Development of a Nomogram That Predicts Outcomes After Radical Cystectomy for Bladder Cancer Using Data from Siriraj Hospital, Thailand

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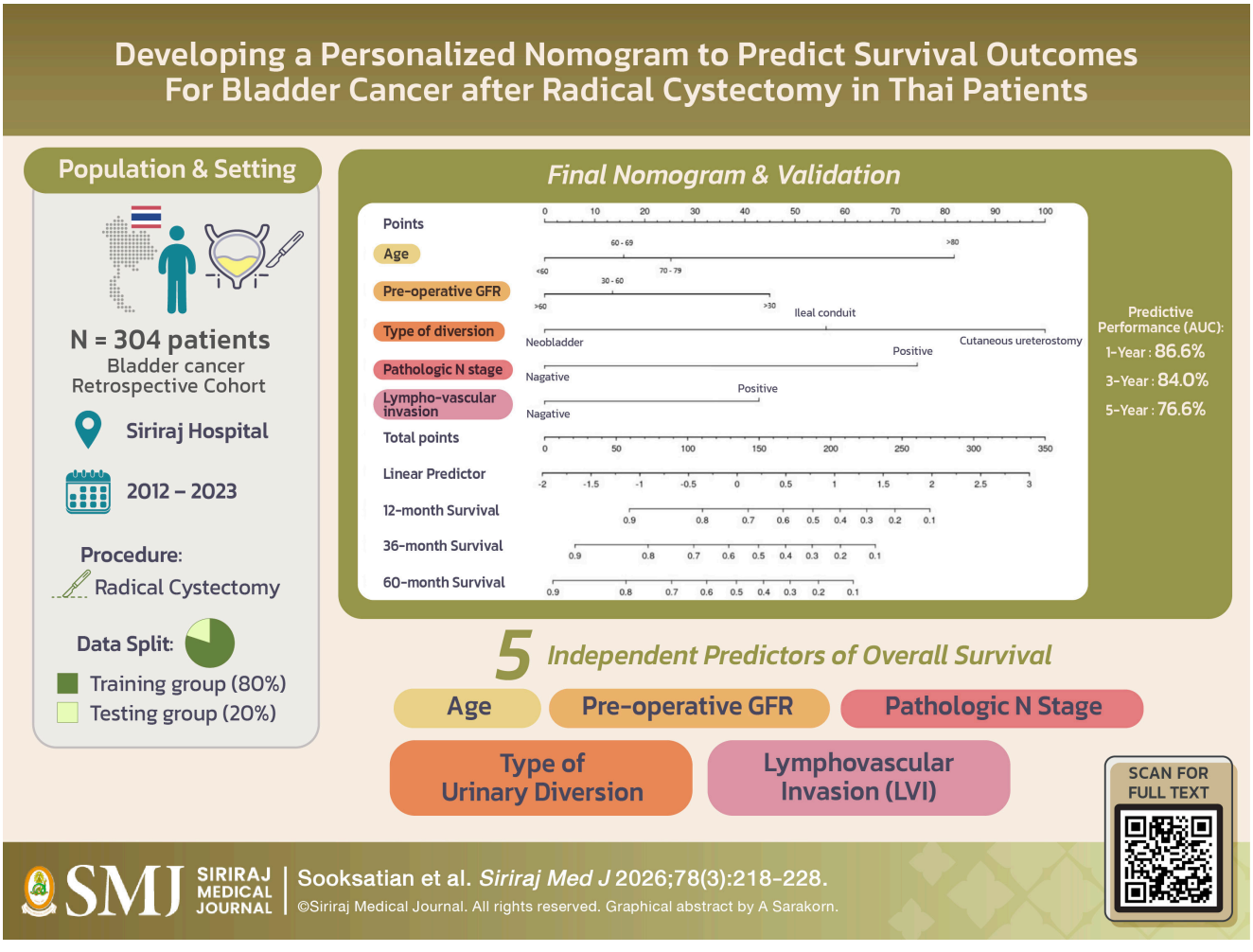

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ABSTRACT

Objective: This study aimed to develop and validate a prognostic nomogram to estimate individualized overall survival (OS) for bladder cancer patients in Thailand undergoing radical cystectomy (RC), using data from Siriraj Hospital.

Materials and Methods: We retrospectively analyzed a cohort of 304 bladder cancer patients who underwent RC at Siriraj Hospital between 2012 and 2023. The patients were randomly allocated to the training (80%) and testing (20%) cohorts. Cox regression analyses were employed to identify predictors of OS from a range of clinical, pathological, and treatment-related variables. A prognostic nomogram was subsequently constructed and its performance was validated using the concordance index and the area under the receiver operating characteristic curve (AUC).

Results: The median patient age was 68 years and the majority of patients presented with muscle-invasive disease. The median duration of follow-up was 61 months, with a median overall survival of 51 months. Multivariate analysis identified five independent predictors of OS: age, preoperative glomerular filtration rate, type of urinary diversion, pathological N stage, and presence of lymphovascular invasion. The nomogram demonstrated strong predictive performance, with AUC values of 86.6% at 12 months, 84.0% at 36 months, and 76.6% at 60 months.

Conclusion: We have developed and validated a prognostic nomogram tailored for Thai bladder cancer patients undergoing RC. This tool provides individualized survival estimates and may be a valuable aid in patient counseling, risk stratification, and formulation of postoperative management strategies. Future multicenter validation and integration of molecular markers will enhance the clinical utility of the prognostic nomogram.

Keywords: Nomogram; cystectomy; bladder cancer; prognostic; survival (Siriraj Med J 2026;78(3):218-228)

INTRODUCTION

Bladder cancer is the 12th most commonly diagnosed malignancy globally, accounting for 573,278 new cases and 212,536 deaths in 2020.[1] In Thailand, bladder cancer is among the top ten most common malignancies and ranks 9th in men. It accounts for approximately 2,700 deaths annually.[2] Approximately 20%–40% of patients are diagnosed with muscle-invasive bladder cancer (MIBC), a condition that, if left untreated, is associated with a mortality rate of up to 85% within two years.[3] Radical cystectomy (RC) remains the standard of care for MIBC; however, survival outcomes are heterogeneous. Reports from Europe and China indicate 5-year survival rates after RC ranging from 54.5% to 68%[4], whereas data from Thailand suggest survival rates between 47.1% and 50%.[5,6]

In recent years, the field of uro-oncology has witnessed an increasing emphasis on personalized medicine, with nomograms emerging as practical instruments for individualized risk prediction. Nomograms integrate multiple clinical and pathological parameters to generate patient-specific prognostic probabilities, thereby supporting shared decision-making between clinicians and their patients. Several studies have demonstrated that predictive models that incorporate demographic, pathological, and treatment variables can improve the accuracy of survival estimation following RC. Nevertheless, such models have been developed largely using data from Western populations, and their applicability to Southeast Asian cohorts remains uncertain.[7-11] At Siriraj Hospital, continuous clinical research on bladder cancer and radical cystectomy has been conducted over many years, resulting in the systematic collection of comprehensive clinical, pathological, and treatment-related data.[12-14] This study was conducted to identify relevant prognostic factors and to construct a nomogram to predict overall survival (OS) in Thai bladder cancer patients following RC.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of the Siriraj Hospital Faculty of Medicine (SIRB) (COA no. Si 192/2024). The study was a single-center retrospective analysis of patients with bladder cancer aged ≥18 years who underwent radical cystectomy at the Division of Urology, Department of Surgery, Siriraj Hospital, between January 1, 2012 and December 31, 2023. Patients were excluded if they had incomplete medical records, metastatic bladder cancer, a concurrent malignancy, or had undergone palliative surgery or non-standard treatments such as alternative medicine. The variables analyzed were selected based on their clinical relevance and availability within the dataset. These variables encompassed demographic and clinical information, pathological tumor characteristics, surgical details and perioperative treatments. The factors were chosen and synthesized from published studies to ensure the inclusion of all potential variables that might influence survival outcomes.[15-23] Collectively, these variables provide a

comprehensive overview of the patients' clinical, surgical and oncological profiles. OS was defined as the time from the date of radical cystectomy to death from any cause. Patients who were alive at the time of last follow-up or had incomplete follow-up were not excluded; instead, they were censored at the date of last known follow-up. Survival outcomes were estimated using the Kaplan-Meier method. Prognostic factors for OS were identified using univariate and multivariate Cox proportional hazard models. Subsequently, a prognostic nomogram was developed based on the independent predictors identified in the multivariate analysis. The model's validation was performed using the concordance index (C-index) and the area under the receiver operating characteristic curve (AUC) at 12, 36 and 60 months. All statistical analysed were conducted using SPSS software (version 21.0; IBM Corp., Armonk, NY, USA) and R program (version 4.3.3).

RESULTS

Patient characteristics

A total of 304 patients were included in the final analysis. The median age was 68 years and the cohort was predominantly male. Most of the patients presented with muscle-invasive disease and the predominant surgical approach was open radical cystectomy with ileal conduit diversion. A minority of patients received neoadjuvant chemotherapy. The patient cohort was randomly divided into a training set (n=242, 80%) for model development and a testing set (n=62, 20%) for validation (Fig 1). There were no statistically significant differences in baseline characteristics, including age, disease stage and treatment patterns, between the two cohorts (all P-values > 0.05), confirming the appropriateness of the randomization.

Baseline demographic, preoperative, surgical and oncological characteristics indicated that the majority of patients were older adults, predominantly male, with a median age approaching 70 years. Parameters such as renal function, body mass index and American Society of Anesthesiologists Physical Status (ASA) Classification System were comparable between the groups. A small proportion of patients received neoadjuvant chemotherapy. The majority of the patients underwent open radical cystectomy, with ileal conduit being the most common form of urinary diversion, followed by neobladder and other types. Most of the patients had muscle-invasive disease at the time of surgery and a subset had nodal involvement or lymphovascular invasion (LVI). Overall, no significant differences were observed between the training and testing cohorts, which supports the validity of the random allocation (Table 1 and Table 2). The median follow-up time for this study was 61 months, and the median OS was 51 months.

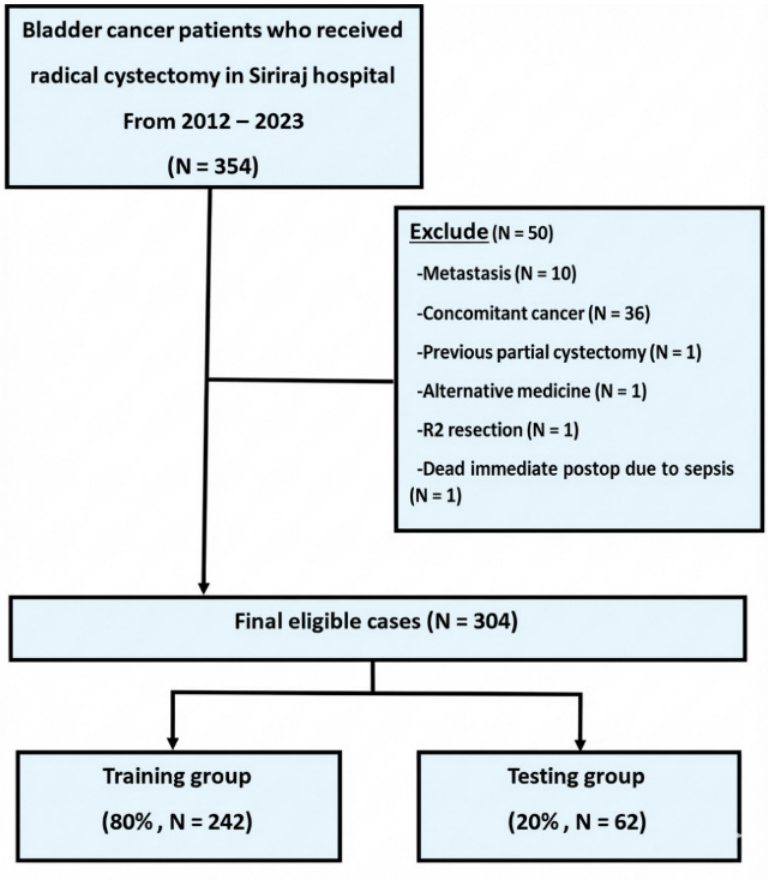

Fig 1. Flow diagram for filtering and selecting patient records from the Siriraj database.

TABLE 1. Demographic and preoperative data.

	Total data	Training data (N = 242)	Testing data (N = 62)	P-value
Age (Years)	67.5±14.0	68±14.0	66.5±12.8	0.482
Age group, n (%)				
<60	63(20.7)	53(21.9)	10(16.1)	0.103
60-69	112(36.8)	81(33.5)	31(50.0)	
70-79	97(31.9)	80(33.1)	17(27.4)	
>80	32(10.5)	28(11.6)	4(6.5)	
Sex, n (%)				0.303
Male	240(78.9)	194(80.2)	46(74.2)	
Female	64(21.1)	48(19.8)	16(25.8)	
BMI	23.4±6.0	23.6±6.1	22.4±5.3	0.076
BMI, n (%)				
<18.5	28(9.2)	22(9.1)	6(9.7)	0.515
18.5-25	174(57.2)	135(55.8)	39(62.9)	
>25	102(33.6)	85(35.1)	17(27.4)	
ASA classification, n (%)				0.954
1	57(18.8)	45(18.6)	12(19.4)	
2	167(54.9)	134(55.4)	33(53.2)	
>=3	80(26.3)	63(26.0)	17(27.4)	
Pre-operative GFR	57.1±32.0	59.0±30.0	49.5±33.3	0.050
Pre-operative GFR, n (%)				
>60	135(44.4)	114(47.1)	21(33.9)	0.169
30-60	134(44.1)	102(42.1)	32(51.6)	
<30	80(26.3)	26(10.7)	9(14.5)	
Pre-operative Hydronephrosis, n (%)				0.170
No	156(51.3)	129(53.3)	27(43.5)	
Yes	148(48.7)	113(46.7)	35(56.5)	
Primary tumor size, n (%)				0.010
<4cm	118(38.8)	104(43.0)	14(22.6)	
>=4cm	132(43.4)	97(40.1)	35(56.5)	
Unknown	54(17.8)	41(16.9)	13(21.0)	
Tumor number, n (%)				0.588
Solitary	176(58.3)	143(59.6)	33(53.2)	
Multiple	105(34.5)	80(33.3)	25(40.3)	
Diffuse	21(6.9)	17(7.1)	4(6.5)	
Tumor morphology, n (%)				0.897
Papillary	160(52.6)	129(53.3)	31(50.0)	
Sessile	93(30.6)	73(30.2)	20(32.3)	
Flat lesion	51(16.8)	40(16.5)	11(17.7)	
Primary tumor location, n (%)				
Trigone	55(18.3)	37(15.5)	18(29.0)	0.014
Dome	73(24.3)	56(23.4)	17(27.4)	0.514
Lateral wall	195(64.8)	156(65.3)	39(62.9)	0.870
Anterior wall	81(26.9)	60(25.1)	21(33.9)	0.165
Posterior wall	147(48.8)	116(48.5)	31(50.0)	0.837
Bladder neck	58(19.3)	42(17.6)	16(25.8)	0.143
Time Diagnosis to surgery	91±118.0	91±117.0	90+119.0	0.661
Time Diagnosis to surgery, n (%)				
<=90 day	150(50)	119(50)	31(50.0)	1.000
>90	150(50)	119(50)	31(50.0)	
Clinical T stage, n (%)				0.713
Localized disease (stage <=2)	115(37.8)	92(38)	22(35.5)	
Locally advanced disease (stage>3)	190(62.5)	150(62)	40(64.5)	

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists Physical Status (ASA) Classification System; GFR, glomerular filtration rate;

TABLE 2. Surgical and Oncological data.

	Total data (N = 304)	Training data (N = 242)	Testing data (N = 62)	P-value
Surgical approach, n (%)				0.901
Open	241 (79.3)	193 (79.8)	48 (77.4)	
Laparoscopic	24 (7.9)	19 (7.9)	5 (8.1)	
Robotic assisted	39 (12.8)	30(12.4)	9 (14.5)	
Type of diversion, n (%)				0.574
Ileal conduit	252 (82.9)	198 (81.8)	54 (87.1)	
Neobladder	29 (9.5)	24 (9.9)	5 (8.1)	
Ureterostomy	23 (7.6)	20 (8.3)	3 (4.8)	
Histology, n (%)				0.202
Urothelial carcinoma	289 (95.1)	232 (95.9)	57 (91.9)	
Non-urothelial carcinoma	15 (4.9)	10 (4.1)	5 (8.1)	
Pathologic T stage, n (%)				0.448
T0	12 (3.9)	11 (4.5)	1 (1.6)	
T1	24 (7.9)	17 (7.0)	7 (11.3)	
T2	93 (30.6)	78 (32.2)	15 (24.2)	
T3	115 (37.8)	90 (37.2)	25 (40.3)	
T4	60 (19.7)	46 (19)	14 (22.6)	
N stage, n (%)				0.190
N0	195 (64.1)	156 (64.5)	39 (62.9)	
N1	45 (14.8)	40 (16.5)	5 (8.1)	
N2	50 (16.4)	36 (14.9)	14 (22.6)	
N3	11 (3.6)	10 (4.1)	4 (6.5)	
Lymphovascular invasion, n (%)				0.739
No	161 (52.7)	127 (52.5)	34 (54.8)	
Yes	143 (47.0)	115 (47.5)	28 (45.2)	
Margin positive, n (%)				0.820
No	242 (79.6)	192 (79.3)	50 (80.6)	
Yes	62 (20.4)	50 (20.7)	12 (19.4)	
Carcinoma in situ, n (%)				0.325
No	252 (82.9)	198 (81.8)	54 (87.1)	
Yes	52 (17.1)	44 (18.2)	8 (12.9)	
Chemotherapy				
Pre-operative	90 (29.6)	76 (31.4)	14 (22.6)	0.174
Post-operative	46 (15.2)	38 (15.8)	8 (12.9)	0.575
Radiation therapy, n (%)				
Pre-operative	1 (0.3)	1 (0.4)	0 (0)	1.000
Post-operative	12 (4.0)	11 (4.6)	1 (1.6)	0.471

Identification of prognostic factors

Univariate analysis was performed on 21 potential prognostic factors. Of these, 11 were significantly associated with OS at a significance threshold of $P < 0.15$. These factors included age, body mass index (BMI), preoperative glomerular filtration rate (GFR), presence of hydronephrosis, tumor location, surgical approach, type of urinary diversion, pathological T and N stage, LVI, and margin status (Table 3). Subsequent multivariate Cox regression analysis identified five independent predictors of OS: age, preoperative GFR, type of urinary diversion, pathologic N stage, and LVI (Table 4).

TABLE 3. Predictive factors of 5-year overall survival.

Factor	Univariate analysis Unadjusted HR (95%CI)			P-value
Age				
<60	Reference			
60-69	1.043	0.632	1.720	0.870
70-79	1.207	0.734	1.985	0.459
>80	2.195	1.222	3.942	0.009
Sex				
Male	Reference			
Female	0.892	0.567	1.404	0.622
BMI				
<18.5	Reference			
18.5-25	0.759	0.427	1.351	0.349
>25	0.607	0.330	1.118	0.109
ASA				
1	Reference			
2	1.361	0.835	2.217	0.217
>=3	1.478	0.849	2.573	0.167
Pre-operative GFR				
>60	Reference			
30-60	1.651	1.119	2.436	0.012
<30	2.495	1.476	4.216	0.001
Pre-operative hydronephrosis				
No	Reference			
Yes	1.348	0.948	1.918	0.097
Primary tumor size				
<4cm	Reference			
>=4cm	0.992	0.671	1.466	0.966
Unknown	0.936	0.571	1.533	0.793
Tumor number				
Solitary	Reference			
Multiple	1.200	0.824	1.749	0.341
Diffuse	1.101	0.529	2.293	0.797
Tumor morphology				
Papillary	Reference			
Sessile	0.934	0.625	1.397	0.741
Flat lesion	0.782	0.473	1.294	0.339
Primary tumor location				
Trigone	1.345	0.855	2.117	0.200
Dome	1.035	0.686	1.564	0.869
Lateral wall	1.193	0.810	1.756	0.372
Bilateral lateral wall	1.234	0.661	2.304	0.509
Anterior wall	1.126	0.757	1.673	0.558
Posterior wall	1.183	0.830	1.685	0.353
Bladder neck	1.394	0.897	2.165	0.140

TABLE 3. Predictive factors of 5-year overall survival. (Continue)

Factor	Univariable analysis Unadjusted HR (95%CI)			P-value
Time Diagnosis to surgery				
<=90 day	Reference			
>90	0.988	0.687	1.422	0.949
Surgical approach				
Open	Reference			
Laparoscopic	1.007	0.540	1.880	0.982
Robotic assisted	0.371	0.163	0.845	0.018
Type of diversion				
Ileal conduit	Reference			
Neobladder	0.339	0.138	0.833	0.018
Ureterostomy	2.426	1.408	4.181	0.001
Histology				
Urothelial carcinoma	Reference			
Non-urothelial carcinoma	0.620	0.229	1.680	0.347
Pathologic T stage				
T0	Reference			
T1	4.330	0.541	34.630	0.167
T2	2.974	0.404	21.910	0.285
T3	7.644	1.058	55.250	0.044
T4	8.765	1.197	64.200	0.033
N stage				
N0	Reference			
N positive	3.553	2.483	5.084	<0.001
Lymphovascular invasion				
No	Reference			
Yes	2.656	1.846	3.821	<0.001
Margin positive				
No	Reference			
Yes	1.687	1.131	2.514	0.010
Carcinoma in situ				
No	Reference			
Yes	1.093	0.699	1.710	0.695
Chemotherapy				
Pre-operative	0.769	0.507	1.167	0.216
Post-operative	0.799	0.490	1.303	0.368
Radiation therapy				
Pre-operative	0.000	0.000	0.000	0.995
Post-operative	1.201	0.586	2.461	0.617

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists Physical Status (ASA) Classification System; GFR, glomerular filtration rate;

TABLE 4. Predictive factors of 5-year overall survival.

Factor	Univariable analysis Unadjusted HR (95%CI)			P-value	Multivariable analysis Adjusted HR (95%CI)			P-value
Age								
<60	Reference							
60-69	1.043	0.632	1.720	0.870	1.26	0.76	2.10	0.375
70-79	1.207	0.734	1.985	0.459	1.45	0.86	2.44	0.164
>80	2.195	1.222	3.942	0.009	3.33	1.75	6.34	0.000
BMI								
<18.5	Reference							
18.5-25	0.759	0.427	1.351	0.349				
>25	0.607	0.330	1.118	0.109				
Pre-operative GFR								
>60	Reference							
30-60	1.651	1.119	2.436	0.012	1.220	0.807	1.845	0.346
<30	2.495	1.476	4.216	0.001	1.935	1.093	3.428	0.024
Pre-operative hydronephrosis								
No	Reference							
Yes	1.348	0.948	1.918	0.097				
Primary tumor location								
Bladder neck	1.394	0.897	2.165	0.140				
Surgical approach								
Open	Reference							
Laparoscopic	1.007	0.540	1.880	0.982				
Robotic assisted	0.371	0.163	0.845	0.018				
Type of diversion								
Ileal conduit	Reference							
Neobladder	0.339	0.138	0.833	0.018	0.44	0.18	1.09	0.076
Ureterostomy	2.426	1.408	4.181	0.001	1.90	1.07	3.39	0.029
Pathologic T stage								
T0	Reference							
T1	4.330	0.541	34.630	0.167				
T2	2.974	0.404	21.910	0.285				
T3	7.644	1.058	55.250	0.044				
T4	8.765	1.197	64.200	0.033				
N stage								
N0	Reference							
N positive	3.553	2.483	5.084	<0.000	2.98	1.96	4.54	<0.001
Lymphovascular invasion								
No	Reference							
Yes	2.656	1.846	3.821	<0.000	1.88	1.22	2.89	0.004
Margin positive								
No	Reference							
Yes	1.687	1.131	2.514	0.010				

Abbreviations: BMI, body mass index; GFR, glomerular filtration rate;

Development and validation of a prognostic nomogram

A nomogram was constructed incorporating the five independent prognostic factors. This nomogram uses a point-based scoring system to estimate the 1-, 3-, and 5-year OS probabilities for individual patients (Fig 2). The predictive accuracy of the nomogram was confirmed through C-index and ROC analysis. The model demonstrated a high discriminatory power, with AUC values of 86.61% (95% CI 77.2–96.0) at 12 months, 83.97% (95% CI 73.0–94.9) at 36 months, and 76.56% (95% CI 62.0–91.1) at 60 months (Fig 3).

DISCUSSION

This study represents the first initiative to develop a prognostic nomogram specifically for bladder cancer patients undergoing RC in Thailand. The model identified age, preoperative GFR, type of urinary diversion, lymph node involvement (N stage) and LVI as key independent prognostic factors. These findings are consistent with the results of earlier studies conducted in Western and Asian populations. It should be noted that pathological T stage including subgroup analysis comparing pT0–2 versus pT3–4 did not retain its significance in the final multivariate model, an observation likely attributable to the multicollinearity with N stage and LVI, both of which more directly reflect tumor aggressiveness and the potential for systemic dissemination.

Each variable included in the final model has previously been established as a powerful prognostic marker in bladder cancer. Age is a known independent factor associated with both cancer-specific and all-cause mortality, as older patients typically present with more comorbidities and reduced physiological reserve.[7] N stage remains one of the most consistent predictors of a poor

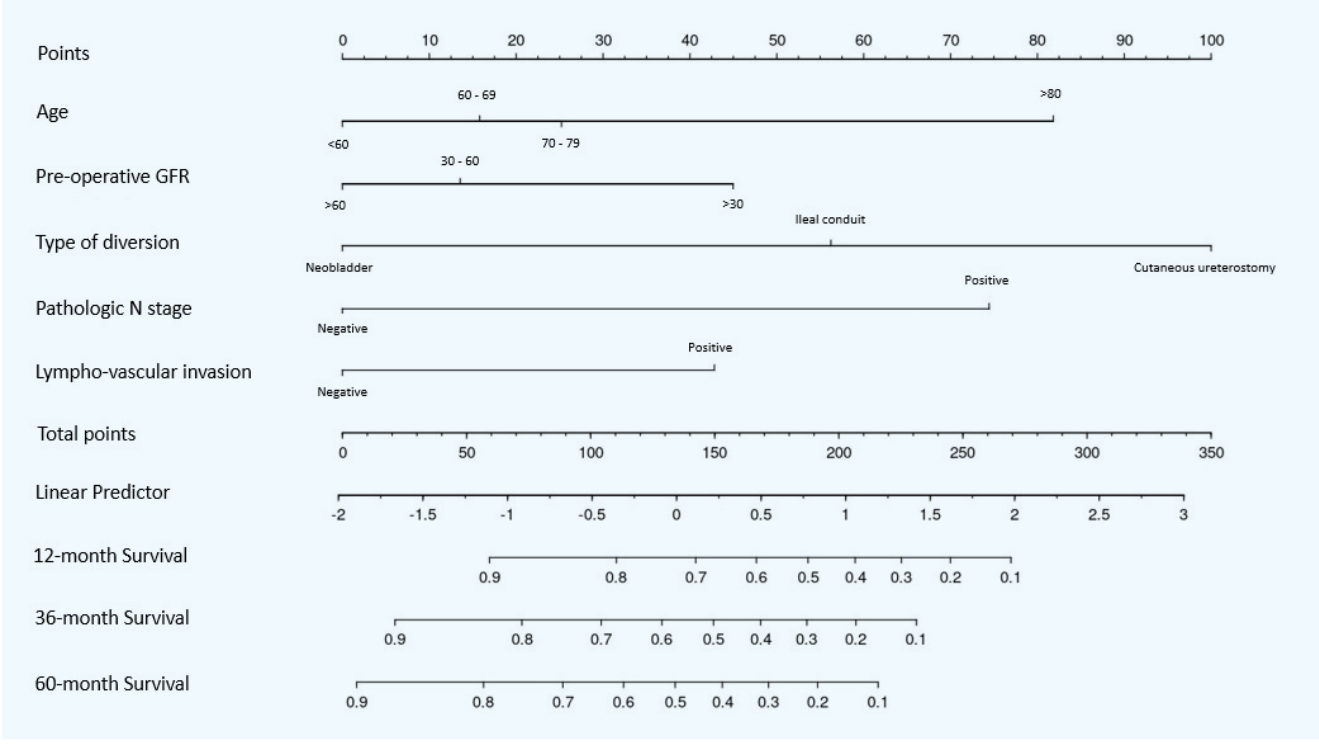

Fig 2. Nomogram predicting overall survival probability of 1- 3- and 5-years after radical cystectomy. Variables include Age, Pre-operative glomerular filtration rate (GFR), Type of diversion, Pathologic N stage, and Lympho-vascular invasion.

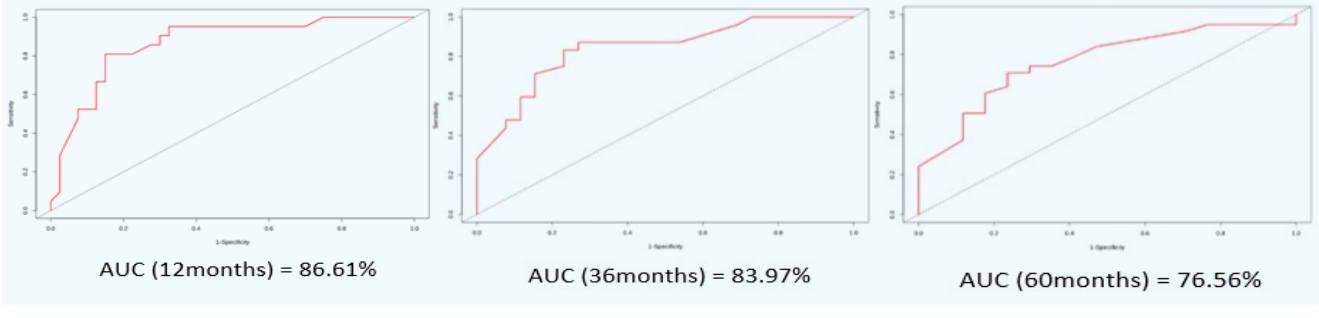

Fig 3. Validation of the nomogram.

prognosis, given that nodal metastasis is indicative of systemic spread and necessitates aggressive multimodal therapy.[11] A reduced preoperative GFR not only restricts eligibility for cisplatin-based chemotherapy but also serves as an indicator of overall health status, which can impact long-term outcomes.[17] Furthermore, LVI is a well-established marker of aggressive tumor biology and metastatic potential.[21] The type of diversion is a significant factor in this study. Patients undergoing neobladder reconstruction typically have fewer comorbidities and a better baseline functional status compared to those receiving other types of diversion, which may contribute to better survival outcomes. However, we still included this factor in the development of the nomogram because the type of diversion is an important postoperative factor applicable to every patient after radical cystectomy.[8]

Neoadjuvant chemotherapy (NAC), despite being recommended by international guidelines for muscle-invasive bladder cancer, was not a significant predictor in our model. This finding is in alignment with a large SEER cohort study of T2-4N0-3M0 MIBC, in which, after the inverse probability of treatment weighting, NAC did not confer a statistically significant OS advantage over adjuvant chemotherapy. However, subgroup analysis revealed that in patients without lymph node involvement (N0), NAC was associated with superior OS and cancer-specific survival compared to adjuvant chemotherapy, suggesting that nodal status may mediate the benefit of NAC in MIBC. The lack of significance in our cohort may be due to selection bias, as patients receiving NAC often present with more advanced disease or worse baseline characteristics, potentially offsetting the therapeutic benefit. Additionally, variability in chemotherapy regimens, incomplete treatment courses, and the absence of a centralized response evaluation may dilute the observed impact. Immune checkpoint inhibitors were not included in the present analysis, as their use was limited to the most recent 2–3 years and involved a very small number of patients, precluding meaningful statistical analysis.

In our cohort, the low uptake of NAC and inconsistencies in treatment documentation could further diminish statistical power. Moreover, our study did not include data on pathologic downstaging post-NAC, which is a critical intermediate endpoint correlated with long-term benefit.[24] Consequently, the non-significance of NAC in this study does not imply a lack of benefit, but rather highlights the challenges of capturing its value in retrospective, real-world datasets.

The nomogram developed in this study provides a clinically practical tool for individualized risk prediction. It enables clinicians to estimate OS at multiple time points, thereby enhancing prognostic counseling, tailoring surveillance strategies, and informing treatment planning. Patients identified as high-risk by the model may be considered for more intensive follow-up or additional therapeutic interventions.

Several limitations of this study should be acknowledged. The retrospective single-center design limits the generalizability of the findings, and the presence of missing data could have influenced variable selection and statistical significance. Certain potentially relevant prognostic factors, such as smoking status, nutritional parameters and molecular or genetic markers, were not available for analysis. Furthermore, the study lacks external validation in an independent cohort. The relatively small number of patients who received NAC may also have limited the statistical power to detect a survival benefit associated with this treatment.

In practical application, this nomogram can be implemented as a web-based or electronic medical record-integrated tool, allowing clinicians to input patient-specific variables to generate immediate survival estimates. This can help guide patient counseling and facilitate risk-adapted follow-up protocols, ultimately contributing to improved patient outcomes and more efficient resource allocation.

CONCLUSION

We have successfully developed and validated a nomogram that predicts OS in bladder cancer patients following RC at Siriraj Hospital. This model provides clinicians with an individualized prediction tool tailored to the Thai population, which can assist in shared decision-making and postoperative planning. Future research should focus on prospective multicenter validation and the integration of molecular biomarkers to strengthen the reliability and clinical utility of the model.

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DECLARATIONS

Grants and Funding Information

None.

Conflict of Interest

All authors declare no personal or professional conflicts of interest, and no financial support from the companies that produce and/or distribute the drug, devices, or materials described in this report.

Registration Number of Clinical Trial

None.

Author Contributions

Conceptualization and methodology: K.S., T.T., T.H.; Investigation: K.S., V.W.; Formal analysis: K.S., K.J., P.R.; Visualization and writing—original draft: K.S., T.T.; Writing-review and editing: T.T., E.C., S.J.; Supervision: T.T.

Ethical Approval Statement

This study was approved by the Institutional Review Board of the Siriraj Hospital Faculty of Medicine (SIRB) (COA no. Si 192/2024).

Use of Artificial Intelligence

No artificial intelligence tools or technologies were used in the writing and analysis.

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