Effectiveness and Safety of Generic Formulation of Piperacillin/Tazobactam (Astaz-P^{R}) for Treatment of Infected Patients at Siriraj Hospital

Lantharita Charoenpong MD*,
Sasima Tongsai PhD*, Visanu Thamlikitkul MD*

** Division of Infectious Diseases and Tropical Medicine, Department of Medicine, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand*

Objective: *To determine effectiveness and safety of generic piperacillin/tazobactam (Astaz-P^{R}) that has been available as a substitute for original piperacillin/tazobactam (Tazocin^{R}) in Siriraj Hospital since October 2011.*

Material and Method: *Medical records of hospitalized adult patients who received piperacillin/tazobactam for at least 48 hours from January 2011 to June 2012 were reviewed. The data on demographics, clinical features of infections, antibiotic treatments, clinical courses and outcomes of the patients who received original piperacillin/tazobactam and generic piperacillin/tazobactam were analyzed and compared.*

Results: *The medical records of 300 patients who received original piperacillin/tazobactam and 300 patients who received generic piperacillin/tazobactam were included. The characteristics of the patients and clinical and microbiological features of infections of the patients in both groups were not significantly different. Overall favorable clinical outcome and overall mortality were comparable between generic and original groups (74.0% vs. 74.7%, p = 0.93; 18.3% vs. 18.0%, p = 1.00, respectively). No significant difference of adverse effect was found between two groups. The non-inferiority test indicated that the clinical outcome and overall mortality of the patients who received generic piperacillin/tazobactam were not inferior to those who received original piperacillin/tazobactam (p = 0.004 and p = 0.001, respectively).*

Conclusion: *Generic piperacillin/tazobactam (Astaz-P^{R}) was not inferior to original piperacillin/ tazobactam (Tazocin^{R}) for therapy of infections in the hospitalized patients at Siriraj Hospital.*

Keywords: *Piperacillin/tazobactam, Original, Generic, Non-inferiority, Effectiveness, Safety*

J Med Assoc Thai 2013; 96 (Suppl. 2): S104-S110
Full text. e-Journal: *http://jmat.mat.or.th*

Piperacillin/tazobactam is a combination of beta-lactam antibiotic (piperacillin) and beta-lactamase inhibitor (tazobactam). Piperacillin/tazobactam is a broad spectrum antibiotic that contains activity against gram positive and gram negative bacteria, including *Pseudomonas aeruginosa*, as well as anaerobes[1-3]. Piperacillin/tazobactam has been used for therapy of moderate and severe bacterial community-acquired and hospital-acquired infections[1-3]. Piperacillin/tazobactam was shown to be effective and safe in therapy of nosocomial pneumonia, intra-abdominal infections, febrile neutropenia and other infections[4-8]. The usual dosage of piperacillin/tazobactam is 4.5 grams every 6-8 hours for 7 to 14 days.

Correspondence to:
Thamlikitkul V, Division of Infectious Diseases and Tropical Medicine, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.
Phone & Fax: 0-2419-7783
E-mail: visanu.tha@mahidol.ac.th

The original innovator of piperacillin/tazobactam is Tazocin^{R}. The original piperacillin/tazobactam has been used in Thailand for more than a decade. Piperacillin/tazobactam is classified as category D in the National List of Essential Medicines of Thailand. The cost of piperacillin/tazobactam is rather expensive. Piperacillin/tazobactam is one of the restricted antibiotics at Siriraj Hospital. It can be approved for 5 indications: 1) confirmed or suspected infection due to *Pseudomonas aeruginosa*, 2) infection due to pathogen resistant to cephalosporins, aminoglycosides and fluoroquinolones, 3) empiric therapy for febrile neutropenia, 4) infection due to the pathogen being susceptible to other antibiotics but the patient is unable to receive such antibiotics and 5) empiric therapy of nosocomial infections.

Generic formulation of piperacillin/tazobactam (Astaz-P^{R}) has been approved to be used as a substitute for original product (Tazocin^{R}) since October 2011. The objective of the present study was to compare

effectiveness and safety of generic piperacillin/tazobactam with original product for treatment of infections in hospitalized patients at Siriraj Hospital according to the policy of Siriraj Hospital to assess effectiveness and safety of new generic products in hospital formulary since 2008.

Material and Method

The present study was approved by the Siriraj Institutional Review Board. The identifications of hospitalized patients who received piperacillin/tazobactam from January 2011 to June 2012 were identified from the pharmacy database of Siriraj Hospital. The eligible patients aged 18 or older who received piperacillin/tazobactam for at least 48 hours were selected by systematic random sampling. The medical records of the chosen patients were reviewed to obtain demographic data, underlying conditions, indications of prescribing piperacillin/tazobactam, type and site of infection, causative organism, previous and concurrent antibiotic use, microbiological and clinical outcomes and adverse events.

The present study was conducted to demonstrate non-inferiority of generic piperacillin/tazobactam in relation to overall favorable outcome including cure and improvement at the end of treatment. The authors assumed a favorable outcome of 70% with the original drug and non-inferiority margin of 10% for the generic drug. With a power of 80% and type I errors of 5% by using n Query Advisor 5.0, a sample size of at least 260 patients per each group was needed to show non-inferiority of generic piperacillin/tazobactam to original piperacillin/tazobactam.

Mean, standard deviation, median and range were used to summarize continuous variables, whereas categorical variables were expressed as numbers and percentages. Chi-square test (Pearson's, Yates' continuity correction or Fisher's exact test) for categorical variables and unpaired t-test or Mann-Whitney U-test for continuous variables were used to compare differences between the two groups as appropriate. Non-inferiority test was used to compare the efficacy and safety between groups. All statistical procedures were conducted on PASW statistics 18.0 (SPSS) and statistical software R version 2.15.1 (R Development Core Team, 2012). A p-value of 0.05 or less was considered statistically significant using two tailed or one tailed test as appropriate.

Results

The characteristics of patients who received original and generic piperacillin/tazobactam were not

Table 1. Characteristics of the patients

	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
Age (yr)			0.64
Mean ± SD	63.1 ± 18.4	63.6 ± 18.0	
Median (min, max)	64 (18, 103)	67 (18, 100)	
Gender			
Male	139 (46.3%)	155 (51.7%)	0.22
Female	161 (53.7%)	145 (48.3%)	
Department			
Medicine	203 (67.7%)	222 (74.0%)	0.19
Surgery	63 (21.0%)	54 (18.0%)	
Other	34 (11.3%)	24 (8.0%)	
Underlying disease	275 (91.7%)	281 (93.7%)	0.43
Diabetes mellitus	78 (26.0%)	100 (33.3%)	0.06
Heart disease	73 (24.3%)	82 (27.3%)	0.46
Malignancy	111 (37.0%)	100 (33.3%)	0.39
Renal disease	39 (13.0%)	60 (20.0%)	0.03
Hypertension	140 (46.7%)	154 (51.3%)	0.29
HIV infection	6 (2.0%)	6 (2.0%)	1.00
Liver disease	28 (9.3%)	24 (8.0%)	0.66
Pulmonary disease	17 (5.7%)	33 (11.0%)	0.03
Immunosuppressive drug	15 (5.0%)	15 (5.0%)	1.00
Other	118 (39.3%)	106 (35.3%)	0.35
Previous antibiotic use	73 (24.3%)	71 (23.7%)	0.92

significantly different, as shown in Table 1. Forty-six percent to 52% of the patients were males with a mean age of 63 years. Most of the patients were hospitalized in medical wards. More than 90% of patients in both groups had co-morbidities in which hypertension, diabetes mellitus, heart disease and malignancy are common. Approximately 24% of the patients in both groups had prior use of other antibiotics.

The clinical and microbiological features of infections of the patients in both groups were not significantly different, as shown in Table 2. Most of the infections were nosocomial-acquired and health-care associated infections. Respiratory tract and genitourinary tract were common sites of infections. More than 95% of the patients in both groups had evidence of infections. Among the patients who had microbiological documented infections, *P. aeruginosa* was the most common pathogen. Most of the patients received only piperacillin/tazobactam and concurrent antibiotics were given to 13.0% and 8.3% of the patients who received generic piperacillin/tazobactam and original piperacillin/tazobactam respectively as shown in Table 3. More than 95% of the patients in both groups received piperacillin/tazobactam according to indications of piperacillin/tazobactam as recommended by the hospital in which the indication of confirmed or suspected infection due to *P. aeruginosa* was the most common, as shown in Table 4. The median dose of piperacillin/tazobactam was 13.5 grams per day and the median duration of piperacillin/tazobactam therapy was 6 days as shown Table 5.

The outcomes of piperacillin/tazobactam therapy are shown in Table 6. There was no significant difference in terms of favorable clinical outcome (74.0%

Table 2. Clinical and microbiological features of infections of the patients

	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
Type of infection			0.18
Community-acquired	84 (28.0%)	69 (23.0%)	0.19
Health-care associated	43 (14.3%)	57 (19.0%)	0.15
Nosocomial	173 (57.7%)	174 (58.0%)	1.00
Site of infection			
Respiratory	117(39.0%)	138 (46.0%)	0.09
Genitourinary	32 (10.7%)	46 (15.3%)	0.11
Wound/soft tissue	26 (8.7%)	22 (7.3%)	0.65
Catheter-associated blood stream	1 (0.3%)	1 (0.3%)	1.00
Intra-abdominal	31 (10.3%)	15 (5.0%)	0.02
Endocarditis	1 (0.3%)	0 (0%)	1.00
Bone & joint	2 (0.7%)	1 (0.3%)	1.00
Primary bacteremia	11 (3.7%)	11 (3.7%)	1.00
Others	5 (1.7%)	5 (1.7%)	1.00
Evidence of infection			0.30
Microbiological documented	106 (35.3%)	121 (40.3%)	
Clinical documented	188 (62.7%)	176 (58.7%)	
No	6 (2.0%)	3 (1.0%)	
Causative organism			
E. coli (ESBL- ve)	6 (2.0%)	15 (5.0%)	0.08
E. coli (ESBL+ ve)	15 (5.0%)	14 (4.7%)	1.00
K. pneumoniae (ESBL- ve)	15 (5.0%)	14 (4.7%)	1.00
K. pneumoniae (ESBL+ ve)	9 (3.0%)	10 (3.3%)	1.00
Pseudomonas aeruginosa	37 (12.3%)	41 (13.7%)	0.71
Acinetobacter baumannii	8 (2.7%)	11 (3.7%)	0.64
Stenotrophomonas maltophilia	8 (2.7%)	11 (3.7%)	0.37
MSSA	8 (2.7%)	6 (2.0%)	0.78
MRSA	3 (1.0%)	5 (1.7%)	0.72
Enterococcus spp.	9 (3.0%)	5 (1.7%)	0.48
Coagulase Negative Staphylococci	2 (0.7%)	0 (0%)	0.48
Streptococcus spp.	2 (0.7%)	5 (1.7%)	0.44

Table 3. Concurrent antibiotics

	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
No	261 (87.0%)	275 (91.7%)	0.09
Yes	39 (13.0%)	25 (8.3%)	
Beta-lactams	2 (0.7%)	2 (0.7%)	1.00
Aminoglycosides	3 (1.0%)	0 (0%)	0.25
Fluoroquinolones	5 (1.7%)	5 (1.7%)	1.00
Glycopeptides	18 (6.0%)	11 (3.7%)	0.25
Macrolides	4 (1.3%)	4 (1.3%)	1.00
Other	7 (2.3%)	3 (1.0%)	0.34

Table 4. Indications of piperacillin/tazobactam

Indication	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
No	5 (1.7%)	4 (1.3%)	1.00
Yes	295 (98.3%)	296 (98.7%)	
Confirmed or suspected infection due to *P.aeruginosa*	248 (82.7%)	258 (86.0%)	0.32
Infection due to pathogen resistant to cephalosporins, aminoglycosides, fluoroquinolones	5 (1.7%)	7 (2.3%)	0.77
Empiric therapy for febrile neutropenia	40 (13.3%)	28 (9.3%)	0.16
Infection due to pathogen susceptible to other antibiotics but the patient is unable to receive such antibiotics	2 (0.7%)	1 (0.3%)	1.00
Others	0 (0%)	2 (0.7%)	0.50

Table 5. Dosage and duration of piperacillin/tazobactam

	All patients	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
Dosage of piperacillin/tazobactam (gram per day)				0.33
Mean $\pm$ SD	11.7 $\pm$ 3.5	11.9 $\pm$ 3.6	11.6 $\pm$ 3.3	
Median (min, max)	13.5 (6.8, 18.0)	13.5 (6.8, 18.0)	13.5 (6.8, 18.0)	
Duration of piperacillin/tazobactam (day)				0.79
Mean $\pm$ SD	6.7 $\pm$ 4.2	6.6 $\pm$ 3.8	6.7 $\pm$ 4.7	
Median (Min, Max)	6.0 (2.0, 60.0)	6.0 (2.0, 29.0)	6.0 (2.0, 60.0)	

vs. 74.7%, p = 0.93), microbiological eradication of pathogen (25.3% vs. 23.7%), median length of hospital stay (19 days vs. 19 days), adverse effects (6.7% vs. 3%) and overall mortality (18.3% vs. 18%) between the generic and the original groups respectively. Non-inferiority analysis of favorable clinical outcome and overall mortality between the generic piperacillin/ tazobactam group and the original piperacillin/

tazobactam group revealed that generic piperacillin/tazobactam was not inferior to original piperacillin/tazobactam (p = 0.004 and p = 0.001 respectively) as shown in Table 7.

Discussion

Generic medicines are increasingly used in clinical settings for several reasons among which a significant cost saving is one of them. Although generic medicine prescription or substitution can increase affordability for the public, especially in developing countries, its effectiveness and safety remains an issue of controversy[9]. Several studies showed that some generic drugs were inferior to innovator products[10-13]. Registration of generic intravenous preparation to Thai Food and Drug Administration (FDA) Office does not require any data on bioequivalence or therapeutic equivalence to the original innovator. In vitro potency evaluations of various piperacillin/tazobactam generic products compared with the innovator revealed that many of the generic products contained less potent activity than original product[14,15]. Therefore,

Table 6. Outcomes of piperacillin/tazobactam therapy

	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	p-value
Clinical outcome within 48 hours after end of treatment with piperacillin/tazobactam			0.70
Favorable outcome (Cure + Improve)	222 (74.0%)	224 (74.7%)	0.93
Infection worse	60 (20.0%)	64 (21.3%)	0.76
Die due to infection	17 (5.7%)	11 (3.7%)	0.33
Others	1 (0.3%)	1 (0.3%)	1.00
Microbiological outcome			0.23
Eradicate	76 (25.3%)	71 (23.7%)	0.70
Persist	5 (1.7%)	10 (3.3%)	0.30
New organism	22 (7.3%)	33 (11.0%)	0.16
Undetermined	197 (65.7%)	186 (62.0%)	0.40
Length of hospital stay (day)			0.74
Mean $\pm$ SD	31.1 $\pm$ 35.3	28.9 $\pm$ 31.0	
Median (min, max)	19.0 (3.0, 252.0)	19.0 (2.0, 217.0)	
Discharge status			0.88
Alive	245 (81.7%)	246 (82.0%)	1.00
Die due to infection treated with piperacillin/tazobactam	22 (7.3%)	20 (6.7%)	0.87
Die of other infection	19 (6.3%)	21 (7.0%)	0.87
Die of other causes	13 (4.3%)	13 (4.3%)	1.00
Against advice	1 (0.3%)	0 (0%)	1.00
Adverse effects			
Antibiotic allergy	1 (0.3%)	0 (0%)	1.00
Antibiotic-associated diarrhea	19 (6.3%)	9 (3.0%)	0.08
Overall mortality	55 (18.3%)	54 (18.0%)	1.00

Table 7. Non-inferiority analysis of main outcomes of piperacillin/tazobactam therapy

Outcome	Generic Piperacillin/ Tazobactam (n = 300)	Original Piperacillin/ Tazobactam (n = 300)	Difference (95% CI)	Chi-square test (p-value)	Non-inferiority test (p-value)
Favorable clinical outcome	222 (74.0%)	224 (74.7%)	-0.7% (-7.6, 6.3)	0.93	0.004
Overall mortality	55 (18.3%)	54 (18.0%)	0.3% (-5.9, 6.5)	1.00	0.001

effectiveness and safety of using generic drugs in a clinical setting still remain issues of physician and public concern, especially for life-saving drugs.

Siriraj Hospital has launched a policy to assess effectiveness and safety of new generic products included in hospital formulary since 2008. Piperacillin/tazobactam is a broad spectrum antibiotic to be used for patients with moderate and severe bacterial community-acquired and hospital-acquired infections[1-3] and it is one of the life-saving antibiotics. Therefore, generic piperacillin/tazobactam should contain effectiveness and safety not inferior to the innovator product.

Although randomized controlled trial comparing generic piperacillin/tazobactam with original piperacillin/tazobactam is the most suitable research design to determine non-inferiority of generic piperacillin/tazobactam, such a study design is expensive and time consuming. Therefore, this study was conducted by reviewing and analyzing the information from the patients who received generic piperacillin/tazobactam or original piperacillin/tazobactam as prescribed by practicing physicians. There are two main limitations of this study methodology. The confounders, such as characteristics of the patients, the severity of infections and co-interventions given to the patients in both groups might be different since it was not a prospective randomized controlled trial. Most of the patients who received original piperacillin/tazobactam were hospitalized during January to September 2011 whereas most of the patients who received generic piperacillin/tazobactam were hospitalized during October 2011 to June 2012. The difference in duration of prescriptions with original piperacillin/tazobactam and generic piperacillin/tazobactam mentioned earlier is that most of healthcare coverage policies indicated that generic drugs should be prescribed if they are available.

Although the methodology used in our study might be susceptible to biased results due to the aforementioned limitations, the present study results revealed that all major confounders of the patients and co-interventions given to the patients in both group were quite similar. Moreover, the observed primary outcome of the present study, favorable clinical response, was similar to the figure we expected and we used it to estimate the sample size. Therefore, the present study results of non-inferiority of generic piperacillin/tazobactam to original piperacillin/tazobactam observed in our study should be valid. It should be kept in mind that the results of this study were from the treatment of the patients with a specified generic piperacillin/tazobactam (Astaz-P^{R}) and the results of the present study cannot be generalized to other generic piperacillin/tazobactam products.

Acknowledgement

The present study is supported by Novartis (Thailand) Limited.

Potential conflicts of interest

None.

References

1. Perry CM, Markham A. Piperacillin/tazobactam: an updated review of its use in the treatment of bacterial infections. Drugs 1999; 57: 805-43.
2. Sanders WE Jr, Sanders CC. Piperacillin/tazobactam: a critical review of the evolving clinical literature. Clin Infect Dis 1996; 22: 107-23.
3. Charbonneau P. Review of piperacillin/tazobactam in the treatment of bacteremic infections and summary of clinical efficacy. Intensive Care Med 1994; 20 (Suppl 3): S43-8.
4. Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean NC, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis 2007; 44 (Suppl 2): S27-72.
5. American Thoracic Society; Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005; 171: 388-416.
6. Solomkin JS, Mazuski JE, Bradley JS, Rodvold KA, Goldstein EJ, Baron EJ, et al. Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America. Clin Infect Dis 2010; 50: 133-64.
7. Freifeld AG, Bow EJ, Sepkowitz KA, Boeckh MJ, Ito JI, Mullen CA, et al. Clinical practice guideline for the use of antimicrobial agents in neutropenic patients with cancer: 2010 update by the infectious diseases society of america. Clin Infect Dis 2011; 52: e56-93.
8. Stevens DL, Bisno AL, Chambers HF, Everett ED, Dellinger P, Goldstein EJ, et al. Practice guidelines for the diagnosis and management of skin and soft-tissue infections. Clin Infect Dis 2005; 41: 1373-

406.
9. Cameron A, Ewen M, Ross-Degnan D, Ball D, Laing R. Medicine prices, availability, and affordability in 36 developing and middle-income countries: a secondary analysis. Lancet 2009; 373: 240-9.
10. Mastoraki E, Michalopoulos A, Kriaras I, Mouchtouri E, Falagas ME, Karatza D, et al. Incidence of postoperative infections in patients undergoing coronary artery bypass grafting surgery receiving antimicrobial prophylaxis with original and generic cefuroxime. J Infect 2008; 56: 35-9.
11. Kesselheim AS, Misono AS, Lee JL, Stedman MR, Brookhart MA, Choudhry NK, et al. Clinical equivalence of generic and brand-name drugs used in cardiovascular disease: a systematic review and meta-analysis. JAMA 2008; 300: 2514-26.
12. Berg MJ, Gross RA, Tomaszewski KJ, Zingaro WM, Haskins LS. Generic substitution in the treatment of epilepsy: case evidence of breakthrough seizures. Neurology 2008; 71: 525-30.
13. Piyasirisilp S, Premprawat W, Thamlikitkul V. Therapeutic equivalence of generic imipenem/cilastatin for therapy of infections at Siriraj Hospital. J Med Assoc Thai 2010; 93 (Suppl 1): S117-25.
14. Jones RN, Fritsche TR, Moet GJ. In vitro potency evaluations of various piperacillin/tazobactam generic products compared with the contemporary branded (Zosyn, Wyeth) formulation. Diagn Microbiol Infect Dis 2008; 61: 76-9.
15. Moet GJ, Watters AA, Sader HS, Jones RN. Expanded studies of piperacillin/tazobactam formulations: variations among branded product lots and assessment of 46 generic lots. Diagn Microbiol Infect Dis 2009; 65: 319-22.

ประสิทธิผลและความปลอดภัยของยาสามัญ Piperacillin/Tazobactam (Astaz-P^{R}) ในการรักษาผู้ป่วยโรคติดเชื้อในโรงพยาบาลศิริราช

ลัลธริตา เจริญพงษ์, ศศิมา ทองสาย, วิษณุ ธรรมลิขิตกุล

วัตถุประสงค์*: เพื่อทราบประสิทธิผลและความปลอดภัยของยาสามัญ Piperacillin/Tazobactam (Astaz-P^{R}) ที่โรงพยาบาลศิริราชนำมาใช้ทดแทนยาต้นแบบในการรักษาโรคติดเชื้อตั้งแต่ตุลาคม พ.ศ. 2554*

วัสดุและวิธีการ*: เก็บข้อมูลจากเวชระเบียนผู้ป่วยอายุตั้งแต่ 18 ปีที่รับไว้รักษาในโรงพยาบาลและมีการติดเชื้อที่ได้รับยา Piperacillin/Tazobactam นานอย่างน้อย 48 ชั่วโมง แล้วนำข้อมูลลักษณะทั่วไปของผู้ป่วย ลักษณะการติดเชื้อ การรักษาด้วยยาต้านจุลชีพ การดำเนินโรค และผลการรักษาของผู้ป่วยที่ได้รับยาสามัญ Piperacillin/Tazobactam มาเปรียบเทียบกับผู้ป่วยที่ได้รับยาต้นแบบ Piperacillin/Tazobactam*

ผลการศึกษา*: การวิเคราะห์เวชระเบียนผู้ป่วยที่ได้รับยาสามัญ Piperacillin/Tazobactam จำนวน 300 คน และผู้ป่วยที่ได้รับยาต้นแบบ Piperacillin/Tazobactam จำนวน 300 คน พบว่าลักษณะทั่วไปและลักษณะของการติดเชื้อของผู้ป่วยทั้งสองกลุ่มไม่แตกต่างกันอย่างมีนัยสำคัญ อัตราผู้ป่วยหายหรือดีขึ้นจากการติดเชื้อ (ร้อยละ 74.0 เปรียบเทียบกับร้อยละ 74.7, p = 0.93) และอัตราตายรวม (ร้อยละ 18.3 เปรียบเทียบกับร้อยละ 18.0, p = 1.00) ของกลุ่มที่ได้รับยาสามัญและยาต้นแบบตามลำดับไม่พบความแตกต่างกันอย่างมีนัยสำคัญ ผลข้างเคียงของยาทั้งสองขนานก็ไม่พบความแตกต่างอย่างมีนัยสำคัญ การทดสอบความไม่ด้อยกว่ากันของผลการรักษาหลักก็พบว่ายาสามัญมีผลการรักษาทางคลินิกและอัตราการตายรวมไม่ด้อยกว่ายาต้นแบบ (p = 0.004 และ p = 0.001 ตามลำดับ)*

สรุป*: ยาสามัญ Piperacillin/Tazobactam (Astaz-P^{R}) มีประสิทธิผลและความปลอดภัยในการรักษา โรคติดเชื้อในผู้ป่วยที่รับไว้รักษาที่โรงพยาบาลศิริราชไม่ด้อยกว่ายาต้นแบบ*