THE DIAGNOSTIC VALUE OF PROCALCITONIN FOR EARLY DETECTION OF UROSEPSIS

[1]M. Andriady S. Nasution, [1]Sunaryo Hardjowijoto, [1]Doddy M. Soebadi, [2]Aryati, [3]Widodo JP

[1]Department of Urology, Faculty of Medicine/Airlangga University, Soetomo Hospital, Surabaya
[2]Department of Clinical Pathology, Faculty of Medicine/Airlangga University, Soetomo Hospital, Surabaya
[3]Faculty of Public Health/Airlangga University, Soetomo Hospital, Surabaya

ABSTRAK

Tujuan Penelitian: *Urosepsis merupakan kegawatdaruratan di bidang urologi yang dapat mengancam nyawa dan prognosisnya sangat tergantung pada deteksi dini yang dapat dilakukan. Prokalsitonin merupakan penanda sepsis yang dapat menunjukkan secara akurat dan dini pada kasus urosepsis sehingga dapat mencegah jatuhnya urosepsis menjadi sepsis yang lebih berat, syok septik bahkan kematian.* ***Bahan & Cara:*** *Kami melakukan penelitian uji diagnostik prokalsitonin, CRP, leukosit darah pada 21 pasien. Pasien terdiri dari 12 pasien urosepsis dan 9 pasien non–urosepsis. Pasien non–urosepsis merupakan pasien yang mengalami trauma. Penelitian ini dilakukan pada bulan September sampai dengan bulan Desember 2010.* ***Hasil Penelitian:*** *Rerata prokalsitonin pada pasien urosepsis 27,9 ± 30,7 ng/ml, CRP 8,9 ± 7,9 mg/l dan leukosit darah 15125,0 ± 8969,9 mm3. Nilai sensitivitas prokalsitonin pada pasien urosepsis sekitar 83,3%, spesifisitas 77,8%, nilai duga positif 83,3%, nilai duga negatif 77,8%, rasio kemungkinan positif 3,75 dan rasio kemungkinan negatif 0,2. Nilai diagnostik prokalsitonin lebih baik dibandingkan dengan nilai diagnostik CRP dan leukosit darah. Pada kurve ROC – AUC diperoleh prokalsitonin 0,806 (95% CI = 0,607 – 1,004), leukosit darah 0,773 (95% CI = 0,568 – 0,979) dan CRP 0,602 (95% CI = 0,341 – 0,863).* ***Simpulan:*** *Prokalsitonin mempunyai nilai diagnostik yang baik sehingga dapat digunakan sebagai deteksi dini kasus urosepsis.*

Kata Kunci: *Urosepsis, prokalsitonin, CRP, leukosit darah.*

ABSTRACT

Objective: *To study procalcitonin as an early and accurate marker for urosepsis.* ***Material & Method:*** *We performed a diagnostic study of procalcitonin, CRP and peripheral blood leucocyte in 21 patients. Patients included 12 urosepsis patients with urosepsis, and 9 trauma patients without urosepsis. This study was conducted from September 2010 to December 2010.* ***Results:*** *Mean and standard deviation of procalcitonin level in urosepsis patients was 27,9 ± 30,7 ng/ml, CRP was 8,9 ± 7,9 mg/l and blood leucocyte was 15125,0 ± 8969,9 mm^3. Sensitivity of procalcitonin in diagnosis of urosepsis was 83,3%, specificity was 77,8%, positive predictive value was 83,3%, negative predictive value was 77,8%, positive odds ratio was 3,75 and negative odds ratio was 0,2. Diagnostic value of procalcitonin was better compared to CRP and blood leucocyte. In the receiver operating characteristics (ROC) plot, area under the curve (AUC) for procalcitonin, blood leucocyte, and CRP were 0,806 (95% CI = 0,607 – 1,004), 0,773 (95% CI = 0,568 – 0,979), and 0,602 (95% CI = 0,341 – 0,863), respectively.* ***Conclusion:*** *Procalcitonin is an early marker for urosepsis cases with better diagnostic value than CRP and blood leucocyte.*

Keywords: *Urosepsis, procalcitonin, CRP, blood leucocyte.*

Correspondence: M. Andriady S. Nasution, c/o: Department of Urology, Faculty of Medicine/Airlangga University, Soetomo Hospital. Jl. Mayjen.Prof.Dr. Moestopo 6-8, Surabaya 60286. Phone: 031-5501318. Mobile phone: 081332621198. Email: mandriadys@gmail.com

INTRODUCTION

Sepsis is an infection accompanied by systemic responses. And, sepsis caused by infection in urinary tract and/or male genital organ is called urosepsis.[1,2] Approximately, 20-30% of sepsis cases may be caused by urinary tract infection considered as a risk factor of urosepsis. Actually, urosepsis may be caused by urinary tract stones (43%), prostate adenoma (25%), urologic cancers (18%), and catheterization (14%), manipulation actions in urology, and other urologic diseases.[1]

Moreover, the enforcement of sepsis can actualy be done by blood and urine tests, such as microbiological examination of blood culture. In urosepsis cases, the examination of blood and urin cultures even is necessary.[3] However, blood cultures used as a reference gold standard for sepsis cases still remain a dilemma. The occurrence of the dilemma is caused by the limitations of current microbial techniques for diagnosing bacterial infections.[4] In a large population with clinical diagnosis of sepsis, there are 15% of negative blood culture results.[5] Other literatures even state that in more than 50% of severe sepsis cases negative blood culture results are obtained.[3]

Therefore, the ideal sepsis markers should not only have high sensitivity and specificity, but can also be used easily with affordable cost. The ideal sepsis markers, furthermore, should also be able to know both the stages of diseases and the prognosis of patients. With the ideal sepsis markers, early treatment then can be performed, as a result, they can not only prevent the occurrence of severe sepsis and septic shock, but can also reduce the rates of mortality significantly.[6]

Some of the ideal sepsis markers are *Tumor Necrosis Factor*- (TNF-), Interleukin–1 (IL–1), Interleukin–6 (IL–6), Interleukin–8 (IL–8), *C–Reactive Protein* (CRP), and procalcitonin (PCT).[6-8] Procalcitonin (PCT) is a peptide with 116 amino acids considered as an identical sequence for the prohormone of calcitonin. Nevertheless, PCT has no activity as hormones. But, PCT has roles, such as (1) can distinguish between infection and non infection in SIRS, (2) can distinguish between bacterial and viral sepsis, 3) (with the form of *Cut off*) can provide optimum sensitivity and specificity for diagnosing infection with a variety of different circumstances, 4) can reduce the effects of antimicrobial and vasoactive drugs.[8-12]

Furthermore, in published studies, the diagnostic value of PCT showed higher values of sensitivity (85%), specificity (91%), positive expected value (89%), and negative expected value (95%) than those of CRP, TNF-, IL–2, IL–6, IL–8, which then can be used to distinguish patients with sepsis and patients with SIRS. For instance, in the research conducted on 33 patients of ICU (Intensive Care Unit) diagnosed with SIRS, sepsis, and septic shock[13], Castelli et al (2004) reported that there were the differences of CRP and PCT images. In this research, moreover, it is known that CRP concentrations immediately increased during severe organ dysfunction and systemic inflammatory, but the value was not increased during the more severe stages of the organ dysfunction. It is also known that PCT levels were particularly elevated in patients with organ dysfunction, severe sepsis, and septic shock. This is because the presence of different kinetic work on these two parameters. Since the concentration of PCT has higher levels than one of CRP, the significant increasing of PCT during severe sepsis and septic shock can actually be considered as the major force of PCT.[14] Procalcitonin is also considered to be better than CRP in detecting the onset of sepsis in 53 patients who experienced septic shock.[15] Thus, the procalcitonin examination in urosepsis cases is expected to be ale to detect early the occurrence of sepsis in urological disorders which can not only prevent the occurrence of more severe sepsis, and septic shock, but can also prevent the occurrence of death.[15]

OBJECTIVE

This research is aimed to study procalcitonin focused on its diagnostic value in order to be used as an early detection in urosepsis cases.

MATERIAL & METHOD

This research is a diagnostic research conducted from September 2010 to December 2010 in order to analyze the diagnostic values of blood leucocytes, blood culture, CRP, and procalcitonin towards urosepsis. Cross-sectional design was then used in this research. And, measurements were also conducted covertly (blinding) in urosepsis patients as diagnostic gold standard.

The samples of this research were patients of Dr. Soetomo Hospital who met the criteria of SIRS with abnormalities in the urologic field accompanied by infections in the urinary tract. The total number of sample obtained was 21 patients. After conducting blood culture examination, the sample was then divided into two groups, namely urosepsis group (12 patients) and non-urosepsis group (9 patients) including trauma and burns.

By examining sensitivity value, specificity value, positive expected value, negative expected value, and positive and negative probability ratios of procalcitonin, cross sectional analysis was then conducted. Next, both 2 x 2 table analysis, ROC curve analysis (Receiving Operating Characteristic) with

the output of area under the curve (AUC), and tiered analysis were also conducted.

RESULTS

The characteristics of the research sample (Table 1) show that the average age of patients in the urosepsis group was about 46,1 years, while that in the non-urosepsis group was about 30,2 years. Moreover, it is also known that the age range in the urosepsis group was 13-60 years, while that in the non-urosepsis group was 10-52 years old.

Furthermore, five cases of bilateral hydronephrosis and one case of hydronephrosis on one side of the kidneys were found in this research. And, hydronephrosis even was also found in the case of perirenal abscess. Actually, hydronephrosis is a case found mostly in the urosepsis group. But, this case also comes with other diagnoses, such as urinary tract stones (83,3%), either pyelum stones, proximal ureteric stones, or distal ureteric stones, as well as benign prostatic enlargement (16,7%).

The value of procalcitonin found in 10 cases of urosepsis was high (table 2). The value was even higher than that of CRP and blood leucocytes in the urosepsis cases. Meanwhile, in trauma cases, the value of CRP and procalcitonin was as high as that of blood leucocytes.

From table 3, there were four mortality cases in the urosepsis group and one mortality case in the non-urosepsis group (trauma). In those four mortality cases in the urosepsis group, the value of procalcitonin obtained was high with the highest value reached 100.

The sensitivity of blood leucocytes was about 50%; the specificity of blood leucocytes was about 77,8%; the positive expected value of blood leucocytes was about 75%; the negative expected value of blood leucocytes was about 53,8%; the positive probability ratio of blood leucocytes was about 2,3; and the negative probability ratio of blood leucocytes was about 0,6 (table 4). It is also known that the specificity value of blood leucocytes is higher than other diagnostic values. And, the sensitivity value of blood leucocytes was also considered to be the lowest value compared to other diagnostic values.

From table 5, the sensitivity of CRP was about 58,3%; the specificity of CRP was about 77,8%; the positive expected value of CRP was about 77,8%, the negative expected value of CRP was about 58,3%; the positive probability ratio of CRP was about 2,6; and the negative probability ratio of CRP was about 0,5. It is also known that the specificity value and the positive expected value are the highest diagnostic values compared with other diagnostic values. And, the sensitivity of CRP was also considered to be higher than that of blood leucocytes.

Table 1. The Characteristics of the research samples.

Characteristic	Urosepsis	Non Urosepsis (Trauma)
Sex (Male /Female)	9/3	8/1
Age (year)	46,1 ± 13,1	30,2 ± 16,7
	(13 – 60)	(10 – 52)
Blood leucocytes $(mm)^3$	15125 ,0 ± 8969 ,9	8166 ,7 ± 3614,2
	(5000 – 32000)	(4500 – 15000)
CRP (mg/l)	8,9 ± 7,9	5,9 ± 10,7
	(0,42 – 18,68)	(0,04 – 33,27)
PCT (ng/ml)	27,9 ± 30,7	2,6 ± 6,1
	(0,062 – 100)	(0,020 – 18,49)
Mortality (%)	33,33%	11,11%

Table 2. The distribution of the research samples of blood cultures, urine cultures, blood leucocytes, CRP, PCT and mortality.

	Blood Cultures		Urine Cultures		Blood Leucocytes		CRP		PCT		Mortality	
	+		+		Abnormal	Normal	Abnormal	Normal	Abnormal	Normal	Death	Life
Urosepsis	8	4	11	1	6	6	7	5	10	2	4	8
Non Urosepsis (Trauma)	1	8	1	8	2	7	2	7	2	7	1	8

Table 3. The distribution of the research samples of mortality based on the results of blood cultures, urine cultures, and the values of blood leucocytes, CRP, and PCT.

			Blood Cultures	Urin e Cultures	Blood Leucocytes	CRP	PCT
Mortality	Urosepsis	1	*Klebsiella pneumoniae*	*Klebsiella Sp*	27,000	10,78	59,70
		2	*Klebsiella pneumoniae*	*Escherichia coli*	32,000	17,74	100
		3	*Staphylococcus haemolyticus*	*Staphylococcus Sp*	21,000	14,83	49,19
		4	*Staphylococcus hominis*	*Staphylococcus Sp*	25,500	16,01	48,92
	Non-Urosepsis (Trauma)	1	*Acinetobacter baumannii*	*Escherichia coli*	15,000	9,96	18,49

Table 4. The diagnostic test value of blood leucocytes in the urosepsis group.

		Urosepsis		
		Positive	Negative	
Blood Leucocytes	Abnormal	6 (28,6%)	2 (9,5%)	8 (38,1%)
	Normal	6 (28,6%)	7 (33,3%)	13 (61,9%)
		12 (57,2%)	9 (42,8%)	21 (100%)

Table 5. The diagnostic test value of CRP in the urosepsis group.

		Urosepsis		
		Positive	Negative	
CRP	Abnormal	7 (33,3%)	2 (9,5%)	9 (42,8%)
	Normal	5 (23,9%)	7 (33,3%)	12 (57,2%)
		12 (57,2%)	9 (42,8%)	21 (100%)

Table 6. The diagnostic test value of blood cultures in the urosepsis group.

		Urosepsis		
		Positive	Negative	
Blood Cultures	Positive	8 (38,1%)	1 (4,7%)	9 (42,8%)
	Negative	4 (19,1%)	8 (38,1%)	12 (57,2%)
		12 (57,2%)	9 (42,8%)	21 (100%)

The sensitivity of blood cultures was about 66,7%; the specificity of blood cultures was about 88,9%; the positive expected value of blood cultures was about 88,9%; the negative expected value of blood cultures was about 66,7%; the positive probability ratio of blood cultures was about 6,1; and the negative probability ratio of blood cultures was about 0,2 (table 6). It is also known that the specificity value and the positive expected value are the highest diagnostic values compared with other diagnostic values. And, the sensitivity and specificity values of blood cultures were also considered to be higher than those of blood leucocytes and CRP.

From table 7, the sensitivity of procalcitonin was about 83,3%; the specificity of procalcitonin was about 77,8%; the positive expected value of procalcitonin was about 83,3%; the negative expected value of procalcitonin was about 77,8%; the positive probability ratio of procalcitonin was about 3,75, and the negative probability ratio of procalcitonin was about 0,2. It is also known that the sensitivity value and the positive expected value are

Table 7. The diagnostic test value of procalcitonin in the urosepsis group.

		Urosepsis		
		Positive	Negative	
Procalcitonin	Abnormal	10 (47,7%)	2 (9,5%)	12 (57,2%)
	Normal	2 (9,5%)	7 (33,3%)	9 (42,8%)
		12 (57,2%)	9 (42,8%)	21 (100%)

Table 8. Area under the curve.

Variable (s) of Test Result	Area	Asymptomatic 95% Confidence Interval	
		Lower Bound	Upper Bound
PCT	,806	,607	1,004
CRP	,602	,341	,863
blood leukocytes	,773	,568	,979

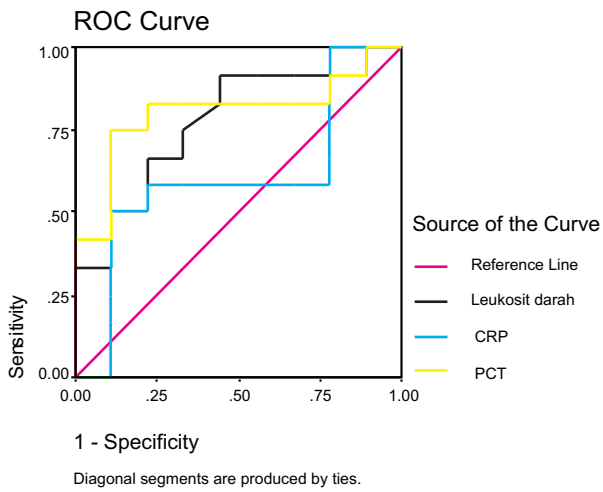

Figure 1. ROC Curve of CRP, blood leucocytes, and procalcitonin.

the highest diagnostic values compared with other diagnostic values. And, the sensitivity of procalcitonin was also considered to be higher than that of blood leucocytes, CRP, and blood cultures. But, the specificity of procalcitonin was lower than that of blood cultures.

ROC Curve (see Figure 1), furthermore, shows that procalcitonin has the highest diagnostic values compared with blood leucocytes and CRP. Besides that, it is also known that blood leucocytes has the highest diagnostic values compared with CRP.

The test results of variable(s) show that blood leucocytes has at least one tie between the positive actual state group and the negative actual state group. Statistics may also be biased, a) Under the nonparametric assumption, b) Null hypothesis : true area = 0,5.

DISCUSSION

Blood leucocytes obtained in patients with urosepsis in this research was about 15125,0 ± 8969,9 mm^3, CRP was about 8,9 ± 7,9 mg/l, and procalcitonin was about 27,9 ± 30,7 ng/ml. Meanwhile, blood leucocytes obtained in patients with non-urosepsis was about 8166,7 ± 3614,2 mm^3, CRP was about 5,9 ± 10,7 mg/l, and procalcitonin was about 2,6 ± 6,1 ng/ml. In a previous research comparing the values of blood leucocytes, CRP, and procalcitonin in patients with sepsis and non-sepsis (burnt cases), it is also known that the diagonistic values of blood leucocytes obtained were about 11183,3 ± 18443,6 mm^3 (in sepsis cases) and 8116,7 ± 4807,1 mm^3 (in non-sepsis cases). Meanwhile, the diagnostic values of CRP obtained were about 2,8 ± 2,3 mg/l (in sepsis cases) and 2,5 ± 1,4 mg/l (in non-sepsis cases). It is also known that the diagonistic values of procalcitonin were about 8,45 ± 7,8 ng/ml (in sepsis cases) and 0,5 ± 1,0 ng/ml ng/ml (in non-sepsis cases).[16]

Hydronephrosis, moreover, is actually the largest urology cases found in this research. The occurrence of hydronephrosis in this research was usually associated with both urinary tract stone cases (83,3%), either pyelum stones, proximal ureteric stones, or distal stones, and benign prostatic enlargement (16,7%). In another research, the occurrence of hydronephrosis, on the other hand, was caused not only by urinary tract stone obstruction (52%) caused by either stones in proximal, middle, or distal ureter, but also by uretropelvic junction obstruction (UPJ) (26%) and by a tumor pressing the ureter (12%).[17]

Meanwhile, mortality urosepsis obtained in this research was only about 33,33%. The urosepsis

mortality occured in this research was usually associated with the discoveries of blood culture and urine culture. Blood leucocyte values obtained in this research were also not normal. The high values of CRP and procalcitonin in patients with urosepsis actually can cause mortality. In other literature, the

On the other hand, in this research, the diagnostic value of procalcitonin obtained was about > 25 ng/ml. Four patients of five urosepsis cases even were died. Meanwhile, in another research, six patients of seven *Plasmodium falciparum* malaria cases were died with the diagonistic values of procalcitonin about > 25 ng/ml.[18]

The results of blood cultures obtained in this research, moreover, were Gram-negative organisms which are the most common factor causing urosepsis, approximately about 41,67%. Meanwhile, Gram-positive organisms obtained in this research were about 16,67%, and yeast was about 8,3% both of which can actually cause urosepsis. Gram-negative organisms found in this research are *Klebsiella pneumoniae* (16,67%), *Burkholderia cepacia* (8,3%), *Pseudomonas fluorescens* (8,3%), and *Pseudomonas aeruginosa* (8,3%). Meanwhile, Gram-positive organisms found in this research are *Staphylococcus haemolyticus* (8,3%) and *Staphylococcus hominis* (8,3%). Actually, Gram-positive infections occured in dr. Soetomo Hospital until June of 2009 have already been published. It is then known that there were top five Gram-positive bacteria, namely *Staphylococus coagulase negative* (13,25%), *Staphylococcus spp* (6,95%), *non-hemolytic Streptococcus* (5,49%), *Staphylococcus aureus* (2,58%), and *Streptococcus viridans* (1,62%).[19]

The results of urine culture obtained from this research, furthermore, consisted of Escherichia coli, a bacterium most found in urosepsis cases (25%), *Staphylococcus sp* (16,67%), *Candida sp* (16,67%), *Pseudomonas sp* (16,67%), *Proteus sp* (8,3%), and *Klebsiella sp* (8,3%). In another study conducted for 7 months (June to December 2001) on 349 urine specimens from a variety of treatment rooms, 157 (45%) specimens obtained showed positive culture results. Among those positive culture results, the prevalence rates of microbes studied are *Escherichia coli* (31,85%), *Klebsiella sp* (18,47%), *Pseudomonas sp* (14,65%), *Pseudomonas aeruginosa* (10,83%), *Candida sp* (7,01%), *Staphylococcus epidermidis* (5,1%), *Proteus sp* (3,82%), *Streptococcus pyogenes* (3,19%), and *Streptococcus faecalis* (1,91%).[20]

Based on another research, it is also known that *Escherichia coli* is the largest uropatogen. *Escherichia coli* became uropatogen for boys who are not circumcised. Among 79 patients studied, it was found that 66 young male patients (84%) all of whom had not been circumcised had *Eschericia coli*. Thus, the research result can be concluded that *Escherichia coli* is uropatogen which has high risk of urinary tract infections.[21] *Escherichia coli* is also considered to be germs mostly found in renal colic and urinary tract stone cases (68,7%), Proteus (18,7%), as well as *Enterococcus* and *Citrobacter* (6,3% for each).[22]

The diagnostic value of procalcitonin obtained in this research then is known to be the highest one, especially for its sensitivity compared to that of blood leucocytes, CRP, and blood cultures. The sensitivity value of procalcitonin obtained was about 83,3%, while its specificity one was about 77,8%. Moreover, its positive expected value was about of 83,3%, while its negative expected value was about 77,8%. And, its positive probability ratio was about 3,75, while its negative probability ratio was about 0,2%.

On the other hand, the sensitivity value of CRP obtained was about 58,3%, while its specificity was about 77,8%. Its positive expected value, furthermore, was about 77,8%, while its negative expected value was about 58.3%. And, its positive probability ratio was about 2,6 %, while its negative probability ratio was about 0,5%. In a research analyzing biomarkers, CRP in urinary diversion cases conducted urgently in patients with renal colic and urinary stones even was known to be about 75,8% for its sensitivity value, 88,9% for its specificity value, 87,2% for its positive expected value, and 78,6% for its negative expected value.[22]

In a research comparing procalcitonin and CRP in order to determine the estimation of severity degree of sepsis in community-acquired pneumonia (CAP), moreover, it is also known that the sensitivity value of procalcitonin obtained was about 46.3% in patients with SIRS, while its specificity value was about 85,3% in patients without SIRS. On the other hand, the sensitivity value of CRP was about 98,1% in patients with SIRS, while its specificity value was about 0% in patients without SIRS. The positive expected value of procalcitonin, furthermore, was about 83,3%, while its negative expected value was about 50%. On the other side, the positive expected value of CRP was about 60,9%, while its negative expected value was about 0%.[23]

In a research evaluating procalcitonin as a marker of infection in patients with fever in the hospital,

furthermore, it is also known that the sensitivity value of procalcitonin with bacteremia was about 65%, while its specificity value was about 69%. Its positive expected value, moreover, was about 38%, while its negative expected value was about 87%. In addition, the sensitivity value of procalcitonin suspected of having bacterial infection was about 54%, while its specificity value was about 70%. Its positive expected value, moreover, was about 52%, while its negative expected value was about 69% (Munoz et al, 2004).[24]

ROC curve value of CRP in this research, furthermore, is indicated to have a weak diagnostic value for AUC obtained from ROC method, about 60,2%. Meanwhile, blood leucocytes is indicated to have middle diagnostic value based on the ROC curve since AUC value obtained from ROC method was about 77,3%. This is in contrast with the results of another research analyzing biomarkers. CRP in urinary diversion cases conducted *urgent* in patients with renal colic and urinary stones, for instance, obtained a good diagnostic value for ROC curve value of CRP since AUC value obtained from ROC method was about 86,8%, but also obtained a weak diagnostic value for ROC curve value of leukocytes since AUC value obtained from ROC method was about 68,8%.[22]

ROC curve value of procalcitonin in this research, on the other hand, had good diagnostic value since AUC value obtained from ROC method was about 80,6%. This result is actually similar with that in the previous research which found that procalcitonin obtained was better than CRP in order to detect early the occurrence of renal parenchymal inflammation in cases of children who have urinary tract infection. Similarly, in that research, AUC value of procalcitonin obtained from ROC curve was about 98,8% also indicating a very good diagnostic value, as well as AUC value of CRP obtained was about 95,7% indicating a very good diagnostic value, too.[25]

Besides providing diagnostic value in sepsis cases, procalcitonin actually can also serve as a monitor of antibiotic use in order to become more effective and efficient. It is because the excessive use of antibiotics can not only cause high cost, but can also increase bacterial resistance. Approximately, 110 patients who underwent surgery, but only 57 of whom use antibiotics monitored by procalcitonin every day. Meanwhile, another group, 53 patients, used standard antibiotic usage for about 8 days. And, it is then known that the use of antibiotics in those patients monitored with procalcitonin is shorter than that in patients monitored as the control group ($5,9 \pm 1,7$ days vs. $7,9 \pm 0,5$ days, $p < 0,001$).[26]

Researcher, moreover, have better diagnostic value of procalcitonin than that of CRP and blood leukocytes in the cases of urosepsis exemined in this research. Actually, it is not easy to get patients with early urosepsis cases, but by using inclusion and exclusion criteria the sample of this research finally could be collected. Procalcitonin with high diagnostic value (especially procalcitonin value > 25 ng / ml) obtained in this study can be considered as an early warning of impending mortality in those urosepsis patients. Therefore, it had better to conduct special treatments immediately and seriously for those patients with procalcitonin, > 25 ng / ml.

The finding obtained after the examination of blood leucocytes and CRP in this research is that procalcitonin can provide additional diagnostic value in early cases of urosepsis. Besides that, the finding also shows that the prognosis of urosepsis is associated with procalcitonin value. The higher the procalcitonin value is, the poorer the prognosis is.

CONCLUSION

Finally, it can be concluded that procalcitonin have good diagnostic value (better than CRP and blood leucocytes). As a result, it can be used as an early detection of urosepsis cases.

REFERENCES

1. Wagenlehner FME, Pilatz A, Naber KG, Weidner M. Therapeutic challenges of urosepsis. European Journal of Clinical Investigation. 2008; 38: 45-9.
2. Marx G, Reinhart K. Urosepsis: From the intensive care viewpoint. Internasional Journal of Antimicrobial Agents. 2008; 31S: S79-S84.
3. Schiefer HG, Diemer TH, Weidner W. Urosepsis in: Hohenfeller M, Santucci (edits): Emergencies in Urology. Springer – Verlag, Berlin, Heidelberg, New York. 2007; 5: 45-9.
4. Schuetz P, Crain MC, Muller B. Procalcitonin and other biomarkers for the assessment of disease severity and guidance of treatment in bacterial infections. Advances in Sepsis. 2008; 6(3): 82-9.
5. Landenberg PV, Shoenfeld Y. New approaches in the diagnosis of sepsis. IMAJ. 2001; 3: 439-42.
6. Reinhart K, Meisner M, Brunkhorst FM. Markers for sepsis diagnosis: What is usefull? Crit Care Clin. 2006; 22: 503-19.
7. Lever A, Mackenzie I. Sepsis: Definition, epidemiology and diagnosis. BMJ. 2007; 335: 879-83.

8. Redl H, Spittler A, Strohmaider W. Markers of sepsis in: Vincent JL, Carlet J, Opal SM (edits): The Sepsis Text. New York; Kluwer Academic Publishers. 2002; 4: 47-66.
9. Buchori, Prihatini. Diagnosis sepsis menggunakan procalcitonin. Indonesian Journal of Clinical Pathology and Medical Laboratory. 2006; 12(3): 131-7.
10. Kosanke R, Beier W, Lipecky R, Meisner M. Clinical benefits of procalcitonin. Tanaffos. 2008; 7(1): 14-8.
11. Maruna P, Nedelnikova K, Gurlich R. Physiology and genetics of procalcitonin. Physiol. Res. 2000; 49(Suppl. 1): S57-S61.
12. Muller B, Becker KL. Procalcitonin how a hormone became a marker and mediator of sepsis. Swiss Med Wkly. 2001; 131: 595-602.
13. Balci C, Sungurtekin H, Gurses E, Sungurtekin U, Kaptanoglu B. Usefull of procalcitonin for diagnosis of sepsis in the intensive care unit. Critical Care. 2003; 7: 85-90.
14. Castelli GP, Pognani C, Meisner M. Procalcitonin and C – reactive protein during systemic inflammatory response syndrome, sepsis and organ dysfunction. Critical care. 2004; 8: R234-R42.
15. Claeys R, Vinken S, Spapen H, Elst K, Decochez K, Huyghens L. Plasma procalcitonin and C – reactive protein in acute septic shock: Clinical and biological correlates. Crit Care Med. 2002; 30(4): 757-62.
16. Barati M, Alinejad F, Bahar MA, Tabrisi MS, Shamshiri AR, Bodouhi A. Comparison of WBC, ESR, CRP and PCT serum levels in septic and non – septic burn cases. Burns Journal. 2008; 34: 770-4.
17. Christoph F, Weikert S, Muller M, Miller K, Schrader M. How septic is urosepsis? Clinical course of infected hydronephrosis and therapeutic strategies. World J Urol. 2005; 23: 243-7.
18. Chiwakata CB, Manegold C, Bonicke L, Waase I, Julch C, Dietrich M. Procalcitonin as a parameter of disease severity and risk of mortality in patients with plasmodium falciparum malaria. The Journal of Infectious Diseases. 2000; 183: 1161-4.
19. Vitanata M. Infeksi berat gram positif. Journal of Institute of Tropical Disease. 2010; 29(3): 205-12.
20. Kuntaman, Mudihardi E, Harsono S, Debora K, Mertaniasih NM. Aspek mikrobiologi pada infeksi saluran kemih in: Nasronudin, Hadi U, Vitanata, Erwin AT, Baramantono, Suharto, Soewandojo E: Penyakit infeksi di Indonesia solusi kini dan mendatang. Airlangga University Press, Surabaya, Indonesia; 2007. p. 166-8.
21. Bonacorsi M, Lefevre S, Clermont O, Houdouin V, Bourrillon A, Loirat C. Escherichia coli strains causing urinary tract infection in uncircumcised infants resemble urosepsis – like adult strains. J Urol. 2005; 173(2): 195-7.
22. Angulo JC, Gaspar MJ, Rodriguez N, Tello AG, Torres G, Nunez C. The value C – reactive protein determination in patients with renal colic to decide urgent urinary diversion. J Urol. 2010; 76(2): 301-6.
23. Hirakata Y, Yanagihara K, Kurihara S, Izumikawa K, Seki M, Miyazaki Y. Comparison of usefulness of plasma procalcitonin and C – reactive protein measurements for estimation of severity in adults with community – acquired pneumonia. Diagnostic Microbiology and Infectious Disease. 2008; 1: 170-4.
24. Munoz P, Simarro N, Rivera M, Alonso R, Alcala L, Bouza E. Evaluation of procalcitonin as a marker of infection in a nonselected sample of febrile hospitalized patients. Diagnosis Microbiology and Infectious Disease. 2004; 49: 237-41.
25. Kotoula A, Gardikis S, Tsalkidis A, Mantadakis E, Zissimopoulus AA, Deftereos S. Comparative efficacies of procalcitonin and conventional inflammatory markers for prediction of renal parenchymal inflammation in pediatric first urinary tract infection. J Urol. 2009; 73(4): 782-6.
26. Hochreiter M, Kohler T, Schweiger AM, Keck FS, Bein B, Spiegel TV. Procalcitonin to guide duration of antibiotic therapy in intensive care patients: A randomized prospective controlled trial. Critical Care. 2009; 13(R83): 1-7.