ANTICANCER RESEARCH *38*: 3097-3103 (2018)
doi:10.21873/anticanres.12568

A Genitourinary Cancer-specific Scoring System for the Prediction of Survival in Patients with Bone Metastasis: A Retrospective Analysis of Prostate Cancer, Renal Cell Carcinoma, and Urothelial Carcinoma

TAKUYA OWARI, MAKITO MIYAKE, YASUSHI NAKAI, YOSUKE MORIZAWA, SHUNTA HORI, SATOSHI ANAI, NOBUMICHI TANAKA and KIYOHIDE FUJIMOTO

Department of Urology, Nara Medical University, Kashihara, Japan

Abstract. *Aim: The aim of this study was to develop a risk scoring system specific to patients with bone metastasis of genitourinary cancer. Materials and Methods: This study included 180 patients with bone metastasis of three major types of genitourinary cancer: prostate cancer (n=111), renal cell carcinoma (n=43,), and urothelial carcinoma (n=26). Clinical factors at diagnosis of bone metastasis were evaluated to identify independent prognostic factors. Results: Multivariate analysis showed that type of primary cancer, poor performance status, the presence of visceral metastases, high Glasgow prognostic score and elevated neutrophil-to-lymphocyte ratio were independently predictive of poor prognosis. Patients were able to be classified by the prognostic risk score into four prognostic groups with low, intermediate, high, and very high risk. Conclusion: This risk scoring system could be useful for predicting survival of patients with bone metastasis of genitourinary cancer and in making decisions on appropriate treatments for them.*

The bones are a major metastatic site of genitourinary cancer, especially in prostate cancer (PCa), with 84.4-91.1% of patients with metastatic PCa having bone metastases (1-2). Similarly, rates of bone metastases in patients with metastatic renal cell carcinoma (RCC) and urothelial carcinoma (UC) of the bladder have been reported to be 29.5% (3) and 15.8-24.7% (4, 5), respectively. Although radiotherapy is the main treatment of choice for patients with bone metastasis, surgical intervention is an alternative option in selected patients. Palliative radiotherapy is effective for relieving pain and improving quality of life. Recommended dosing schedules include a single 8 Gy dose, 20 Gy in five fractions, 24 Gy in six fractions and 30 Gy in 10 fractions (6). Re-irradiation rates have been reported to be higher in patients receiving a single 8 Gy dose than in those receiving 20 Gy in five fractions (7), suggesting that a longer course of radiotherapy may be beneficial for patients with longer expected survival.

Surgical intervention is indicated for patients with intense bone pain, pathological fracture, and neurological symptoms making them unsuitable for radiotherapy as well as in patients who develop metastatic spinal cord compression. Moreover, aggressive surgery, such as resection of metastatic lesions, has been recommended for patients with longer expected survival. Accurately predicting the prognosis of patients with bone metastasis is therefore essential for determining appropriate treatment.

Several prognostic risk scoring systems for patients with bone metastasis have been developed. These include prognostic scoring systems for patients undergoing surgery (8-10) or radiotherapy (11) for bone metastasis. However, because these studies may have actually excluded patients who underwent radiotherapy or surgery, they may have introduced selection biases. A more recently developed scoring system was based on an analysis of patients with newly developed bone metastasis, regardless of treatment (12).

Another drawback of these earlier scoring systems was that these studies included a relatively small proportion of patients with genitourinary cancer, ranging from 11-30% (8-12). To our knowledge, no prognostic scoring system for patients with genitourinary cancer has yet been developed. In order to develop a more accurate and clinically fitted prognostic scoring system specific to genitourinary cancer with bone metastasis, this retrospective analysis evaluated prognostic risk factors in a cohort of these patients.

Correspondence to: Makito Miyake MD, Ph.D., Department of Urology, Nara Medical University, 840 Shijo-cho, Kashihara-shi, Nara 634-8522, Japan. Tel: +81 744223051, Fax: +81 744257657, e-mail: makitomiyake@yahoo.co.jp

Key Words: Bone metastasis, genitourinary cancer, prognostic factor, scoring system, predicting survival.

Table I. *Patient characteristics of 180 patients with bone metastasis from genitourinary cancer.*

Variable	Value	Primary cancer			*p*-Value
		PCa	RCC	UC	
Total	180 (100%)	111 (62%)	43 (24%)	26 (14%)	-
Age at bone metastasis, years					
Mean±SD	69.5±9.9	71.5±8.2	65.6±12.1	65.8±9.9	<0.001
Gender, n (%)					
Male	168 (93%)	111 (100%)	36 (84%)	21 (81%)	0.93†
Female	12 (6.8%)	0 (0%)	7 (16%)	5 (19%)	
ECOG-PS, n (%)					
0 or 1	132 (73%)	91 (82%)	27 (63%)	14 (54%)	0.66†
2	32 (18%)	14 (8%)	10 (23%)	8 (31%)	
3 or 4	16 (9%)	6 (3%)	6 (14%)	4 (15%)	
Visceral metastases, n (%)					
No	119 (66%)	95 (86%)	16 (37%)	8 (31%)	<0.001†
Yes	61 (34%)	16 (14%)	27 (63%)	18 (69%)	
Multiple bone metastases, n (%)					
No	31 (17%)	15 (14%)	8 (19%)	8 (31%)	0.73†
Yes	149 (83%)	96 (86%)	35 (81%)	18 (69%)	
Extra-spinal bone metastases, n (%)					
No	26 (14%)	10 (9%)	7 (16%)	9 (35%)	0.8†
Yes	154 (86%)	101 (91%)	36 (84%)	17 (65%)	
GPS, n (%)					
0	118 (66%)	82 (74%)	25 (58%)	11 (42%)	0.78†
1	45 (25%)	26 (23%)	9 (21%)	10 (38%)	
2	17 (9%)	3 (3%)	9 (21%)	5 (19%)	
Baseline Hb, ng/dl					
Mean±SD	12.4±2.0	13.0±1.8	11.9±2.2	11.0±1.6	<0.001‡
Baseline ALP, U/l					
Mean±SD	491.7±530.7	572.7±172.9	342.0±174.0	395.0±364.3	0.032‡
Baseline Ca, mg/dl					
Mean±SD	9.4±0.86	9.26±0.75	9.63±1.06	9.59±0.89	0.025‡
Baseline NLR					
Mean±SD	3.7±4.2	3.1±2.3	4.0±2.1	5.8±8.7	0.007‡
NLR, n (%)					
Normal	92 (51%)	63 (57%)	20 (47%)	9 (35%)	0.067†
Elevated	88 (49%)	48 (43%)	23 (53%)	17 (65%)	
BMA, n (%)					
No	18 (10%)	4 (4%)	8 (19%)	6 (23%)	0.93†
Yes	162 (90%)	107 (96%)	35 (81%)	20 (77%)	
RT for bone metastases, n (%)					
No	123 (68%)	93 (84%)	16 (37%)	14 (54%)	0.61†
Yes	57 (32%)	18 (16%)	27 (63%)	12 (46%)	
Surgery for bone metastases, n (%)					
No	159 (88%)	105 (94%)	28 (65%)	26 (100%)	0.08†
Yes	21 (12%)	6 (6%)	15 (35%)	0 (0%)	

PCa, Prostate cancer; RCC, renal cell carcinoma; UC, urothelial carcinoma; ECOG-PS, Eastern Cooperative Oncology Group Performance Status; GPS, Glasgow Prognostic Score; Hb, hemoglobin; ALP, alkaline phosphatase; Ca, calcium; NLR, neutrophil-to-lymphocyte ratio; BMA, bone-modifying agent; RT: radiotherapy. †Kruskal–Wallis test; ‡two-way ANOVA.

Materials and Methods

Collection of data of patients with bone metastasis. The protocol of this retrospective study was approved by the Institutional Review Board of Nara Medical University, which waived the requirement for informed consent because of the retrospective nature of this study (reference no. 1594). Clinical data were collected on 180 patients with PCa, RCC, and UC with bone metastasis, diagnosed at our Institution between January 2007 and December 2016. Of these 180 patients, 111 (62%) had PCa, 43 (24%) had RCC, and 26 (14%) had UC, including 13 (7%) with bladder cancer and 13 (7%) with upper tract UC. Clinical characteristics obtained from medical

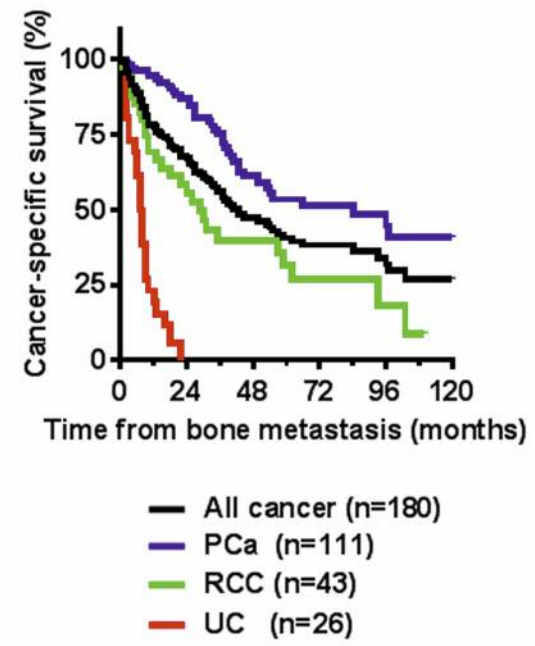

Figure 1. *Kaplan–Meier curves for cancer-specific survival in all study patients with genitourinary cancer and bone metastasis, and according to cancer type. PCa: Prostate cancer; RCC: renaI cell carcinoma; UC: urothelial carcinoma.*

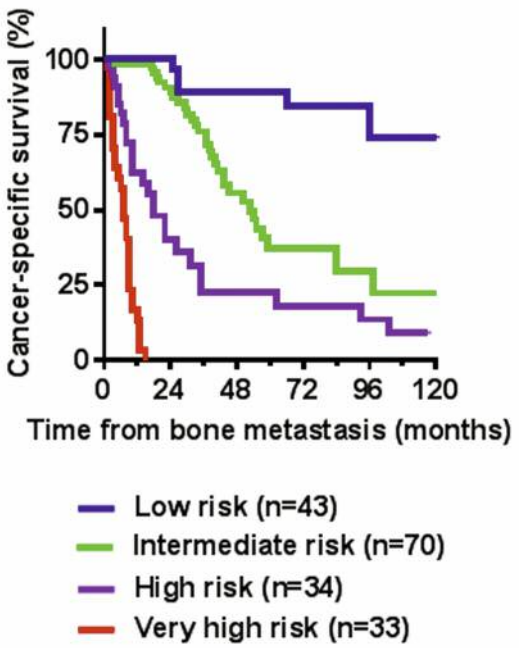

Figure 2. *Kaplan–Meier curves for cancer-specific survival for the four prognostic risk groups according to Fujimoto-Owari-Miyake bone score. Low risk: Score 0, intermediate risk: score 1-2, high risk: score 3-4, and very high risk: score ≥5.*

records included patient age at diagnosis of bone metastasis; sex; Eastern Cooperative Oncology Group Performance Status (ECOG-PS); the presence of visceral metastases; multiplicity of bone metastasis sites; the presence of extraspinal bone metastases; baseline serum hemoglobin (Hb) level; serum alkaline phosphatase (ALP) and serum calcium (Ca) concentrations; Glasgow prognostic score (GPS); neutrophil-to-lymphocyte ratio (NLR); treatment for bone metastasis; and cancer-specific survival (CSS). Types of treatment, including surgical intervention, radiotherapy or use of bone-modifying agents (BMA: zoledronic acid or denosumab), were at the discretion of each attending physician.

Prognostic risk factors. The prognostic factors potentially associated with survival were analyzed. These included type of primary cancer, age at diagnosis of bone metastasis, ECOG-PS, the presence of visceral metastases, multiplicity of bone metastatic sites, the presence of extra-spinal bone metastases, laboratory data at diagnosis of bone metastasis and BMA use. GPS and NLR were obtained from laboratory data. GPS was defined as described elsewhere (13). Briefly, patients with an elevated C-reactive protein (CRP) concentration (>1.0 mg/dl) or hypoalbuminemia (<3.5 g/dl) were classified as having a GPS of 1; those with both these were classified as having a GPS of 2; and those with neither of these abnormalities were classified as having a GPS of 0. NLR is considered a marker of systemic inflammation and has been shown to predict survival of patients with metastatic PCa (14), metastatic RCC (15) and metastatic UC (16), as well as other cancer types. As described elsewhere (15, 16), the cut-off level for the NLR was set at 3.0.

Develop of the scoring system: Fujimoto–Owari–Miyake bone score (B–FOM score). The score allocated to each significant prognostic factor was derived from regression coefficients. Prognostic factors with regression coefficients ≤1 were allocated 1 point; factors with regression coefficients >1 and ≤2 were allocated 2 points; and prognostic factors with regression coefficients >2 were allocated 3 points. The sum of points for all prognostic factors was defined as the prognostic, or B–FOM, score.

Statistical analysis. The primary end-point was CSS, measured in months from the diagnosis of bone metastasis to the date of death or last follow up. The baseline tumor characteristics at the diagnosis of bone metastasis were compared using the Kruskal–Wallis test or two-way ANOVA test. CSS curves were plotted using the Kaplan–Meier method and compared with the log-rank test. Univariate and multivariate Cox proportional hazards regression analyses were used to identify independent prognostic risk factors associated with CSS. Value of $p<0.05$ were considered statistically significant. Statistical analyses were performed using SPSS for Windows (version 20.0; IBM, Armonk, NY, USA) or GraphPad Prism 7.00 (GraphPad Software, San Diego, CA, USA).

Results

Patient characteristics. The clinical characteristics of the 180 patients with bone metastasis from genitourinary cancer are outlined in Table I. The mean age at diagnosis of bone metastasis was significantly higher in patients with PCa than

Table II. *Analyses of clinical variables predicting cancer-specific survival.*

	Univariate			Multivariate†		
Variable	HR	95% CI	*p*-Value	HR	95% CI	*p*-Value
Primary cancer						
PCa	1					
RCC	2.5	1.41-4.55	<0.001	1.8	1.00-3.11	0.049
UC	9.9	3.55-27.5	<0.001	9.3	4.51-18.9	<0.001
Age at bone metastasis						
Per year	1.04	0.51-1.03	0.73			
ECOG-PS						
0 or 1	1			1		
2	4.3	2.08-8.9	<0.001	4.4	2.53-7.68	<0.001
3 or 4	6.9	1.72-27.5	<0.001	3.5	1.64-7.42	0.001
Visceral metastases						
No	1			1		
Yes	3.9	2.39-6.34	<0.001	2.7	1.58-4.50	<0.001
Multiple bone metastases						
No	1					
Yes	0.9	0.51-1.7	0.81			
Extra-spinal bone metastases						
No	1					
Yes	0.7	0.4-1.3	0.208			
GPS						
0	1			1		
1	2.7	1.56-4.8	<0.001	1.8	1.04-2.99	0.036
2	5.5	1.6-19.1	<0.001	3.5	1.68-7.40	0.001
NLR						
Normal	1			1		
Elevated	2	1.32-3.0	<0.001	1.6	1.01-2.47	0.044
BMA						
Yes	1			1		
No	3.2	1.2-8.5	<0.001	1.04	0.51-2.11	0.917

Pca, Prostate cancer; RCC, renal cell carcinoma; UC, urothelial carcinoma; HR, hazard ratio; 95% CI, 95% confidence interval; ECOG-PS, Eastern Cooperative Oncology Group Performance Status; GPS, Glasgow Prognostic Score; NLR, neutrophil-to-lymphocyte ratio; BMA, bone-modifying agents. †Cox regression analysis.

in patients with RCC and UC ($p<0.001$). Visceral metastases were significantly less common in patients with PCa than in patients with RCC and UC ($p<0.001$). Baseline NLR was significantly higher in patients with UC than in patients with PCa and RCC ($p=0.007$), but there was no significant difference in GPS among these three groups, suggesting that higher NLR in patients with UC reflects a greater degree of cancer-associated systemic inflammation in these patients. Baseline ALP was significantly higher in patients with PCa than in those with RCC and UC ($p=0.032$). Fifteen (35%) patients with RCC underwent surgery, compared to none of the patients with UC.

CSS rate and prognostic factors. For patients overall, the median CSS was 41 months. The CSS rates in patients with PCa, RCC, and UC were 96%, 85% and 69%, respectively, at 6 months; 94%, 69%, and 19%, respectively, at 12 months; and 87%, 56%, and 0%, respectively, at 24 months (Figure 1). In order to assess factors prognostic of CSS in patients with genitourinary cancer with bone metastasis, we carried out univariate and multivariate analyses (Table II). Univariate analysis of prognostic factors showed that primary cancer type, ECOG-PS, the presence of visceral metastases, high GPS, and elevated NLR were significantly correlated with poor prognosis. In multivariate analysis, primary cancer type, ECOG-PS, the presence of visceral metastases, high GPS and elevated NLR were significant independent prognostic factors. Compared with patients with PCa, those with UC had the highest hazard ratio (HR) (*vs.* PCa, HR=9.25, 95% CI=4.51-18.9, $p<0.001$), with RCC also being independently prognostic or CSS (HR=1.76, 95% CI=1.00-3.11, $p=0.049$). ECOG PS also had high HRs (0 or 1 *vs.* 2, HR=4.41, 95% CI=4.51-18.9, $p<0.001$; and 0 or 1 *vs.* 3 or 4, HR=3.49, 95% CI=1.64-7.42, $p=0.001$). The HR

Table III. *Fujimoto-Owari-Miyake bone (B-FOM) score allocated to each significant prognostic factor.*

Prognostic factor	Regression coefficient	Score
Primary cancer		
PCa	-	0
RCC	0.6	1
UC	2.2	3
ECOG-PS		
0 or 1	-	0
2	1.5	2
3 or 4	1.3	2
Visceral metastasis		
No	-	0
Yes	1	1
GPS		
0	-	0
1	0.6	1
2	1.3	2
NLR		
Normal	-	0
Elevated	0.5	1
Total		
-	-	9

Pca, Prostate cancer; RCC, renal cell carcinoma; UC, urothelial carcinoma; ECOG-PS, Eastern Cooperative Oncology Group Performance Status; GPS, Glasgow Prognostic Score; NLR, neutrophil-to-lymphocyte ratio; BMA, bone-modifying agent.

for GPS 2 was significantly higher than that for GPS 3 (HR=3.53, 95% CI=1.68-7.40, p=0.001). The HRs for the other significant prognostic factors were less than 3.

Survival rate of patients by B-FOM score and prognostic risk groups. The B–FOM score for each patient was calculated as the sum of five scores representing significant prognostic factors and ranged from 0 to 9 (Table III). The 24-month CSS rates in patients with B-FOM scores of 0, 1 or 2, 3 or 4, and 5 were 100%, >80%, <50%, and 0%, respectively (Table IV).

The patients were classified into four prognostic risk groups according to B-FOM score (Table V). Kaplan–Meier survival curves for the four risk groups after diagnosis of bone metastasis are shown in Figure 2, with significant differences observed among the four groups (log-rank test: p<0.001). The median CSS was not reached in the low-risk group, but was 18 months in the high-risk group and 7 months in the very high-risk group (Table V).

Discussion

Bone metastasis, which can give rise to bone pain, pathological fracture, and paralysis, can reduce activities of daily living and quality of life. Accurate prediction of the prognosis of patients with bone metastasis is essential in determining appropriate treatment. Multivariate analysis showed that the type of primary cancer (UC *vs*. PCa and RCC *vs*. PCa); ECOG-PS; the presence of visceral metastases; NLR and GPS, systemic markers of inflammation; and hypoalbuminemia, a systemic marker of malnutrition, were independent predictors of CSS. Based on these five factors, we developed a genitourinary cancer-specific risk scoring system predictive of CSS in patients with genitourinary cancer and bone metastasis.

Several other risk scoring systems have been developed to predict survival of patients with bone metastasis. Two of these scoring systems analyzed patients who had undergone only surgical intervention for bone metastases (9, 10), whereas the third scoring system was found to be predictive of survival in 342 patients who had undergone radiotherapy alone (11). Because 32% of our patients were treated with radiotherapy and only 12% with surgery, these scoring systems may have had selection bias and may not be representative of all patients with bone metastasis. In addition, the proportions of patients in these studies with genitourinary cancer were relatively low. To our knowledge, the prognostic scoring system we developed is the first to exclusively evaluate patients with bone metastasis of three major genitourinary cancer type.

Type of primary cancer was the strongest predictor of CSS (8-12), although in most previous studies, UC was not categorized into prognostic risk groups. Bladder cancer has the poorest prognosis, but was given maximal weight only in the revised Tokuhashi score (17). In the present study, UC had the highest HR (9.25 *vs*. PCa, p<0.001) and was, therefore, given maximal weight in our scoring system. ECOG-PS has been shown to be an independent prognostic risk factor in patients with advanced cancer (18), with high PS significantly and independently associated with shorter term survival of patients with bone metastasis (8, 11, 12, 18). Similarly, in our study, poor ECOG-PS, defined as ECOG-PS of 2 or more was significantly predictive of poor prognosis.

Although some laboratory parameters have been found to predict survival in patients with various malignancies, most previous prognostic scoring systems for patients with bone metastasis have not included laboratory data. Cancer-associated inflammation has been associated with poor prognosis in patients with various malignancies. Elevated NLR, an indicator of inflammation, was found to be associated with poor prognosis in patients with metastatic PCa (14), metastatic RCC (15), muscle-invasive bladder cancer after cystectomy (19), and metastatic UC (16), as well as other cancer types. We found that an elevated NLR, defined as 3.0 or more (15, 16), was associated with poor CSS in patients with genitourinary cancer and bone metastasis. We also tested the prognostic significance of GPS, which is based on serum concentration of CRP, a

Table IV. *Cancer-specific survival (CSS) for 180 patients stratified by the Fujimoto-Owari-Miyake bone (B-FOM) score.*

B-FOM score	No. of patients	Median CSS (months)	Survival rate			
			6 Months	12 Months	24 Months	60 Months
0	43	-	100%	100%	100%	85%
1	42	53	97%	97%	89%	35%
2	28	57	100%	100%	87%	37%
3	22	22	86%	58%	42%	27%
4	12	18	72%	64%	24%	0%
5	14	9	71%	15%	0%	0%
6	9	7	50%	16%	0%	0%
7	4	3	10%	0%	0%	0%
≥8	4	4	33%	0%	0%	0%
Total patients	180	43	89%	78%	67%	40%

Table V. *Cancer-specific survival (CSS) for 180 patients according to prognostic risk group defined by the Fujimoto-Owari-Miyake bone (B-FOM) score*

Risk group	B-FOM score	No. of patients	Median CSS (months)	Survival rate			
				6 Months	12 Months	24 Months	60 Months
Low	0	43	-	100%	100%	100%	85%
Intermediate	1,2	70	53	98%	98%	89%	37%
High	3,4	34	18	81%	60%	38%	19%
Very high	≥5	33	7	57%	14%	0%	0%
Total		180	43	89%	78%	67%	40%

marker of inflammation, and hypoalbuminemia, an index of malnutrition. Higher GPS was found to be associated with poor survival in patients with advanced cancer (13, 20). Similarly, our results showed that GPS was a significant risk factor, with GPS 2 being especially strongly related to survival of patients with bone metastasis of genitourinary cancer (HR=3.53, 95% CI=1.68-7.40, p=0.001).

A scoring system for specific cancer types should be precise. Scoring systems for a combination of several types of cancer are less useful, as the nature and treatment of each cancer type are different (21, 22). Our scoring system for genitourinary cancer with bone metastasis allocated points based on patient survival rates. In addition, most scoring systems for bone metastases were developed by orthopedic surgeons (8-10, 12) or radiation oncologists (11). Our results confirm that the B–FOM score, developed by urological oncologists, may be applicable in clinical practice and is a useful tool for urological oncologists, radiation oncologists and orthopedic surgeons for estimating patient life expectancy.

Patients classified into the intermediate-risk group based on B–FOM score had an expected 24-month survival rate of 89%. In contrast, patients in the very high-risk group were not expected to survive to 24 months. Patients with a long life expectancy according to this scoring system and who experience prolonged progressive neurological symptoms, indicative of an inadequate response to radiotherapy, may be candidates for surgical intervention (23-25). In contrast, less invasive treatment, such as hypofractionated palliative radiotherapy, should be considered for patients classified as being at very high risk.

This study had several limitations. Firstly, it was a retrospective study conducted at a single institution and included patients with bone metastases from several types of genitourinary cancer. A second limitation was that treatment for bone metastases was not consistent at our Institution and was not randomized. In addition, the proportion of patients who underwent surgical treatment was relatively small (12%), making it difficult to determine the optimal treatment strategy for bone metastases. Further validation, including a larger number of patients, with more who underwent surgical treatment or radiotherapy, is needed to confirm the accuracy of our scoring system.

In conclusion, the B–FOM score may be useful in predicting life expectancy and in selecting the most appropriate treatment for patients with bone metastasis of three major types of genitourinary cancer.

References

1 Gandaglia G, Abdollah F, Schiffmann J, Trudeau V, Shariat SF, Kim SP, Perrotte P, Montorsi P, Montorsi P, Briganti A, Trinh QD, Karakiewics PI and Sun M: Distribution of metastatic site in patients with prostate cancer: A population-based analysis. Prostate *74(2)*: 210-216, 2014.

2 Bubendorf L, Schopfer A, Wagner U, Sauter G, Moch H, Willi N, Gasser TC and Mihatsch MJ: Metastatic pattern of prostate cancer: An autopsy study of 1589 patients. Hum Pathol *31(5)*: 578-583, 2000.

3 Bianich M, Sun M, Karakiewicz PI, Shariat SF, Trudeau V, Briganti A, Tian Z, Graefen M, Shmitges J, Perrotte P, Menon M, Montorsi P and Karakiewics PI,: Distribution of metastatic sites in renal cell carcinoma: a population-based analysis. Ann Oncol *23(4)*: 973-980, 2012.

4 Nakagawa T, Hara T, Kawahara T, Ogata Y, Nakanishi H, Komiyama M, Arai E, Kanai Y and Fujimoto H: Prognostic risk stratification of patients with urothelial carcinoma of the bladder with recurrence after radical cystectomy. J Urol *189(4)*: 1275-1281, 2013.

5 Bianichi M, Roghmann F, Becker A, Sukumar S, Briganti A, Menon M, Karakiewics PI, Sun M and Trinh QD: Age-stratified distribution of metastatic sites in bladder cancer: a population-based analysis. Can Urol Assoc J *8(3-4)*: E148-158, 2014.

6 Lutz S, Balboni T, Jones J, Lo S, Pettit J, Rich SE, Wong R and Hahn C: Palliative radiation therapy for bone metastases: Update of an ASTRO evidence-Based Guideline. Pract Radiat Oncol *7(1)*: 4-12, 2017.

7 Roos DE, Turner SL, Smith JG, Spry NA, Burmeister BH, Hoskin PJ and Ball DL: Randomized trial of 8Gy in 1 *versus* 20Gy in 5 fractions of radiotherapy for neuropathic pain due to bone metastases (Trans-Tasman Radiation Oncology Group, TROG96.05). Radiother Oncol *75(1)*: 54-63, 2005.

8 Tokuhashi Y, Matsuzaki H, Toriyama S, Kawano H and Ohsaka S: Scoring system for the preoperative evaluation of metastatic spine tumor prognostic. Spine *15(11)*: 1110-1113, 1990.

9 Bauer HC and Wedin R: Survival after surgery for spinal and extremity metastases. Acta Orthop Scand *66(2)*: 143-146, 1995.

10 Tomita K, Kawahara N, Kobayashi T, Yoshida A, Murakami H and Akamaru T: Surgical strategy for spinal metastases. Spine *26(3)*: 298-306, 2001.

11 Van der Linden YM, Dijjksta SP, Vonk EJ, Marijnen CA and Leer JW: Prediction of survival in patients with metastases in the spinal column: results based on a randomized trial of radiotherapy. Cancer *103(2)*: 320-328, 2005.

12 Katagiri H, Okada R, Takagi T, Takahashi M, Murata H, Harada H, Nishimura T, Asakaru H and Ogawa H: New prognostic factors and scoring system for patients with skeletal metastasis. Cancer Med *3(5)*: 1359-67, 2014.

13 Tomita M, Ayabe T, Chosa E and Nakamura K: Prognostic significance of pre- and postoperative Glasgow prognostic score for patients with non-small cell lung cancer. Anticancer Res *34(6)*: 3137-3140, 2014.

14 Kawahara T, Yokomizo Y, Ito Y, Ito H, Ishiguro H, Teranishi J, Makiyama K, Miyoshi Y, Miyamoto H, Yao M and Uemura H: Pretreatment neutrophil-to-lymphocyte ratio predicts the prognosis in patients with metastatic prostate cancer. BMC Cancer *16*: 111, 2016.

15 Santoni M, Giorgi UD, Lacovelli R, Conti A, Burattini L, Rossi L, Luca Burgio S, Berardi S, Muzzoniguro G, Cortesi D, Amadorl D and Cascinu S: Pre-treatment neutrophil-to-lymphocyte ratio may be associated with outcome in patients treated with everolims for metastatic renal cell carcinoma. Br J Cancer *109(7)*: 1755-1759, 2013.

16 Su YL, Hsieh MC, Chiang PH, Sung MT, Lun L, Luo HL, Huang CC, Huang CH, Tang Y and Rau KM: Novel inflammation-based prognostic score for predicting survival in patients with metastatic urothelial carcinoma. PLOS one *12(1)*: e0169657, 2017.

17 Tokuhashi Y, Matsuzaki H, Oda H, Ohshima M and Ryu J: A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis. Spine *30(19)*: 2186-2191, 2005.

18 Laird BJ, Kaasa S, McMillan DC, Fallon MT, Hjemstad MJ, Fayers P and Klepstad P: Prognostic factors in patients with advanced cancer: A comparison of clinicopathological factors and the development of an inflammation-based prognostic system. Clin Cancer Res *19(19)*: 5456-5464, 2013.

19 Morizawa Y, Miyake M, Shimada K, Hori S Tatsumi Y, Nakai Y, Anai S, Tanaka N, Konishi N and Fujimoto K: Neutrophil-to-lymphocyte ratio as a detection marker of tumor recurrence in patients with muscle-invasive bladder cancer after radical cystectomy. Urol Oncol *34(6)*: e11-17, 2016.

20 Miyake M, Morizawa Y, Hori S, Marugami N, Iida K, Onishi K, Gotoh D, Tatsumi Y, Nakai Y, Anai Y, Torimoto K, Tanaka N, Shimada K, Konishi N and Fujimoto K: Integrative assessment of pretreatment inflammation-, nutrition-, and muscle-based prognostic markers in patients with muscle invasive bladder cancer undergoing radical cystectomy. Oncology *93(4)*: 259-269, 2017.

21 Crnlic S, Lofvenberg R, Bergh A, Widmark A and Hildingsson C: Predicting survival for surgery of metastatic spinal cord compression in prostate cancer. Spine *37(26)*: 2168-2176, 2012.

22 Tokuhashi Y, Uei H, Oshima M and Ajiro Y: Scoring system for prediction of metastatic spine tumor prognosis. World J Orthop *5(3)*: 262-271, 2014.

23 Patchell RA, Tibbs PA, Regine WF, Payne R, Saris S, Kryscio RJ, Mohiuddin M and Young B: Direct decompressive surgical resection in the treatment spinal cord compression caused by metastatic cancer: a randomized trial. Lancet *366(9486)*: 643-648, 2005.

24 Verlann JJ, Choi D, Versteeg A, Albert T, Arts M, Bunger C, Chung CK, Coppes CK, Crockard HA, Haropp J, Kawahara N, Kim ES, Lee Y, Liu Z, Massicotte EM, Mayer B, Peul W, Tokuhashi Y, Tomita K, Wang M and Oner FC: Characteristic of patients who survived <3 months or >2 years after surgery spinal metastases: Can we avoid inappropriste patient selection ?. J Clin Oncol *34(25)*: 3054-3061, 2016.

25 Williams BJ, Benjamin D, Sciubba DM, Suki D, Tu SM, Kuban D, Gokaslan ZL, Rhines LD and Rao G: Surgical management of prostate cancer metastatic to spine. J Neurosurg Spine *10(5)*: 414-422, 2009.

Received February 24, 2018
Revised March 29, 2018
Accepted April 2, 2018