Procalcitonin and white blood cell as predictors of urosepsis in urinary tract obstruction patients at Sanglah Hospital Denpasar

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Abstract

Introduction: Patients with urinary tract obstruction are often accompanied by urinary tract infections. In some cases, it develops into urosepsis that increases mortality. Early detection capability is essential. The purpose of this study was to determine the role of serum procalcitonin (PCT), nitrite urine (NU) and white blood cell (WBC) as urosepsis predictors in patients with urinary obstruction.

Methods: This is a cross-sectional study involving 36 samples carried out at our hospital using consecutive sampling technique from December 2016 to February 2017. Statistical analyses used were a bivariate test and multivariate test using Poisson regression.

Results: From the bivariate test analysis, serum PCT level of ≥ 0.25 ng/ml, positive result for NU, and a WBC amount of $\geq 12,000$ cells/mm³ were predictors for urosepsis. In the multivariate test, we obtained a PCT serum level of ≥ 0.25 ng/ml, and WBC of $\geq 12,000$ cells/mm³ were true predictors of urosepsis in patients with urinary tract obstructions with infections.

Conclusion: Serum PCT and WBC can be used as a predictor of urosepsis in patients with urinary tract obstruction.

Keywords: urinary tract obstruction, urosepsis, procalcitonin, white blood cell

Introduction

Obstruction of the urinary tract can occur along the urinary tract, starting from the pelviococcal kidney to the urethra. Most are found in the lower urinary tract, especially men with an incidence of 15 out of 1,000 people per year and experience an increase of 38 out of 1,000 people per year at the age of 75 to 79 years.¹ Out of these, 12% may develop into urosepsis.² This situation causes an increase in mortality, which reaches 20-40% in severe urosepsis.³⁻⁶ Urosepsis caused by urinary tract obstruction is up to 80%.^{3,4,7} This is an emergency in the urology department that requires immediate urinary tract decompression and drainage, either using retrograde stents or percutaneous nephrostomy tube placement.⁸

Diagnosis of urinary tract infections or urosepsis is obtained from history taking, physical examination, and investigations. There are several supporting laboratory tests, such as white blood cell (WBC), serum urinary nitrite (NU), procalcitonin (PCT), and blood or urine cultures.^{5,8-10} Some of these tests do not provide rapid results so they can affect the management and outcome of the patients.⁸ The ability to diagnose patients with urinary tract obstruction as early as possible with infection can reduce the risk of urosepsis and prevent mortality. This study aims to examine the role of serum PCT, NU, and WBC levels as predictors of urosepsis in patients with urinary

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tract obstruction.

Patients and Methods

This study used a cross-sectional design carried out in the Emergency Room (ER) and surgical ward of the Sanglah General Hospital from December 2016 to February 2017. A total sample of 36 people aged >18 years old with urinary tract obstruction was selected by consecutive sampling technique. Exclusion criteria included pregnancy, lactating mothers, undergoing hemodialysis, kidney transplant history, and immunodeficiency diseases. The study protocol was approved by the institutional board of ethical research.

The study was conducted by examining serum PCT, NU, and WBC levels as well as vital signs (blood pressure, pulse frequency, respiration rate, and body temperature) and recording the occurrence of urosepsis in the subjects. The statistical test used was a bivariate analysis by making cross-tabulations. Multivariate analysis was used to determine the relationship of each predictor of the occurrence of urosepsis after being analyzed simultaneously. The analysis used is Poisson regression. All calculations were carried out by using SPSS 20.0 software. A p-value of <0.05 was considered significant.

Results

A total of 36 subjects were enrolled in this study, consisting of 17 (42.7%) males and 19 (57.3%) females. The characteristics of the subjects are shown in Table 1.

Table 1. Characteristics of the subjects and research variables.

Characteristics	N
Sex, n (%)	
Male	17 (42.7)
Female	19 (57.3)
Cause of obstruction, n (%)	
Urinary stones	18 (50)
Urinary tract malignancy	5 (13.9)
Ureter stenosis	13 (36.1)
Serum WBC, n (%)	
High	15 (41.7)
Normal	21 (58.3)
Procalcitonin level, n (%)	
> 0.25 ng/ml	16 (57.3)
< 0.25 ng/ml	17 (42.7)
Urine nitrite presence, n (%)	
Positive	10 (27.85)
Negative	26 (72.2)

Table 2 shows results from the bivariate analysis of serum PCT levels (RR: 7.158), NU (RR: 2.08), and WBC (RR: 3.64) as predictors of urosepsis.

From multivariate Poisson regression analysis (Table 3), we found that serum PCT levels (RR: 7.158) and WBC (RR: 3.64) were good predictors of the occurrence of urosepsis in patients with urinary tract obstruction with infection.

Table 2. Bivariate analysis of the tests used to predict the occurrence of urosepsis.

Variables	Urosepsis		p-value	RR	95%CI
	Yes	No			
WBC					
High	13 (36.1%)	2 (5.56%)	<0.001	3.640	1.651-8.024
Normal	5 (13.89%)	16 (44.4%)			
Procalcitonin					
> 0.25 ng/ml	16 (44.4%)	3 (8.33%)	<0.001	7.158	1.919-26.696
< 0.25 ng/ml	2 (5.56%)	15 (41.67%)			
Urine nitrite					
Positive	8 (22.22%)	2 (5.56%)	0.026	2.080	1.169-3.702
Negative	10 (27.78%)	16 (44.4%)			

RR: risk ratio; CI: confidence interval

Table 3. Multivariate analysis of the tests used predicts the occurrence of urosepsis

Variables	RR	p-value ^a	95%CI
Procalcitonin	0.709	0.007	0.543 - 0.910
WBC	0.766	0.022	0.610 - 0.962
Urine nitrite	0.962	0.795	0.716 - 1.291

RR: risk ratio; CI: confidence interval; ^aPoisson analysis

Discussion

Procalcitonin is the most widely studied biomarker and is recommended to confirm or rule out the possibility of sepsis.⁹ It has high sensitivity and specificity to diagnose bacterial sepsis.¹⁰ In this study, we found that PCT was a good predictor of urosepsis from bivariate and multivariate analysis. This result is also supported by Nieuwkoop *et al.*,¹¹ who used PCT to detect urosepsis in ureteric stone patients with urinary tract infections. This is because the majority of bacteria in urinary tract infections by gram-negative bacteria and the high number of bacteria affect the amount of free lipopolysaccharide and endotoxin which ultimately affects serum PCT levels.¹¹ So it can be concluded that PCT can be used as a reliable parameter to detect early urosepsis in patients with urinary tract obstruction. In contrast to a study by Tang *et al.*,¹² stated that PCT could not distinguish between sepsis and SIRS without infection.

Procalcitonin can be used as a decision to carry out surgical intervention and broad-spectrum antibiotics in patients with urinary tract obstruction with urosepsis without waiting for the results of blood or urine culture examination.¹⁰ Serum levels can increase from 4 hours since the onset of systemic infection and reach the highest level in 8 up to 24 hours, while false negative results on PCT checks can occur if the sample is taken too fast.¹³

The blood component is also formed by the WBC which is part of the immune system. The infection process activates the complement system then triggers a pro-inflammatory response by stimulating the formation of neutrophil granulocytes so that patients with the infection will experience an increase in the number of WBC.¹³ Some studies suggest WBC has a high sensitivity and specificity as a predictor of urosepsis.^{8,14} Similar to the results of this study, WBC was

obtained as a predictor of urosepsis from bivariate and multivariate analysis. In contrast to another study, it was found that WBC had increased due to exercise, trauma, and emotional stress-induced by catecholamines so that the increasing release of WBC will be stored in the bone marrow.¹⁵

Urine nitrite is formed from nitrate by reductase enzyme produced by bacteria in the urinary tract.¹⁶ In this study, NU serum levels were significant as a predictor of urosepsis according to bivariate analysis, but not substantial in multivariate tests. Meanwhile, other studies state that the examination of NU has a sensitivity of up to 66% as a predictor of urosepsis.¹⁶ This can be caused by total urinary tract obstruction or excessive drinking before urine sampling so that the patients often urinate and ultimately affect the results of urine examination.

Conclusion

Serum PCT levels and WBC levels can be used as predictors of urosepsis in patients with urinary tract obstruction, so that early detection can reduce the risk of urosepsis and prevent mortality.

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