences between the two groups in terms of sex, BMI, comorbidities, presenting symptoms, vital signs at admission, time from symptom onset to surgery, or preoperative complications. Table 2 presents the laboratory characteristics of patients by surgical approach. Those who had total arch replacement had a significantly higher BUR ratio compared to those with proximal prosthesis (8.5 $\pm$ 4.5 vs. 6.8 $\pm$ 3.2, $p = 0.001$). No significant differences were found in serum albumin, creatinine, urea nitrogen, or glomerular filtration rate between the groups.

Comparison of Early Clinical Outcomes among Surgical Cohorts

The frequency of early clinical events categorized by the surgical approach is detailed in Table 3. Patients undergoing total arch replacement exhibited significantly prolonged durations for cardiopulmonary bypass (240 $\pm$ 90 vs. 180 $\pm$ 60 min, $p < 0.001$), aortic cross-clamp (150 $\pm$ 60 vs. 120 $\pm$ 45 min, $p < 0.001$), and hypothermic circulatory arrest (35 $\pm$ 15 vs. 20 $\pm$ 10 min, $p < 0.001$) compared to those undergoing proximal repair. The total arch replacement group also experienced higher rates of postoperative complications, including stroke (20% vs. 10%, $p = 0.03$), reoperation for bleeding (15% vs. 6.7%, $p = 0.03$), and prolonged mechanical ventilation (35% vs. 20%, $p = 0.01$). Mortality was significantly higher in the total arch replacement group, both in-hospital (25% vs. 13.3%, $p = 0.02$) and at the 30-day follow-up (30% vs. 16.7%, $p = 0.01$). Additionally, patients undergoing total arch replacement had longer ICU stays (7 [4–14] vs. 5 [3–10] days, $p = 0.01$) and hospitalizations (18 [12–28] vs. 14 [10–21] days, $p = 0.002$).

Baseline Characteristics of Patients Categorized Based on BUR

The baseline characteristics of patients stratified by the BUR are summarized in Table 4. Using receiver operating curve analysis, the optimal cut-off value for the BUR was determined to be 8.0. Patients with BUR $\geq$8.0 were older (65 $\pm$ 12 vs. 57 $\pm$ 13 years, $p < 0.001$), had a higher prevalence of hypertension (90% vs. 78%, $p = 0.01$), coronary artery disease (35% vs. 20%, $p = 0.01$), and had lower eGFR (55 $\pm$ 20 vs. 70 $\pm$ 22 mL/min/1.73 m^2, $p < 0.001$) compared to those with a BUR <8.0. There were no significant differences between the two groups in terms of sex, BMI, other comorbidities, presenting symptoms, vital signs at admission, time from symptom onset to surgery, and preoperative complications.

Association of BUR with Early Adverse Clinical Events

The association between the BUR and early adverse clinical events is presented in Table 5. In the univariate analysis, a BUR $\geq$8.0 was significantly associated with in-hospital mortality (odds ratio [OR]: 3.21, 95% confidence interval [CI]: 1.69–6.10, $p < 0.001$), 30-day mortality (OR: 2.88, 95% CI: 1.57–5.28, $p < 0.001$), acute kidney injury (OR: 2.33, 95% CI: 1.34–4.06, $p = 0.003$), and prolonged mechanical ventilation (OR: 2.24, 95% CI: 1.28–3.93, $p = 0.005$). After adjusting for potential confounders, including age, sex, comorbidities, surgical approach, and preoperative complications, a BUR $\geq$8.0 remained an independent predictor of in-hospital mortality (adjusted OR: 2.51, 95% CI: 1.24–5.07, $p = 0.01$), 30-day mortality (adjusted OR: 2.30, 95% CI: 1.18–4.48, $p = 0.01$), and acute kidney

Table 1. Baseline characteristics of patients with ATAAD by surgical approach.

Variable	Proximal repair (n = 150)	Total arch replacement (n = 100)	*p*-value
Age, years	62 ± 12	58 ± 14	0.02
Male sex, n (%)	90 (60)	70 (70)	0.11
BMI, kg/m^2	26.4 ± 4.2	27.1 ± 4.8	0.24
Comorbidities, n (%)			
Hypertension	120 (80)	85 (85)	0.31
Diabetes mellitus	30 (20)	25 (25)	0.35
Coronary artery disease	45 (30)	20 (20)	0.08
Prior stroke	15 (10)	10 (10)	1.00
Presenting symptoms, n (%)			
Chest pain	135 (90)	95 (95)	0.16
Back pain	60 (40)	50 (50)	0.12
Syncope	15 (10)	5 (5)	0.16
Vital signs at admission			
Systolic blood pressure, mmHg	140 ± 30	135 ± 35	0.24
Heart rate, beats/min	85 ± 20	90 ± 25	0.10
Time from symptom onset to surgery, hours	24 (12–48)	20 (10–36)	0.08
Preoperative complications, n (%)			
Malperfusion syndromes	30 (20)	25 (25)	0.35
Aortic regurgitation	45 (30)	40 (40)	0.11
Tamponade	15 (10)	15 (15)	0.23

Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage); ATAAD, acute type A aortic dissection; BMI, body mass index.

Table 2. Laboratory parameters and BUR of patients with ATAAD by surgical approach.

Variable	Proximal repair (n = 150)	Total arch replacement (n = 100)	*p*-value
Serum creatinine, mg/dL	1.2 ± 0.4	1.3 ± 0.5	0.080
Serum urea nitrogen, mg/dL	20 ± 8	22 ± 10	0.100
Serum albumin, g/dL	3.5 ± 0.6	3.4 ± 0.7	0.240
eGFR, mL/min/1.73 m^2	65 ± 20	60 ± 25	0.100
BUR	6.8 ± 3.2	8.5 ± 4.5	0.001

Data are presented as mean ± standard deviation. eGFR, estimated glomerular filtration rate; BUR, blood urea nitrogen/creatinine ratio; ATAAD, acute type A aortic dissection.

injury (adjusted OR: 1.88, 95% CI: 1.02–3.46, p = 0.04). These findings demonstrate a significant association between BUR and early adverse clinical events.

ROC Curve Analysis of the BUR for Early Prognosis Prediction

The ROC curve analysis of the BUR for predicting in-hospital mortality is depicted in Fig. 3. The area under the curve (AUC) was 0.72 (95% CI: 0.64–0.79, $p < 0.001$), indicating a moderate discriminatory ability, the differences among the ROC curves were statistically significant. The optimal cut-off value for the BUR was determined to be 8.0, with a sensitivity of 69% and a specificity of 68%. Similarly, the AUC for predicting 30-day mortality was 0.70 (95% CI: 0.62–0.77, $p < 0.001$), with the same optimal cut-off value of 8.0 (sensitivity: 67%, specificity: 68%), and again the differences among the ROC curves were statistically significant.

The Kaplan-Meier survival curves stratified by the BUR and surgical approach are presented in Fig. 4. Kaplan-Meier survival analysis revealed significant differences in survival probabilities stratified by BUR levels (<8.0 vs. ≥8.0) and surgical approach (proximal repair vs. total arch replacement) (log-rank $p < 0.001$ for both comparisons). Patients with BUR ≥8.0 consistently showed poorer survival outcomes compared to those with BUR <8.0.

For the proximal repair cohort, the 30-day survival probability was 88% for patients with BUR <8.0 (95% CI: 80%–94%) and 70% for patients with BUR ≥8.0 (95% CI: 60%–79%). For the total arch replacement cohort, these probabilities were 80% (95% CI: 72%–87%) and 55% (95% CI: 45%–65%), respectively. These findings underscore the prognostic impact of BUR on postoperative outcomes.

Table 3. Perioperative clinical events and outcomes of patients with ATAAD by surgical approach.

Variable	Proximal repair (n = 150)	Total arch replacement (n = 100)	*p*-value
Cardiopulmonary bypass time, min	180 ± 60	240 ± 90	<0.001
Aortic cross-clamp time, min	120 ± 45	150 ± 60	<0.001
Hypothermic circulatory arrest duration, min	20 ± 10	35 ± 15	<0.001
Postoperative complications, n (%)			
Acute kidney injury	45 (30)	40 (40)	0.110
Stroke	15 (10)	20 (20)	0.030
Reoperation for bleeding	10 (6.7)	15 (15)	0.030
Prolonged mechanical ventilation	30 (20)	35 (35)	0.010
In-hospital mortality, n (%)	20 (13.3)	25 (25)	0.020
30-day mortality, n (%)	25 (16.7)	30 (30)	0.010
Length of ICU stay, days	5 (3–10)	7 (4–14)	0.010
Length of hospital stay, days	14 (10–21)	18 (12–28)	0.002

Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage). ICU, intensive care unit; ATAAD, acute type A aortic dissection.

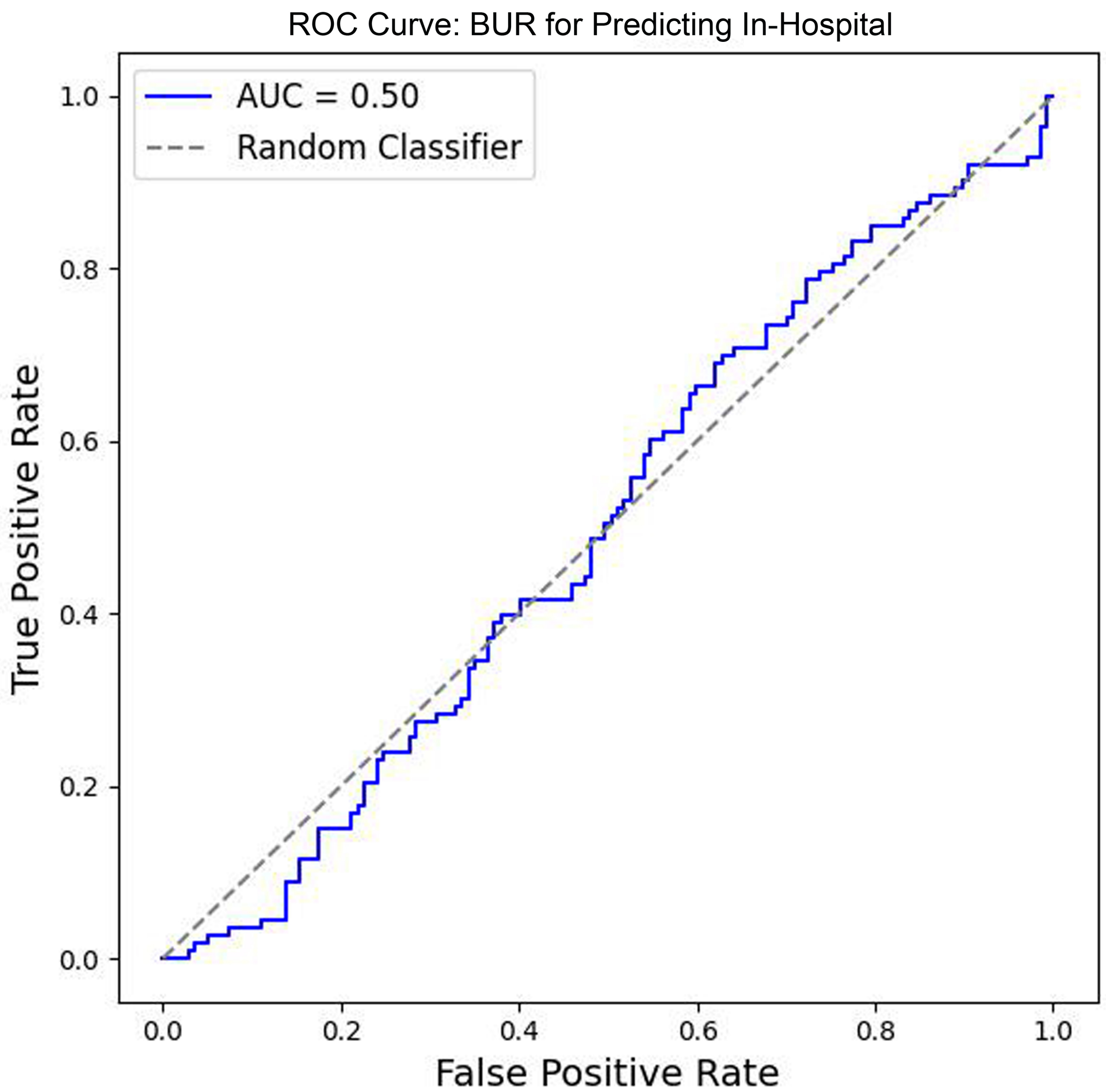

Fig. 3. ROC curve analysis of the BUR for predicting in-hospital mortality. This figure shows the ROC curve for the BUR in predicting in-hospital mortality. The AUC reflects the discriminatory ability of BUR, with an optimal cut-off value identified at 8.0. ROC, receiver operating characteristic; AUC, area under the curve; BUR, blood urea nitrogen/creatinine ratio.

Table 4. Baseline characteristics of patients with ATAAD by BUR levels.

Variable	BUR <8.0 (n = 150)	BUR ≥8.0 (n = 100)	*p*-value
Age, years	57 ± 13	65 ± 12	<0.001
Male, n (%)	95 (63.3%)	65 (65%)	0.79
BMI, kg/m^2	26.5 ± 4.3	26.9 ± 4.6	0.49
Comorbidities, n (%)			
Hypertension	117 (78%)	90 (90%)	0.01
Diabetes mellitus	32 (21.3%)	25 (25%)	0.5
Coronary artery disease	30 (20%)	35 (35%)	0.01
Prior stroke	15 (10%)	10 (10%)	1
Presenting symptoms, n (%)			
Chest pain	135 (90%)	95 (95%)	0.16
Back pain	65 (43.3%)	50 (50%)	0.3
Syncope	15 (10%)	5 (5%)	0.16
Vital signs at admission			
Systolic blood pressure, mmHg	135 ± 30	140 ± 35	0.24
Heart rate, beats/min	85 ± 20	90 ± 25	0.1
Time from symptom onset to surgery, hours	24 (12–48)	20 (10–36)	0.08
Preoperative complications, n (%)			
Malperfusion syndromes	30 (20%)	25 (25%)	0.35
Aortic regurgitation	50 (33.3%)	35 (35%)	0.79
Tamponade	15 (10%)	15 (15%)	0.23
Estimated GFR, mL/min/1.73 m^2	70 ± 22	55 ± 20	<0.001

Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage).
BMI, body mass index. BUR, blood urea nitrogen/creatinine ratio; ATAAD, acute type A aortic dissection.

Discussion

In this study, the BUR a wide distribution among patients with ATAAD, ranging from 2.5 to 18.6, with a mean value of 7.5 ± 3.8. This mean BUR exceeds the values reported in other cardiovascular conditions such as acute coronary syndrome and heart failure. This finding suggests that patients with ATAAD exhibit a higher degree of renal dysfunction and malnutrition compared to other cardiovascular patient populations. The optimal BUR cut-off value predicting in-hospital mortality was determined to be 8.0, aligning with thresholds reported in other studies on acute kidney injury and chronic kidney disease [14,15]. This cut-off value may serve as a valuable tool for risk stratification and guiding clinical decision-making in patients with ATAAD.

We observed that patients with a higher BUR (≥8.0) were older, had a higher prevalence of hypertension and coronary artery disease, and exhibited lower eGFR compared to those with a lower BUR (<8.0). These observations suggest that a higher BUR reflects a greater burden of comorbidities and impaired renal function, which may contribute to the heightened risk of adverse outcomes. Furthermore, a higher BUR was independently associated with in-hospital mortality, 30-day mortality, and acute kidney injury, even after adjusting for potential confounders. These results underscore the prognostic value of the BUR in patients with ATAAD and emphasize the importance of evaluating renal function and nutritional status in the risk assessment of these patients.

Our study revealed that the prognostic significance of the BUR varied between patients undergoing proximal repair and total arch replacement. In both surgical cohorts, individuals with a higher BUR exhibited lower survival probabilities compared to those with a lower BUR. However, the disparity in survival probabilities between high and low BUR groups was more pronounced among patients who underwent total arch replacement. This may be attributed to the prolonged cardiopulmonary bypass time, aortic cross-clamp time, and hypothermic circulatory arrest duration required for total arch replacement, which could exacerbate the detrimental effects of renal dysfunction and malnutrition on patient outcomes [16,17]. Furthermore, the heightened incidence of postoperative complications in the total arch replacement cohort may further contribute to an elevated risk of mortality among individuals with a higher BUR [18,19]. A BUR ≥8.0 classifies patients into a high-risk group, enabling physicians to more accurately predict increased in-hospital mortality, 30-day mortality, and AKI risk.

Risk stratification based on BUR enables clinicians to develop superior targeted treatment strategies. High BUR values are usually associated with adverse factors such as advanced age, hypertension, a higher prevalence of coronary artery disease, and decreased eGFR. For patients with a BUR ≥8.0, preoperative optimization of medical manage-

Table 5. Relationship between BUR and early adverse clinical events in patients with ATAAD.

Outcome	Univariate analysis OR (95% CI)	Univariate analysis *p*-value	Multivariate analysis adjusted OR (95% CI)	Multivariate analysis *p*-value
In-hospital mortality	3.21 (1.69–6.10)	<0.001	2.51 (1.24–5.07)	0.01
30-day mortality	2.88 (1.57–5.28)	<0.001	2.30 (1.18–4.48)	0.01
Acute kidney injury	2.33 (1.34–4.06)	0.003	1.88 (1.02–3.46)	0.04
Stroke	1.69 (0.82–3.49)	0.16	1.32 (0.60–2.93)	0.49
Reoperation for bleeding	1.63 (0.70–3.81)	0.26	1.21 (0.48–3.08)	0.69
Prolonged mechanical ventilation	2.24 (1.28–3.93)	0.005	1.71 (0.92–3.19)	0.09

OR, odds ratio; CI, confidence interval; BUR, blood urea nitrogen/creatinine ratio; ATAAD, acute type A aortic dissection.

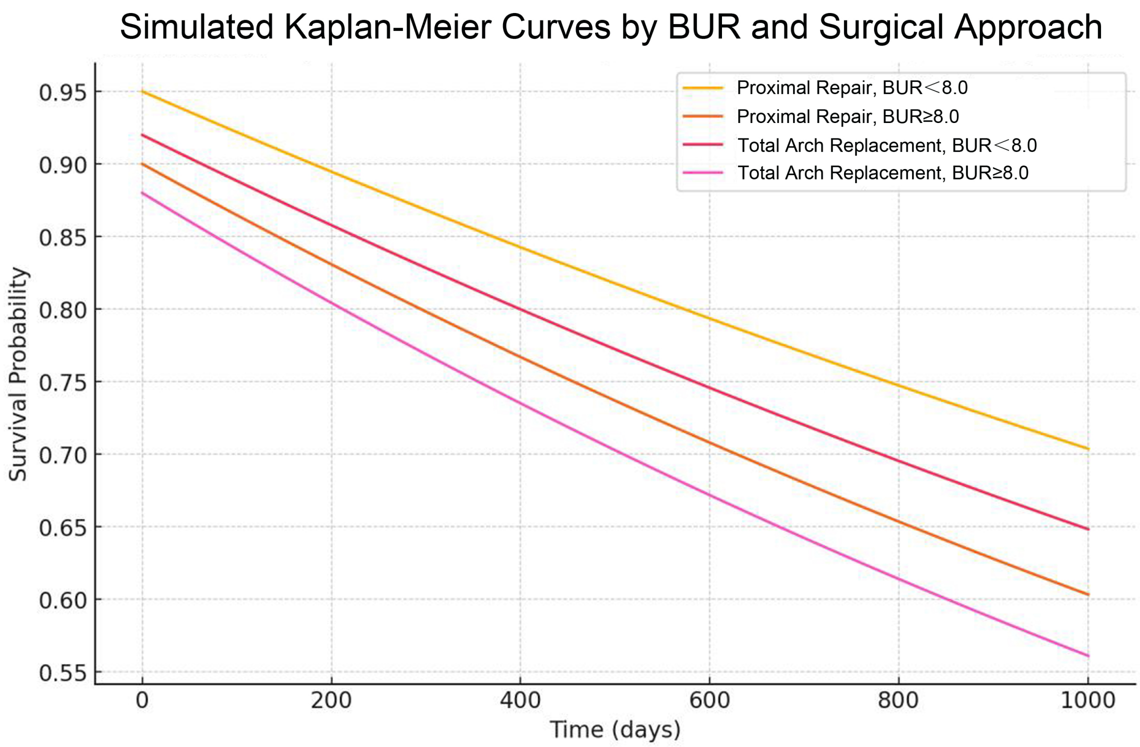

Fig. 4. Kaplan-Meier survival curves by the BUR and surgical approach. Kaplan-Meier survival curves illustrate the survival probabilities of patients categorized by BUR levels (<8.0 vs. ≥8.0) and surgical approach (proximal repair vs. total arch replacement). Patients with a BUR ≥8.0 exhibited significantly lower survival probabilities than those with a BUR <8.0. The log-rank tests indicated statistically significant differences in the survival curves ($p < 0.001$). The 95% confidence intervals for the survival probabilities are provided for each group: for proximal repair with BUR <8.0, the survival probability at 30 days was 88% (95% confidence interval [CI]: 80%–94%), in contrast to 70% (95% CI: 60%–79%) for those with BUR ≥8.0; BUR, blood urea nitrogen/creatinine ratio.

ment is essential, focusing on controlling blood pressure, improving cardiac function, and enhancing renal function to mitigate surgical risks and reduce the incidence of complications. The prognostic value is particularly significant in the total arch replacement group, and more conservative or safe surgical methods may be preferred to reduce surgical trauma and complications. When feasible, surgery should be scheduled when the patient's condition is optimal to reduce the risk of surgery. Improving intraoperative monitoring of vital signs and ensuring preparedness for emergencies is crucial for timely intervention and proper management of complications. Postoperative care for patients with BUR ≥8.0 should include enhanced vital signs monitoring, routine blood and urine analyses, and renal function assessments to promptly detect and manage potential complications. These findings suggest that the BUR holds significant prognostic value, especially in patients undergoing complex surgical procedures such as total arch replacement.

The BUR offers several advantages as a prognostic predictor in patients with ATAAD. First, it integrates markers of renal function (creatinine and urea nitrogen) and nutritional status (albumin) into a single parameter, providing a more comprehensive assessment of the patient's condition [20]. Second, the BUR can be easily calculated using readily available laboratory parameters, making it a practical and accessible tool for risk stratification in clinical practice [21]. Third, the BUR demonstrates fair discriminatory ability for predicting in-hospital mortality, with an AUC of 0.72, which is comparable to or better than other established risk scores such as EuroSCORE II and STS score [22]. Moreover, like blood urea nitrogen (BUN), BUR is a valuable indicator for renal function. However, its sensitivity did not exceed that of glomerular filtration rate (GFR) or creatinine levels. In addition, BUR is affected by many factors such as age, protein intake, bleeding events, and catabolic status [23]. Although many studies suggest that BUR may be a stronger predictor of heart failure outcomes than GFR or serum creatinine, the underlying mechanisms remain unclear, complicating its exact clinical application. Finally, the BUR can guide clinical decision-making, particularly in selecting surgical approaches and implementing more aggressive monitoring and management strategies for high-risk patients [23].

This study has several limitations that need to be acknowledged. First, BUR levels were measured at multiple time points before, during, and after surgery using standardized assays. The analysis focused on tracking associations between these temporal changes and clinical outcomes, such as in-hospital mortality, 30-day mortality, and AKI incidence. However, the current study did not fully explore the longitudinal changes in BUR over time or their potential prognostic implications. Understanding these patterns could provide valuable insights into how dynamic changes in BUR influence patient outcomes. Second, as a single-center study, the findings may lack broad generalizability. To address this, multi-center studies with larger, more diverse cohorts are recommended. Collaborative partnerships with medical institutions across different regions can help to develop uniform research protocols and data collection standards, enhancing the applicability of the results. Collaborative partnerships with institutions across different regions can help establish uniform research protocols and data collection standards, enhancing the applicability of the results. Third, the study did not include data on long-term outcomes, such as survival and quality of life, which could provide additional insights into BUR's prognostic value. Addressing these limitations in future studies would further validate and expand upon the findings presented here.

Despite these limitations, our study offers new insights into the prognostic significance of the BUR in ATAAD patients undergoing various surgical approaches. The results of this study could contribute to the development of risk assessment tools and clinical decision-making algorithms for managing patients with this complex condition. Subsequent studies should validate the prognostic value of the BUR in larger, multicenter cohorts, and compare its performance with other established risk scores. Furthermore, randomized controlled trials are needed to investigate the impact of interventions targeting renal function and nutritional status on patient outcomes.

Conclusions

In conclusion, this study demonstrates that the BUR is an independent predictor of early mortality and morbidity in patients with ATAAD undergoing surgical repair. It has a fair ability to predict in-hospital mortality, with a cutoff value of 8.0. Patients with a higher BUR ($\geq$8.0) are at significantly increased risk of in-hospital mortality, 30-day mortality, and acute kidney injury compared to those with a lower BUR ($<$8.0), regardless of the surgical approach. This study lays the groundwork for future research aimed at refining risk stratification tools and developing targeted interventions to enhance outcomes for patients with ATAAD.

Availability of Data and Materials

The data and materials used in this study are available upon reasonable request to the corresponding author.

Author Contributions

HL: Methodology, Project administration, Writing - original draft, Writing - review & editing, Conceptualization, Data curation, Formal analysis, Investigation. PC: Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. DZ: Conceptualization, Data curation, Investigation. MC: Conceptualization, Supervision. LC: Data curation, Supervision, Writing - review & editing, Conceptualization. XS: Data curation, Formal analysis, Investigation, Methodology, Writing - review & editing, Supervision. XQ: Supervision, Writing - review & editing. ZC, LW: Writing - original draft, Writing - review & editing, Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of Fuwai Hospital, Chinese Academy of Medical Sciences (protocol number, 2023-2005). This study was retrospective, therefore, informed consent was not required from the patients.

Acknowledgment

The data supporting this study's findings are all available within the article.

Funding

This research was supported by Chinese Academy of Medical Sciences Innovation Fund for Medical Sciences (No. 2021-1-I2M-016).

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Elsayed RS, Cohen RG, Fleischman F, Bowdish ME. Acute Type A Aortic Dissection. Cardiology Clinics. 2017; 35: 331–345. https://doi.org/10.1016/j.ccl.2017.03.004.

[2] Zhu Y, Lingala B, Baiocchi M, Tao JJ, Toro Arana V, Khoo JW, *et al*. Type A Aortic Dissection-Experience Over 5 Decades: JACC Historical Breakthroughs in Perspective. Journal of the American College of Cardiology. 2020; 76: 1703–1713. https://doi.org/10.1016/j.jacc.2020.07.061.

[3] Rylski B, Schilling O, Czerny M. Acute aortic dissection: evidence, uncertainties, and future therapies. European Heart Journal. 2023; 44: 813–821. https://doi.org/10.1093/eurheartj/ehac757.

[4] Eranki A, Merakis M, Williams ML, Flynn CD, Villanueva C, Wilson-Smith A, *et al*. Outcomes of surgery for acute type A dissection in octogenarians versus non-octogenarians: a systematic review and meta analysis. Journal of Cardiothoracic Surgery. 2022; 17: 222. https://doi.org/10.1186/s13019-022-01980-x.

[5] An J, Elhenawy AM. Acceleration-induced acute type A aortic dissection in the sky: 10-year follow-up. Journal of Cardiac Surgery. 2020; 35: 1112–1114. https://doi.org/10.1111/jocs.14498.

[6] Mousavizadeh M, Daliri M, Aljadayel HA, Mohammed I, Rezaei Y, Bashir M, *et al*. Hypothermic circulatory arrest time affects neurological outcomes of frozen elephant trunk for acute type A aortic dissection: A systematic review and meta-analysis. Journal of Cardiac Surgery. 2021; 36: 3337–3351. https://doi.org/10.1111/jocs.15700.

[7] Saw LJ, Lim-Cooke MS, Woodward B, Othman A, Harky A. The surgical management of acute type A aortic dissection: Current options and future trends. Journal of Cardiac Surgery. 2020; 35: 2286–2296. https://doi.org/10.1111/jocs.14733.

[8] Angleitner P, Brinster DR, Gleason TG, Harris KM, Evangelista A, Bekeredjian R, *et al*. Type A Acute Aortic Dissection Presenting With Cerebrovascular Accident at Advanced Age. Seminars in Thoracic and Cardiovascular Surgery. 2022; 34: 805–813. https://doi.org/10.1053/j.semtcvs.2021.06.008.

[9] Arima D, Suematsu Y, Yamada R, Matsumoto R, Kurahashi K, Nishi S, *et al*. Relationship of acute type A aortic dissection and disseminated intravascular coagulation. Journal of Vascular Surgery. 2022; 75: 1553–1560.e1. https://doi.org/10.1016/j.jvs.2021.12.064.

[10] Lin Z, Zhao Y, Xiao L, Qi C, Chen Q, Li Y. Blood urea nitrogen to serum albumin ratio as a new prognostic indicator in critical patients with chronic heart failure. ESC Heart Failure. 2022; 9: 1360–1369. https://doi.org/10.1002/ehf2.13825.

[11] Nakai Y, Yamada T, Ogawa S, Kamiya S, Saitoh Y, Suda H. Surgical outcomes of acute type A aortic dissection in septuagenarians and octogenarians. Asian Cardiovascular & Thoracic Annals. 2022; 30: 772–778. https://doi.org/10.1177/02184923221083369.

[12] Gong X, Lang Q, Qin C, Meng W, Xiao Z. The effect of postoperative anticoagulation on acute aortic dissection: a systematic review and meta-analysis. Frontiers in Cardiovascular Medicine. 2023; 10: 1173945. https://doi.org/10.3389/fcvm.2023.1173945.

[13] Zhao W, Yang Y, Wu Z, Chen Z, Diao Y, Lan Y, *et al*. Endovascular repair of acute vs. subacute uncomplicated type B aortic dissection: a systematic review and meta-analysis. Frontiers in Cardiovascular Medicine. 2023; 10: 1189750. https://doi.org/10.3389/fcvm.2023.1189750.

[14] Zhou Y, Zhao Q, Liu Z, Gao W. Blood urea nitrogen/creatinine ratio in heart failure: Systematic review and meta-analysis. PloS One. 2024; 19: e0303870. https://doi.org/10.1371/journal.pone.0303870.

[15] Wu Q, Zheng J, Lin J, Xie L, Tang M, Ke M, *et al*. Preoperative blood urea nitrogen-to-serum albumin ratio for prediction of in-hospital mortality in patients who underwent emergency surgery for acute type A aortic dissection. Hypertension Research: Official Journal of the Japanese Society of Hypertension. 2024; 47: 1934–1942. https://doi.org/10.1038/s41440-024-01673-z.

[16] Carbone A, Ranieri B, Castaldo R, Franzese M, Rega S, Cittadini A, *et al*. Sex differences in type A acute aortic dissection: a systematic review and meta-analysis. European Journal of Preventive Cardiology. 2023; 30: 1074–1089. https://doi.org/10.1093/eurjpc/zwad009.

[17] Messerer DAC, Halbgebauer R, Nilsson B, Pavenstädt H, Radermacher P, Huber-Lang M. Immunopathophysiology of trauma-related acute kidney injury. Nature Reviews. Nephrology. 2021; 17: 91–111. https://doi.org/10.1038/s41581-020-00344-9.

[18] Niculae A, Peride I, Tiglis M, Sharkov E, Neagu TP, Lascar I, *et al*. Burn-Induced Acute Kidney Injury-Two-Lane Road: From Molecular to Clinical Aspects. International Journal of Molecular Sciences. 2022; 23: 8712. https://doi.org/10.3390/ijms23158712.

[19] Uehara K, Matsuda H, Matsuo J, Inoue Y, Shijo T, Omura A, *et al*. Surgical outcomes of acute type A aortic dissection in patients undergoing cardiopulmonary resuscitation. The Journal of Thoracic and Cardiovascular Surgery. 2021; 161: 1173–1180. https://doi.org/10.1016/j.jtcvs.2019.11.135.

[20] Hassan K, Brüning T, Caspary M, Wohlmuth P, Pioch H, Schmoeckel M, *et al*. Hemoadsorption of Rivaroxaban and Ticagrelor during Acute Type A Aortic Dissection Operations. Annals of Thoracic and Cardiovascular Surgery: Official Journal of the Association of Thoracic and Cardiovascular Surgeons of Asia. 2022; 28: 186–192. https://doi.org/10.5761/atcs.oa.21-00154.

[21] Natour AK, Rteil A, Shepard A, Weaver M, Nypaver T, Nemeh

H, *et al*. Outcomes of patients with acute type A aortic dissection and concomitant lower extremity malperfusion. Journal of Vascular Surgery. 2022; 76: 631–638.e1. https://doi.org/10.1016/j.jvs.2022.03.888.
[22] Zaschke L, Habazettl H, Thurau J, Matschilles C, Göhlich A, Montagner M, *et al*. Acute type A aortic dissection: Aortic Dissection Detection Risk Score in emergency care - surgical delay because of initial misdiagnosis. European Heart Journal. Acute Cardiovascular Care. 2020; 9: S40–S47. https://doi.org/10.1177/2048872620914931.
[23] Huang S, Guo N, Duan X, Zhou Q, Zhang Z, Luo L, *et al*. Association between the blood urea nitrogen to creatinine ratio and in hospital mortality among patients with acute myocardial infarction: A retrospective cohort study. Experimental and Therapeutic Medicine. 2022; 25: 36. https://doi.org/10.3892/etm.2022.11735.