Prediction Model of Urosepsis in Patients after Percutaneous Nephrolithotomy and Pre- and Postoperative White Blood Cell Ratio to Predict Urosepsis Progresses to Septic Shock

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Abstract

Background

To study the predictors of urosepsis in patients after percutaneous nephrolithotomy and progression of urosepsis to septic shock, and establish the predictive models.

Methods

A total of 1046 patients were included in the study. Univariate and multivariate logistic regression analyses were used to screen independent risk factors for urosepsis after PCNL and urosepsis progresses to septic shock. The nomogram prediction models was established according to the related independent risk factors. Areas under the receiver operating characteristic curves, calibration plots, and decision curve analysis (DCA) were used to estimate the discrimination, calibration and clinical usefulness of the prediction model, respectively.

Results

Urosepsis occurred in 86 patients, and 24 of these patients developed septic shock. Multivariate logistic regression analyses showed the independent risk factors for urosepsis after PCNL were diabetes, positive urine nitrite levels, staghorn calculi, HU of hydronephrosis >6.0 , AGR <1.705 , and hs-CRP/Alb >0.065 . The pre- and postoperative WBC ratios were independent risk factors for the progression of urosepsis to septic shock. The AUC value for predicting urosepsis risk was 0.891 and that for predicting septic shock risk was 0.982. The P values of the calibration test in the urosepsis cohort and septic shock cohort were 0.946 and 0.714, respectively. DCA of the model in the urosepsis cohort and septic shock cohort showed threshold probabilities of 10–90%.

Conclusion

The individualized nomogram prediction models can help improve the early identification of patients who are at higher risk of developing urosepsis after PCNL and progression of urosepsis to septic shock, to avoid further damage.

Background

Percutaneous nephrolithotomy(PCNL) is the primary treatment for renal and upper ureteral stones > 2 cm [1]. PCNL is associated with a high rate of stone clearance, but it is important to consider potential postoperative complications[2]. Urosepsis is the most common of these complications[3]. Despite the administration of prophylactic antibiotic treatments before PCNL, the incidence of postoperative sepsis remains high[4]. Although the incidence of severe sepsis and sepsis-induced septic shock is low (0.3%-4.7%), the mortality rate of septic shock is as high as 50%[5]. Therefore, a predictive model that can very effectively predict urosepsis and septic shock development needs to be established.

Some previous studies have summarized the risk factors for urosepsis after PCNL[6]. However, most of these studies focused on urinary diseases, such as stone characteristics, anatomical abnormalities, or urinary tract infections. The patient's general condition is also an important indicator for evaluating postoperative infection. Low albumin levels can predict infectious complications after oncologic surgery[7]. High globulin concentrations and high-sensitivity C-reactive protein indicate a recent response to defend against infection. The albumin-globulin ratio (AGR) and high-sensitivity C-reactive protein/albumin ratio (hs-CRP/Alb) are effective predictors of postoperative urosepsis[8–10].

The pre- and postoperative WBC ratios are instructive for predicting septic shock [11, 12], At present, there are three criteria for the prediction of septic shock development after PCNL, namely, SOFA, SIRS, and qSOFA; qSOFA has the advantages of being fast and simple but also has the disadvantage of having low sensitivity[13]. Therefore, we combined the pre- and postoperative WBC ratios and qSOFA scores to predict septic shock after PCNL.

At present, there is no model to predict septic shock onset after PCNL. In this study, a two-step approach was used to predict urosepsis and septic shock onset. First, a model to predict postoperative urosepsis was established by studying preoperative risk factors in patients. When a patient had a high probability of developing urosepsis, the pre- and postoperative WBC ratio of the patient was further measured. Thus, we predicted the likelihood of the progression of urosepsis to septic shock.

Methods

Participants

A total of 1046 adult patients with PCNL were selected for the study. All the patients were recruited from the First Hospital of Hebei Medical University from June 2016 to October 2021, and their complete datasets were retrospectively analyzed. The inclusion criteria included the following: 1. patients who were older than 18 years of age; 2. patients who underwent PCNL surgery in our hospital and were followed up; and 3. patients with complete clinical data. The exclusion criteria were as follows: 1. patients with stage 2 or higher PCNL; 2. patients with horseshoe kidney, who underwent repeat kidney surgeries, and who underwent renal transplantation; and 3. patients on immunosuppressive drugs.

The patient assessments included a physical examination, medical history, and routine preoperative examination. All the patients underwent a preoperative CT examination of the urinary tract to determine the position and size of the calculi to help determine the puncture route. Patients with positive preoperative urine cultures were treated with antibiotics according to the results of the urine culture until a negative urine culture was achieved. All the patients were routinely treated with antibiotics during the induction of anesthesia and after surgery. Patients without urosepsis received antibiotics after surgery until routine urine reexamination results were normal, and urosepsis patients were treated with antibiotics after surgery until routine blood tests, routine urine tests and C-reactive protein levels were normal.

PCNL Procedures

All patients underwent PCNL in the Department of Urology of our hospital. After general anesthesia was administered, a patient was placed in the lithotomy position, and the surgical area was routinely disinfected. A transurethral ureteroscope was placed, along with an indwelling ureteral catheter, which was connected with saline to create artificial hydronephrosis. The ureteral catheter was attached to an 18F three-cavity catheter.

The patient was placed in the prone position with the waist propped up. Under the guidance of B-ultrasound, the renal pelvis was punctured with a 17.5G puncture needle. After clear urine was observed in the puncture needle, a guide wire was placed, and fascial dilators of 10F, 12F, 14F, 16F and 18F were used to gradually expand the puncture channel along the guide wire. An 8/9.8F ureteroscope was inserted along the sheath to identify the calculi. If the stone volume was large, the puncture channel was expanded to 24F. A 0.9% NaCl infusion was applied at a flow rate of 20-300 ml/min during the operation, and holmium YAG laser or ultrasound lithotripsy was performed. Fragments of the stones were extracted or flushed out. When no significant bleeding or residual stones were detected, the ureteral catheter was withdrawn, a 6F double J tube was inserted through the nephrostomy, and a 14F nephrostomy tube was indwelled. If urosepsis did not appear postoperatively, the nephrostomy tube was routinely removed 2–4 days after surgery. If the patient developed urosepsis after surgery, the nephrostomy tube was not removed until the patient's infection was under control.

Routine blood examination was performed 2 hours after the surgery. Heart rate, blood pressure, respiratory rate, body temperature, and the Glasgow Coma Scale (GCS) were measured 2 hours after the operation. Stone fragments obtained during the operation were analyzed to determine stone composition, and the results were obtained within 1-2 days postoperatively.

Definition Of Urosepsis And Septic Shock

Urosepsis was defined as a bodily infection that met two or more of the quick Sepsis-related Organ Failure Assessment (qSOFA) criteria required to diagnose urosepsis [14]: systolic blood pressure < 100 mmHg, highest respiratory rate > 22 bpm, and lowest Glasgow coma score < 15. This diagnosis referred to the consensus of sepsis-3.0.

Septic shock was defined as the need for vasopressors to maintain a mean arterial blood pressure greater than 65 mmHg and a suspected urinary tract infection [15]. The observed hypotension could not have any other possible causes, for example, anesthesia-related hypotension. If these criteria were met, the patients were considered “septic shock patients”. Otherwise, the patients were considered “normal patients”.

Statistical analysis

SPSS 24.0 and R software 3.6.3 were used for all the statistical analyses. Student's t test or the Mann–Whitney U test was used to detect differences between continuous variables. The chi-square test or Fisher's exact test was used to compare categorical variables. The initial cutoff value based on the Youden index of the receiver operating characteristic (ROC) curves showed the highest sensitivity and specificity. Univariate and multivariate regression analyses were used to determine independent risk factors for urosepsis and septic shock development. The regression coefficients were then proportionally converted to 0-100 subscales to generate the predictive nomogram. The predictive performance of the nomogram was measured by its calibration, discrimination, and clinical usefulness[16]. The Hosmer–Lemeshow (HL) test was used, and when the result was insignificant, the correction effect was good. The clinical usefulness of the nomogram was evaluated by decision curve analysis (DCA) by assessing the net benefit at different threshold probabilities. The discriminative performance was assessed by the area under the receiver operating characteristic (ROC) curve (AUC). P value < 0.05 was considered significant.

Results

The medical records of 1046 patients who underwent PCNL were retrospectively collected and analyzed. Of the 1046 included PCNL patients, 86 patients had urosepsis, and 24 of these patients developed septic shock. The demographic characteristics and clinical information of the PCNL patients are presented in Table 1. There were significant differences in the gender, diabetes status, Hounsfield unit (HU) of hydronephrosis, AGR, hs-CRP/Alb ratio, staghorn calculi, urinary white blood cell (WBC) counts, urinary nitrite levels, urinary culture results, stone composition, and pre- and postoperative WBC ratio between PCNL patients with and without urosepsis according to the univariable analysis (all $P < 0.05$). The data are shown in Table 1.

Table 1

Patients characteristics and univariate analysis of predictors for postoperative urosepsis after PCNL

	Normal patients (960)	urosepsis (86)	Septic shock(24)	OR(95% CI)	P
Gender(%)					
Male	625(65.1)	46(53.5)	10(41.7)		
Female	335(34.9)	40(46.5)	14(58.3)	1.622(1.041~2.529)	0.033
Age mean (SD)	49.06±13.88	48.91±13.91	49.42±14.65	0.999(0.983~1.015)	0.923
Diabetes(%)					
No	823(85.7)	65(75.6)	18(75)		
Yes	137(14.3)	21(24.4)	6(25)	1.941(1.149~3.278)	0.013
Hypertension(%)					
No	802(83.5)	72(83.7)	20(83.3)		
Yes	158(16.5)	14(16.3)	4(16.7)	0.987(0.543~1.794)	0.966
BMI mean (SD)	24.02±2.98	24.04±2.64	23.98±2.74	0.956(0.930~1.080)	0.956
operating time(%)					
<60.5 min	479 (49.9)	43 (50)	11 (45.8)		
>60.5 min	481(50.1)	43(50)	13 (54.2)	0.996(0.641~1.548)	0.985
HU of Hydronephrosis(%)					
<6.0	736(76.7)	44(51.2)	12(50)		
>6.0	224(23.3)	42(48.8)	12(50)	3.316(2.003~4.911)	<0.001
AGR(%)					
<1.705	305 (31.8)	78(90.7)	23(95.8)		
>1.705	655 (68.2)	8 (9.3)	1(4.2)	0.041(0.019~0.090)	<0.001
hs-CRP/Alb(%)					
<0.065	765 (79.7)	42 (48.8)	14 (58.3)		
>0.065	195 (20.3)	44 (51.2)	10(41.7)	4.110(2.618~6.453)	<0.001
Number of channels(%)					
Single	905 (94.3)	79 (91.9)	22 (91.7)		

	Normal patients (960)	urosepsis (86)	Septic shock(24)	OR(95% CI)	P
More	55 (5.7)	7 (8.1)	2 (8.3)	1.458(0.643~3.309)	0.367
Hydronephrosis(%)					0.504
Mild	184 (19.2)	11 (12.8)	1 (4.2)		0.324
Moderate	460 (47.9)	43 (50)	12 (50)	1.564(0.789~3.099)	0.200
Severe	316 (32.9)	32 (37.2)	11 (45.8)	1.694(0.834~3.441)	0.145
The stone diameter mm(%)					0.838
<18.5 mm	460 (47.9)	35(40.7)	9(37.5)		
>18.5 mm	500 (52.1)	51(59.3)	15(62.5)	1.341(0.856~2.099)	0.200
Number of calculi(%)					
Single	863 (89.9)	79 (91.9)	22 (91.7)		
Multiple	97 (10.1)	7 (8.1)	2 (8.3)	0.788(0.345~1.756)	0.561
Staghorn calculi(%)					
No	932 (97.1)	71 (82.6)	18 (75)		
Yes	28 (2.9)	15 (17.4)	6 (25)	7.032(3.591~13.769)	<0.001
Renal function(%)					
Normal	693 (72.2)	72 (83.7)	18 (75)		
Abnormal	267 (27.8)	14 (16.3)	6 (25)	0.505(0.280~0.910)	0.023
Urinary WBC(%)					
Normal	763 (79.5)	58 (67.4)	14(58.3)		
Abnormal	197 (20.5)	28 (32.6)	10(41.7)	1.870(1.160~3.014)	0.01
Urinary nitrite(%)					
Normal	813 (84.7)	61 (70.9)	16 (66.7)		
Abnormal	147 (15.3)	25 (29.1)	8 (33.3)	2.267(1.378~3.728)	0.001
Urinary culture(%)					
Normal	763 (79.5)	58 (67.4)	16 (66.7)		
Abnormal	197 (20.5)	28 (32.6)	8 (33.3)	1.870(1.160~3.014)	0.010

	Normal patients (960)	urosepsis (86)	Septic shock(24)	OR(95% CI)	P
Stone composition(%)					
No- struvite stones	847 (88.2)	57 (66.3)	16 (66.7)		
Struvite stones	113 (11.8)	29 (33.7)	8 (33.3)	3.814(2.340~6.214)	<0.001
Recent history of fever(%)					
No	824 (85.8)	71 (82.6)	18 (75)		
Yes	136 (14.2)	15 (17.4)	6 (25)	1.280(0.713~2.299)	0.409
Pre- and Postoperative WBC Ratio (%)				0.014	0.905
<1.08	500 (52.1)	25 (29.1)	0(0)		
>1.08	460 (47.9)	61 (70.9)	24(100)	2.652(1.637~4.296)	<0.001

A collinearity diagnosis was made with the above impact factors, and the VIFs of the above independent risk factors indicated that there was no multicollinearity. Since this prediction model was a preoperative prediction model, postoperative predictors were excluded, and multivariate analysis indicated that diabetes, HU of hydronephrosis>6.0, AGR<1.705, hs-CRP/Alb>0.065, staghorn calculi, and urinary nitrite positivity were independent risk factors for the development of urosepsis after PCNL. The results are shown in Table 2. Univariate and multivariate analyses indicated that the pre- and postoperative WBC ratios were different between urosepsis patients with and without septic shock (P<0.05, Table 3).

Table 2
Multivariate logistic regression of predictors for postoperative urosepsis after PCNL

factors	B	SE	OR	95% CI	P-value
Diabetes	0.835	0.322	2.306	1.227-4.334	0.009
HU of Hydronephrosis >6.0	1.092	0.273	2.980	1.747-5.085	<0.001
AGR<1.705	3.002	0.390	20.131	9.365-43.274	<0.001
hs-CRP/Alb >0.065	1.326	0.272	3.765	2.209-6.417	<0.001
Staghorn calculi	1.536	0.455	4.648	1.905-11.341	0.001
Urinary nitrite positive	1.249	0.321	3.646	1.944-6.837	<0.001

Based on these factors, we established two individualized nomograms to predict urosepsis after PCNL and the progression of urosepsis to septic shock (Fig. 1). From the nomograms, we calculated the score for each risk factor separately and added all the scores together to obtain the total score. The probability corresponding to the total score is the probability of developing urosepsis after PCNL and the progression of urosepsis to septic shock.

We drew the ROC curves of the predicted probability and calculated the AUC values in the two groups. The AUC value for predicting urosepsis risk was 0.891 and that for predicting septic shock risk was 0.982, suggesting that the nomogram has good discriminative ability (Fig. 2). The P values of the calibration test in the urosepsis cohort and septic shock cohort were 0.946 and 0.714, respectively, which showed good fitting of the model with no statistical significance in the HL test (Fig. 3). DCA of the model in the urosepsis cohort and septic shock cohort showed threshold probabilities of 10–90% (Fig. 4). The predictive model was able to identify patients at risk of developing urosepsis after PCNL and the progression of urosepsis to septic shock.

Table 3. Univariate and multivariate logistic regression of predictors for septic shock from urosepsis patients

	Univariate analysis		multivariate analysis	
	OR 95% CI	P-value	OR 95% CI	P-value
Gender Female	1.938 0.746~5.040	0.175		
Age mean (SD)	1.004 0.970~1.039	0.832		
Diabetes Yes	1.044 0.351~3.111	0.938		
Hypertension Yes	1.040 0.292~3.700	0.952		
BMI mean (SD)	0.989 0.826~1.183	0.900		
operating time >60.5 min	1.261 0.490~3.243	0.631		
HU of Hydronephrosis >6.0	1.067 0.416~2.738	0.893		
AGR <1.705	2.927 0.341~25.157	0.328		
hs-CRP/Alb >0.065	0.588 0.227~1.526	0.275		
Number of channels More	1.036 0.187~5.742	0.967		
Hydronephrosis %				
Mild		0.321		
Moderate	3.871 0.446~33.597	0.220		
Severe	5.238 0.591~46.395	0.137		
The stone diameter mm >18.5 mm	1.204 0.457~3.170	0.707		
Number of calculi Multiple	1.036 0.187~5.742	0.967		
Staghorn calculi Yes	1.963 0.613~6.282	0.256		
Renal function Abnormal	2.250 0.688~7.361	0.180		
Urinary WBC Abnormal	1.746 0.656~4.650	0.265		
Urinary nitrite Abnormal	1.324 0.479~3.655	0.589		
Urinary culture Abnormal	1.050 0.386~2.860	0.924		
Stone composition Struvite stones	0.976 0.360~2.649	0.976		
Recent history of fever Yes	1.963 0.613~6.282	0.256		
Pre- and Postoperative WBC Ratio				

<1.15		0.000		0.000
1.15-2.35	43.33 [8.437~222.57]	0.000	43.33 [8.437~222.57]	0.000
>2.35	182.0 [14.544~2277.5]	0.000	182.0 [14.544~2277.5]	0.000

Discussion

In recent years, PCNL has been widely used in the treatment of upper urinary calculi due to its high rate of removing stones [17]. However, PCNL also has some disadvantages, and infection is one of its most common complications. Urosepsis is a systemic inflammatory disease caused by the urinary system, there is no gold standard for its diagnosis at present. Sepsis-3 Task Force redefined sepsis by Sequential (Sepsis-related) Organ Failure Assessment (SOFA) score[18], but SOFA takes time to obtain laboratory test results and thus cannot diagnose sepsis early. Therefore, quick SOFA (qSOFA) was developed for early screening of patients at high risk of septic shock. The median time at which the qSOFA score met its cutoff shorter than that of the SOFA and SIRS scores [13]. Unfortunately, the performance of qSOFA in predicting sepsis onset was criticized because of the lack of essential high sensitivity [19]. In this study, the sensitivity and specificity of the qSOFA score were improved by monitoring the pre- and postoperative WBC ratios.

In this study, the preoperative predictors of urosepsis after PCNL infection included diabetes, HU of hydronephrosis>6.0, AGR<1.705, hs-CRP/Alb>0.065, staghorn calculi, and urinary nitrite positivity. Diabetes has been reported to be an independent risk factor for urosepsis, which is consistent with this study[20]. Although urine culture is the accepted gold standard for diagnosing urinary tract infections, this method takes a long time and delays treatment to some extent. Therefore, it is of great significance to accurately, quickly, and effectively screen for urinary tract infections in the early stage. Previous studies have demonstrated that urine nitrite levels play an important role in urinary tract infections and are considered an adequate tool for evaluating the probability of a urine culture being positive[21]. In a recent study, the urine nitrite model showed a better clinical net benefit than the urine culture model [22].

Some studies have shown that with increases in the size and number of stones, the probability of infection after PCNL also increases [23]. In this study, univariate and multivariate analyses indicated that the presence of a staghorn calculus was an independent risk factor for urosepsis development after PCNL. Due to the large volume of staghorn stones, the operator often continues to expand the puncture channel to 24F to expand the surgical field, resulting in greater damage to the kidney and mucosa. Surgeons often need to adjust the angle of the sheath to further remove the calculi of each calyx, which can easily cause tearing of the renal cortex, open blood vessels and increase absorption of the perfusion fluid, which leads to an increased risk of infection[24].

Increasing amounts of evidence indicate that the preoperative systemic inflammatory response is closely related to postoperative infection [8, 10]. Nutritional status is an important aspect of preoperative status,

and serum albumin concentration is an effective assessment of nutritional status. Some studies found a negative correlation between albumin concentration and postoperative infection[25]. In the early stages of infection, the AGR, which represents the nutritional state and inflammatory state, decreases due to the rapid rise in globulin concentration levels. CRP is an acute-phase reactant produced by hepatocytes, and hs-CRP is a sensitive marker of systemic low-grade inflammation. The hs-CRP/Alb ratio has been shown to be a predictor of patient prognosis[26]. Combined with recent reports and the results of this study, we believe that AGR and the hs-CRP/Alb ratio are predictors of postoperative urinary tract infection [8, 9, 20].

Pyonephrosis refers to infected hydronephrosis, and it is considered a urological emergency that can rapidly progress to urosepsis and septic shock. Therefore, rapid diagnosis and treatment of pyonephrosis are essential to prevent urosepsis. At present, some studies distinguish pyonephrosis from hydronephrosis by measuring the Hounsfield unit (HU) value of the fluid in the dilated renal collecting system[27]. The extended renal pelvis can be easily measured by HU because of routine preoperative CT examination. Some studies have proven that patients with urosepsis have a higher HU value, which is consistent with our study, so the HU value can be used as a potential predictor of urinary tract sepsis[28].

Previous studies suggested that for every hour that treatment of septic shock is delayed, death rates increase by 6%[29]. Therefore, early prediction of the progression of urosepsis to septic shock is of great significance. According to Wu's study, a decrease in white blood cell counts below $2.85 \times 10^9/L$ 2 hours after surgery is a good predictor of the development of infectious toxic shock[12]. According to Cheng's study, the white blood cell ratio performed better than absolute numbers because it eliminated the baseline variance [11]. In this study, the qSOFA score correctly identified all septic shock patients, while the positive predictive value of the qSOFA score in predicting septic shock after PCNL was only 27.9%; however, when the qSOFA score and the pre- and postoperative WBC ratios were combined, the positive prediction rate was 75%. The QSOFA results can be obtained early and quickly at the bedside, and routine blood results can be easily obtained 2 hours after surgery, so the qSOFA score combined with the pre- and postoperative WBC ratios can effectively and quickly predict the progression of urosepsis to septic shock.

The formation of struvite stones is directly related to urease-producing bacteria. During PCNL, bacteria and endotoxins in struvite stones are released into the systemic circulation, leading to postoperative infection, so in some studies, struvite is an independent risk predictor of infection-related complications in PCNL patients [30]. In this study, preoperative factors were used to predict urosepsis development, while obtaining stone composition analysis results required 1-2 days after the operation; thus, struvite was not an independent predictor. In univariate and multivariate analyses, struvite stones were not associated with the progression of urosepsis to septic shock.

This study has some limitations. First, this study was a single-center retrospective study with potential selection bias. Second, the present study did not further analyze the correlation between bacterial species and infection. Third, prospective studies with large samples are still needed to further verify the efficacy of the two prediction models.

Conclusions

Early recognition and treatment of urosepsis and septic shock is critical. We established a predictive model of the development of urosepsis after PCNL based on diabetes, HU of hydronephrosis, AGR, hs-CRP/Alb ratio, staghorn calculi, and urinary nitrite positivity. Furthermore, a new prediction model was established by combining the model mentioned above with the pre- and postoperative WBC ratios to predict the probability of the progression of urosepsis into septic shock. These two prediction models help improve the early identification and screening of high-risk patients.

Abbreviations

PCNL: Percutaneous nephrolithotomy;

Lasso Regression: least absolute shrinkage and selection operator

DCA: decision curve analysis

URS: ureteroscopy

SIRS: systemic inflammatory response syndrome

SOFA: sepsis-related organ failure assessment

qSOFA: quick sepsis-related organ failure assessment

HL: Hosmer–Lemeshow

ROC: receiver operating characteristic

CT: Computed tomography;

WBC: White blood cells;

AGR: albumin-globulin ratio

hs-CRP/Alb: high-sensitivity C-reactive protein/albumin ratio

HU: Hounsfield unit

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration

and its later amendments or comparable ethical standards. The study was approved by the ethics committee of The first hospital of Hebei Medical University.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no conflict of interest.

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Authors' contributions

XH: Protocol development, Data collection, Manuscript writing

XW: Project development, Data collection, Data analysis

HW: Data collection

HD: Data collection

SZ: Manuscript editing

LW: Data analysis

ZL: Data collection

HY: Manuscript editing

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Figures

Figure 1

Nomograms to predict urosepsis after PCNL (A) and the progression of urosepsis to septic shock(B). Total points by adding the points can predict the urosepsis and septic shock rate.

Figure 2

ROC curves for validating the discrimination power of the nomograms. (A) Predict urosepsis. (B) Predict septic shock.

Figure 3

Calibration plot for assessing internal calibration of the nomograms. (A)Predict urosepsis. (B)Predict septic shock.

Figure 4

Decision curve analysis (DCA). (A)Predict urosepsis. (B)Predict septic shock.