

A Novel Scoring System to Predict the Risk for Disseminated Intravascular Coagulation in Obstructive Pyelonephritis Complicated with Upper Urinary Tract Calculi

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Abstract

Background: The present study tried to establish a scoring system to predict the development of disseminated intravascular coagulation (DIC) in obstructive pyelonephritis complicated with upper urinary tract calculi.

Methods: We retrospectively reviewed 103 patients who were hospitalized in our institution between 2007 and 2013. All patients were divided into two groups: patients with DIC (severe group) and those without DIC (non-severe group). Background characteristics were analyzed to determine predictive factors.

Results: Patients were 27–91 years (mean, 64.8 years) and included 22 men and 81 women. DIC was observed in 14 (13.6%) cases. Comparison of background data between both groups demonstrated that older age, poor performance status (PS), septic shock, and no history of urinary stones were risk factors for the development of DIC. Hence, these four clinical factors became the H.A.P.S. scoring system (range, 0–4) predictive for the development of DIC. One point was scored for each factor: no history (H), age ≥ 70 years (A), PS ≥ 3 (P), and septic shock (S). Patients with a H.A.P.S. score ≥ 3 were statistically more likely to develop DIC than those with scores of 0–2. The sensitivity and specificity of the H.A.P.S. score were 92.9% [95% confidence interval (CI): 72.0%–98.7%] and 89.9% (95% CI: 86.6–90.8%), respectively, and its diagnostic odds ratio was 115.6 (95% CI: 16.6–753.8).

Conclusion: The H.A.P.S. scoring system is a useful tool for predicting the development of DIC in patients with obstructive pyelonephritis complicated with urinary calculi.

Keywords: Obstructive pyelonephritis; Disseminated intravascular coagulation; Upper urinary calculi; Predictive factors

Introduction

Acute obstructive pyelonephritis with upper urinary tract calculi is an emergent urinary tract infection. It progresses easily to urosepsis and may result in severe clinical conditions, such as septic shock and disseminated intravascular coagulopathy (DIC) [1,2]. In particular, DIC has been shown to be a strong predictor of multiple organ dysfunction and mortality in critically ill patients, and its mortality rate is reported to be 70% without adequate management and treatment [3,4]. Indeed, in patients with sepsis and DIC, mortality is almost two times higher than that in patients who do not have DIC. Furthermore, a Japanese large-scale multi center study including 1,363 patients from 208 hospitals demonstrated that DIC occurred in 12% of all cases. DIC was one of the predictive risk factors for death among patients with obstructive pyelonephritis [2]. Therefore, it is important that patients with obstructive pyelonephritis be immediately treated to prevent the development of DIC.

In addition to wide-spectrum antimicrobial treatment, a prompt decompression of hydronephrosis, such as percutaneous nephrostomy or ureteral stenting, is often required to prevent the worsening of pyelonephritis [2,5]. For the application of earlier and adequate

management of patients with obstructive pyelonephritis, we must be aware of the earlier identification of patients at high risk. However, the literature has minimal information on risk factors for the progression of DIC in patients with obstructive pyelonephritis complicated with upper urinary tract calculi. We assessed the risks in the present study and tried to establish a scoring system predictive for the development of DIC.

Patients and Methods

Participants

We retrospectively reviewed the records of 103 patients who were hospitalized in our institution with obstructive pyelonephritis complicated with upper urinary tract calculi between 2007 and 2016. A diagnosis of acute pyelonephritis was made based on the following criteria: the presence of more than five white blood cells/high-power field in a centrifuged urinary specimen, bacteriuria of more than 10⁴ colony-forming units/ml in urine bacterial culture, and any specific symptoms related to pyelonephritis. In addition, hydronephrosis with upper urinary calculi was confirmed by radiological imaging findings. At the initial visit, all patients underwent a physical examination and blood biochemical analysis to judge the severity of the disease. Septic shock was defined as the presence of sepsis plus the following criteria:

systolic blood pressure (SBP) < 90 mm Hg or an SBP drop from the normal condition of ≥ 40 mm Hg despite adequate volume resuscitation, based on the Japanese guidelines for the management of sepsis [6]. DIC was diagnosed based on the total from DIC scores for four categories [systemic inflammatory response syndrome (SIRS), platelets, prothrombin time ratio, and fibrinogen degradation product] of the Japanese Association for Acute Medicine DIC criteria [7].

Before the initiation of antibiotic treatment, all microorganisms isolated from urine and/or blood cultures were tested for antibiotic susceptibility. All patients were initially administered intravenous wide-spectrum antibiotics. In addition, the decompression of hydronephrosis, such as percutaneous nephrostomy or ureteral stenting, was performed at the discretion of the attending physician.

All patients were divided into two groups: patients with DIC (severe group) and those without DIC (non-severe group), and the background characteristics were compared to determine risk factors for the incidence of DIC in patients with obstructive pyelonephritis caused by upper urinary calculi.

Statistical Analysis

Variables in the two groups were compared using the Mann-Whitney U test. Categorical data were compared using Fisher's exact test. The SPSS statistical software package (version 22.0; SPSS Inc., Chicago, IL, USA) was used for all analyses and a p value of < 0.05 was considered statistically significant. In addition, we tried to establish a scoring system to predict the development of DIC based on these analyzed data, and we calculated its sensitivity, specificity, and diagnostic odds ratio (OR).

Results

The background characteristics of eligible patients are shown in Table 1. Patients were 27–91 years (mean age, 64.8 years) and included 22 men and 81 women. At the initial visit to our hospital, 67 (65.0%) patients had SIRS.

Septic shock and DIC were observed in 14 (13.6%) and 12 (11.3%) patients, respectively. Left obstructive pyelonephritis was found in 81 patients, and right obstructive pyelonephritis was found in 22 patients. The decompression of hydronephrosis was performed in 51 (49.5%) patients.

Characteristics	Obstructive pyelonephritis n=103
Mean age \pm SD (range), years	64.8 \pm 15.4 (27–91)
Sex (male/female)	22/81
Development of DIC (%)	14 (13.6)
Development of septic shock (%)	12 (11.3)
Performance status	
≥ 3	31 (30.1)
< 2	72 (69.9)
Presence of any urinary disorders (%)	30 (29.1)
Diabetes mellitus (%)	24 (23.3)

Current use of immunosuppressive drugs (%)	5 (4.9)
Past history of urinary stone (%)	28 (27.1)
Side of obstructive pyelonephritis (left/right)	61/42
Size of causative urinary stone (mm)	8.8 \pm 4.9
Location of causative urinary stone	
U1 and U2	80 (77.7)
U3	23 (22.3)

SD: Standard Deviation; DIC: Disseminated Intravascular Coagulation

Table 1: Patient characteristics.

Comparisons of background data between the DIC and non-DIC groups demonstrated that older age, poor performance status (PS), septic shock, and no history of urinary stones were risk factors for the development of DIC (Table 2).

Characteristics	DIC group	non-DIC group	p value
	n=14	n=89	
Mean age \pm SD, years	72.9 \pm 9.4	63.5 \pm 15.7	0.021
Sex (male/female)	Jan-13	21/68	0.292
Septic shock (%)	9(64.2)	3(3.4)	<0.001
Poor performance status (more than PS 3)	12 (85.7)	19 (21.3)	<0.001
Presence of any urinary disorders (%)	2(14.3)	28 (31.5)	0.342
Diabetes mellitus (%)	3(21.4)	21 (23.6)	1
Current use of immunosuppressive drugs (%)	2(14.3)	3(3.4)	0.135
Past history of urinary stone (%)	0(0)	28(27.5)	0.01
Side of obstructive pyelonephritis (left/right)	10-Apr	51/38	0.39
Size of causative urinary stone (mm)	7.5 \pm 3.0	8.9 \pm 5.1	0.201
U3 location of causative urinary stone (%)	5(35.7)	18(20.2)	0.297

SD: Standard Deviation; DIC: Disseminated Intravascular Coagulation

Table 2: Comparisons in patients' characteristics between DIC and non-DIC groups.

These four factors were included in the scoring system called H.A.P.S. scores (0–4) showed the predictiveness for the development of DIC, including no history (H), age ≥ 70 years (A), PS ≥ 3 (P), and septic shock (S) (Table 3).

Variables	Score
H: histories of urinary stones	
No history	1
Any history	0

A: old age \geq 70 years	
Yes	1
No	0
P: performance status of \geq 3	
Yes	1
No	0
S: septic shock	
Yes	1
No	0

Table 3: H.A.P.S. scoring system.

Patients with an H.A.P.S. score \geq 3 were statistically more likely to develop DIC than those with scores of 0–2. The sensitivity and specificity of the H.A.P.S. score were 92.9% [95% confidence interval (CI): 72.0%–98.7%] and 89.9% (95% CI: 86.6%–90.8%), respectively, and its diagnostic OR was 115.6 (95% CI: 16.6–753.8).

Discussion

In the present study, we assessed the risk factors for severe disease in patients with obstructive pyelonephritis based on only the background characteristics of patients at an initial medical examination. Older age, poor PS, septic shock, and no history of urinary stones were the risk factors for the development of DIC. Previous studies determined that some blood data, such as serum albumin, C-reactive protein, procalcitonin, and platelet values, were predictive factors for severity [1,2,8-10]. However, these predictive blood laboratory signs varied widely and changed with time with the development of disease. They are likely to be significantly dependent on time from the onset of the disease. Furthermore, these data may be modified by the patient's comorbidities. Therefore, we cannot always predict the possibility of progression to a serious disease state using only laboratory data, especially in those with mild to moderate disease at the first hospital visit. On the other hand, the assessment of predictive risk based on patient background characteristics at an initial medical examination may be easy and convenient. However, currently available information has been limited.

A previous study that included 98 patients requiring emergency drainage for obstructive pyelonephritis caused by upper urinary tract calculi showed that age and the presence of paralysis were independent risk factors for septic shock [11]. Tambo et al. reported that poor PS and diabetes mellitus were significantly associated with septic shock among 45 patients who underwent emergency drainage for obstructive pyelonephritis [8]. Alternatively, poor PS, age 75 years or older, and female sex were independent risk factors for emergency drainage in 424 patients, suggesting that elderly female patients with poor PS had a potential risk for severe disease [12]. The results of our study are like those found in previous studies.

The present study revealed that one of the risk factors was no history of urinary stones, which was unique. Although the reason is unclear, patients with a history of urinary calculi visited our hospital earlier when symptoms appeared, compared to those without a history, probably because of their past experience. Alternatively, patients with a history of calculi may have received intervention before the

development of obstructive pyelonephritis. However, no data to support these hypotheses were included in the present study.

We established the H.A.P.S. score to predict the development of DIC. Significantly, patients with H.A.P.S. score \geq 3 were statistically more likely to develop DIC than those with scores of 0–2. To our knowledge, this is the first scoring system that predicts the development of DIC among patients with obstructive pyelonephritis complicated by urinary calculi. A similar scoring system (P.U.S.H. score), predictive for urosepsis in patients with complicated pyelonephritis, has been reported [13]. This previous study demonstrated that poorer PS, the presence of ureteral stones, female sex, and hydronephrosis were the predictive factors. They showed that among those with complicated pyelonephritis, patients with P.U.S.H. scores of 3–4 had a significant risk for urosepsis. In contrast, although our study population included only patients with hydronephrosis with upper urinary calculi, our results were likely to be similar to results reported previously in the P.U.S.H. scoring system.

In the H.A.P.S. scoring system, using a cut-off score of 3 points, sensitivity (92.9%) and specificity (89.9%) were excellent. Generally, obstructive pyelonephritis is an emergent disease that progresses easily to septic shock and DIC. With the excellent sensitivity and specificity of the H.A.P.S. scoring system, it is likely to be sufficiently acceptable as an assessment of DIC risk only from the background characteristics of patients.

There are several limitations in the present study. First, this is a retrospective study with a small number of participants. Second, this study only compares the background data of patients with and without DIC at an initial intervention, and these retrospective data may not necessarily be predictive factors prospectively. Especially, the time from the development of pyelonephritis to the initial medical intervention is unclear. The risk of complicated pyelonephritis progressing to DIC is likely to increase with time, as the disease develops. In addition, some clinical data before pyelonephritis, including the presence of urinary tract infection, nutrition, anemia, and serum albumin value, are not included in the present study. Therefore, further analyses, including several studies and more clinical background information, are required to verify our results.

Conclusion

The H.A.P.S. scoring system is a useful tool for predicting the development of DIC in patients with obstructive pyelonephritis complicated with urinary calculi. Patients with a H.A.P.S. score \geq 3 were statistically more likely to develop DIC than those with scores of 0–2.

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