

Bacterial Infections in Hospitalized Patients in Thailand in 1997 and 2000

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Abstract

Two surveys to determine the patterns of bacterial infections and trends in resistance to antibiotics of bacteria causing infections in patients admitted to hospitals in Thailand were conducted in 36 and 37 hospitals throughout Thailand in June 1997 and February 2000. Approximately 50 per cent of infections in hospitalized patients in Thailand were hospital-acquired infections. Urinary tract and lower respiratory tract were the most common sites of infections. Eighty per cent of infections were caused by gram negative bacteria. Gram negative bacteria causing infections in 2000 were more resistant to most commonly used antibiotics when compared with those in 1997. The prevalence of gram positive bacteria causing hospital-acquired infections significantly increased during this period. The trend of increase in resistance in most gram positive bacteria in 2000 was not clearly observed.

Key word : Bacterial Infections, Hospitalized Patients

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Bacterial infection remains the leading cause of hospitalization due to severe community-acquired infections (CAI), and is one of the major leading causes of morbidity and mortality in hospitalized patients due to hospital-acquired infec-

tions (HAI). Over the past decade, there has been a change in types of bacteria and decrease in antibiotic susceptibility of bacteria causing both community-acquired infections and hospital-acquired infections. Antibiotic resistant bacteria of clinical

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concerns such as methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant enterococci (VRE) and multi-drug-resistant gram negative bacilli have emerged and have caused epidemics in many parts of the world(1-8). Information on common causative agents for each site of infection and antibiotic susceptibility of causative bacteria are essential for selecting appropriate empiric antibiotics. Therefore, periodic surveillance of the prevalence of bacteria causing infections and their antibiotic susceptibility are crucial.

The objectives of the study were to determine the patterns of bacterial infections and their trends in resistance to antibiotics in patients admitted to hospitals in Thailand in 1997 and 2000.

MATERIAL AND METHOD

Study sites

The studies were conducted in 36 hospitals in 1997 and 37 hospitals in 2000. The study hospitals included various sizes distributed among 4 regions of Thailand. There were 3-4 university hospitals, 7 regional hospitals, 25 general hospitals and 2 private hospitals as shown in Table 1. Thirty-five hospitals in both study periods were the same hospitals. The hospitals included accounted for 20 per cent of the total hospital beds in Thailand.

Study procedures

Infection control nurses from participating hospitals were invited for orientation of the patients' record forms in the study. Information on all documented culture-proven bacterial infections in all patients admitted to the study hospitals in June 1997 and February 2000 were recorded by trained infection control nurses using the standardized data record forms. The contents in the data record form included types of infection (community-acquired or hospital-acquired infections), sites of infection, types of causative bacteria for each site of infection, and antibiotic susceptibility of causative bacteria. The completed data record forms were sent to Siriraj Hospital for analysis using an SPSS program.

RESULTS

A total of 8,164 and 6,725 episodes of documented culture-proven bacterial infections were collected in 1997 and 2000 respectively. Approximately 47 per cent and 50 per cent of the infections in 1997 and 2000 were hospital-acquired

Table 1. Characteristics of participating hospitals.

	1997	2000
University Hospitals	4	3
Regional Hospitals	7	7
General Hospitals	25	25
Private Hospitals	0	2
Total	36	37

Table 2. Prevalence of community-acquired infections and hospital-acquired infections.

	1997	2000
Total episodes of infections	8,164	6,725
Community-acquired infections	53.1%	49.8%
Hospital-acquired infections	46.9%	50.2%

Table 3. Sites of infections (%).

	1997	2000
Total episodes of infections	8,164	6,725
Urinary tract	27%	27%
Lower respiratory tract	26%	36%
Skin & Soft tissue	24%	21%
Gastro-intestinal tract	8%	5%
Primary bacteremia	8%	7%
Eye & Ear	2%	1%
Others	5%	4%

Table 4. Overall types of bacteria causing infections in hospitalized patients.

	1997	2000
	%	%
Overall infections		
Gram positive bacteria	20.4	20.6
Gram negative bacteria	79.6	79.4
Hospital-acquired infections		
Gram positive bacteria	15	22.7
Gram negative bacteria	85	77.3

infections ($p<0.0001$) as shown in Table 2. The prevalence of hospital acquired infections in university hospitals was significantly higher than those in regional, general and private hospitals in both periods. Urinary tract and lower respiratory tract

Table 5. Types of bacteria causing infections in hospitalized patients.

Organisms	1997 (%)			2000 (%)		
	Total	CAI	HAI	Total	CAI	HAI
<i>E. coli</i>	19.1	63	37	20	64	36
<i>Klebsiella</i> spp	14.4	53	47	14.9	48	52
<i>P. aeruginosa</i>	14.2	33	67	14.3	29	71
<i>Acinetobacter</i> spp	8.7	33	67	7.6	30	70
Methicillin sensitive <i>S. aureus</i>	6.4	69	31	6.1	67	33
<i>Enterobacter</i> spp	5.3	48	52	6.7	40	60
<i>Proteus</i> spp	3.9	59	41	3.3	59	41
Methicillin resistant <i>S. aureus</i>	3.7	30	70	3.4	18	82
<i>Enterococcus</i> spp	2.1	46	54	2.2	47	53
<i>Salmonella</i> spp	1.8	84	16	1.4	91	9
<i>S. pneumoniae</i>	0.8	78	22	1.4	79	21

Table 6. Common causative bacteria in urinary tract infection.

Organisms	1997 (% of 2,162 episodes)	2000 (% of 1,797 episodes)
<i>E. coli</i>	40.0	41.4
<i>Klebsiella</i> spp	15.3	14
<i>P. aeruginosa</i>	9.5	9.1
<i>Enterobacter</i> spp	5.9	7.4
<i>Proteus</i> spp	4.7	3.8
<i>Acinetobacter</i> spp	4.5	3.6
<i>Enterococcus</i> spp	4.4	4.5

Table 7. Common causative bacteria in lower respiratory tract infection.

Organisms	1997 (% of 2,120 episodes)	2000 (% of 2,394 episodes)
<i>P. aeruginosa</i>	23.3	22.0
<i>Klebsiella</i> spp	21.5	20.9
<i>Acinetobacter</i> spp	17.6	13.5
Methicillin resistant <i>S. aureus</i>	4.9	4.6
Methicillin sensitive <i>S. aureus</i>	4.8	4.6
<i>Enterobacter</i> spp	4.4	6.9
<i>E. coli</i>	4.4	6.0
<i>H. influenzae</i>	2.6	4.2
<i>Serratia</i> spp	2.0	1.6
<i>S. pneumoniae</i>	1.7	2.4

were the most common sites of infection in 1997 and 2000 respectively as shown in Table 3. For overall infections, 79.6 per cent and 79.4 per cent of infections in 1997 and 2000 were caused by

gram negative bacteria ($p=0.7$). Gram positive infections were found in 20.4 per cent in 1997 and 20.6 per cent in 2000 ($p=0.7$). However, the prevalence of gram positive bacteria in hospital-acquired infections in 2000 (22.7%) was significantly higher than that in 1997 (15%) ($p=0.0001$) as shown in Table 4. *Escherichia coli* was the most prevalent organism among gram negative bacteria in both periods, followed in rank by *Klebsiella* spp, *Pseudomonas aeruginosa* and *Acinetobacter* spp. *Staphylococcus* spp was the most prevalent organism among gram positive bacteria as shown in Table 5. *Escherichia coli*, *Salmonella* spp, methicillin sensitive *S. aureus* and *S. pneumoniae* were more commonly found in patients with community-acquired infections, whereas, *Pseudomonas aeruginosa*, *Acinetobacter* spp and methicillin resistant *S. aureus* were found in hospital-acquired infections ($p<0.05$) as shown in Table 5. Common causative bacteria for each major site of infection are shown in Tables 6 to 9. Enterobacteriaceae, *P. aeruginosa*, *Acinetobacter* spp and staphylococci were common causative bacteria for all major infections. An increasing resistance to nearly all commonly used antibiotics was observed in the data collected in 2000 when compared with those in 1997 especially in gram negative bacteria causing hospital-acquired infections as shown in Tables 10 to 15. Difference in antibiotic resistance among gram positive bacteria was not significantly observed between 1997 and 2000 as shown in Tables 16 to 19. MRSA accounted for 30 per cent and 35.6 per cent of all isolates of *S. aureus* in 1997 and 2000 respectively. MRSA accounted for 5.6 per cent and 24.4 per

Table 8. Common causative bacteria in skin and soft tissue infections.

Organisms	1997 (% of 1,974 episodes)	2000 (% of 1,405 episodes)
Methicillin sensitive		
<i>S. aureus</i>	19.6	17.6
<i>P. aeruginosa</i>	16.1	13.5
<i>E. coli</i>	12.8	15.8
<i>Klebsiella</i> spp	10.6	9.8
<i>Acinetobacter</i> spp	8.2	5.8
Methicillin resistant		
<i>S. aureus</i>	6.1	7.6
<i>Proteus</i> spp	6.0	6.3
<i>Enterobacter</i> spp	5.8	6.8
<i>Streptococcus</i> gr. A	2.0	1.0

Table 10. Antibiotic susceptibility (%) of *E. coli*.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Cefazolin	73	79	62	74	79	68
Cefotaxime	94	97	88	89	93	81
Ceftriaxone	95	97	88	86	90	79
Ceftazidime	87	91	80	86	93	74
Imipenem	99	99	98	99	99	99
Meropenem				99	100	97
Gentamicin	73	81	60	79	84	69
Amikacin	90	95	83	93	96	88
Netilmicin	85	91	76	90	93	85
Co-amoxiclav	77	77	76	77	79	73
Ciprofloxacin	68	74	58	66	74	50
Co-trimoxazole	29	33	23	33	35	31

cent of *S. aureus* isolates in community-acquired infections and hospital-acquired infections respectively in 1997. The respective figures of MRSA in 2000 were 13 per cent and 57 per cent. Vancomycin resistant enterococci was observed in less than 10 per cent of the isolates in both periods.

DISCUSSION

The starting point for collecting the data in these two surveys was the microbiology laboratory. Therefore, the surveys could only be conducted in those participating hospitals with an available microbiology facility. The accuracy of the data in our surveillance was dependent on the capacity of microbiologists in bacterial recovery and identification, and antibiotic susceptibility testing. It was also dependent on the capacity of infection

Table 9. Common causative bacteria in primary bacteremia.

Organisms	1997 (% of 657 episodes)	2000 (% of 477 episodes)
<i>Staphylococcus</i> spp	25.4	26.4
<i>E. coli</i>	14.9	16.6
<i>Klebsiella</i> spp	11.3	11.1
<i>Salmonella</i> spp	5.6	4.6
<i>Streptococcus</i> spp	10.9	10.7
<i>Acinetobacter</i> spp	4.3	2.9
<i>Enterobacter</i> spp	3.7	5.7
<i>P. aeruginosa</i>	2.9	6.7
<i>Enterococcus</i> spp	2.8	4.0

Table 11. Antibiotic susceptibility (%) of *Klebsiella* spp.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Cefazolin	63	75	41	60	76	46
Cefotaxime	82	90	72	73	91	57
Ceftriaxone	78	93	64	69	85	54
Ceftazidime	64	81	50	66	88	45
Imipenem	97	98	96	97	100	95
Meropenem				98	100	97
Gentamicin	72	84	58	71	87	56
Amikacin	77	96	66	79	92	68
Netilmicin	66	82	53	71	86	58
Co-amoxiclav	64	74	51	63	77	49
Ciprofloxacin	86	93	77	80	91	70
Co-trimoxazole	54	66	43	57	75	44

control nurses in identification of true infections and classification of types of infections. Microbiology laboratories in participating hospitals have been periodically tested for their proficiency in microbiology by Department of Medical Sciences, Ministry of Public Health. Only well-trained infection control nurses were invited to join the studies. Moreover, the investigator team provided workshops for infection control nurses from all participating hospitals prior to the surveys. Definitions of true infections and types of infections were explicitly used in the studies in order to minimize error of the data. It should be mentioned that the patients included in our studies were those who had culture-proven bacterial infections and admitted to the hospitals. Many patients with bacterial infections who were not sick enough to be hospitalized and

Table 12. Antibiotic susceptibility (%) of *Proteus* spp.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Cefazolin	79	85	71	62	72	53
Cefotaxime	97	98	95	91	94	88
Ceftriaxone	94	100	86	88	95	77
Ceftazidime	93	97	85	91	93	88
Imipenem	99	100	98	100	100	100
Meropenem				100	100	100
Gentamicin	84	88	79	80	81	79
Amikacin	95	99	90	98	98	97
Netilmicin	94	95	91	89	93	84
Co-amoxiclav	73	79	61	86	90	78
Ciprofloxacin	77	84	69	75	78	73
Co-trimoxazole	50	65	38	40	42	38

Table 13. Antibiotic susceptibility (%) of *Enterobacter* spp. (%)

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Cefazolin	18	32	2	12	16	10
Cefotaxime	66	82	51	53	71	42
Ceftriaxone	65	75	57	50	71	37
Ceftazidime	58	76	46	50	72	38
Imipenem	98	98	98	100	97	
Meropenem				94	96	90
Gentamicin	65	77	55	62	74	53
Amikacin	77	89	67	75	83	70
Netilmicin	65	76	58	70	81	64
Co-amoxiclav	22	32	12	13	23	7
Ciprofloxacin	77	84	69	75	78	73
Co-trimoxazole	50	65	38	44	61	33

Table 14. Antibiotic susceptibility (%) of *Pseudomonas aeruginosa*.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Ceftazidime	70	79	66	63	80	60
Imipenem	89	93	87	83	94	78
Meropenem				82	94	75
Gentamicin	59	67	56	61	74	56
Amikacin	70	74	68	68	79	63
Netilmicin	80	82	79	79	84	77
Ciprofloxacin	66	73	62	73	88	67

Table 15. Antibiotic susceptibility (%) of *Acinetobacter* spp.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Cefotaxime	31	47	24	34	46	27
Ceftazidime	36	53	29	42	54	37
Imipenem	97	96	98	88	96	85
Meropenem				80	87	76
Gentamicin	33	47	26	34	45	30
Amikacin	46	56	42	49	63	42
Netilmicin	62	78	55	66	73	63
Ciprofloxacin	44	56	37	48	65	42
Sulbac/Cefop.	88	94	84	89	89	89
Ampi/Sulbactam	62	80	55	58	78	51

those who were hospitalized but cultures were not taken were not recruited in the studies.

Approximately 50 per cent of all bacterial infections were acquired while the patients were in the hospitals and this proportion is increasing. This observation confirmed the fact that the magnitude of the burden of hospital-acquired infections in Thailand is enormous. Urinary tract, lower respiratory tract and skin and soft tissue were the common sites of infection accounting for 75 per cent of all infections. The prevalence of lower respiratory tract infections in which 60 per cent of the episodes were hospital-acquired was higher in 2000 than in 1997. Strategy for accurate diagnosis and proper treatment and prevention is urgently needed in order to control these infections with high morbidity and fatality.

Although gram negative bacteria have long been the most important organisms causing bacterial infections in hospitalized patients, the results of our studies demonstrated a trend of increasing gram positive infections in hospital-acquired infections over the next decade. This could be due to the availability of potent anti-gram negative antibiotics, a long duration of hospital stay, and the use of intravascular devices and other life-support devices especially in patients in intensive care units.

Enterobacteriaceae, *Pseudomonas aeruginosa* and *Acinetobacter* spp were prevalent among gram negative bacteria. The isolates causing community-acquired infections were more susceptible to antibiotics than those responsible for hospital-acquired infections. The trend of increasing resistance to antibiotics of these gram negative bacteria

Table 16. Antibiotic susceptibility (%) of *S. aureus*, MSSA.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Penicillin G	8	9	7	7	7	6
Clindamycin	99	98	100	98	99	95
Ciprofloxacin	98	97	100	91	93	87
Cefazolin	97	97	96	99	99	99
Cefotaxime	89	93	82	96	100	94
Ceftriaxone	95	98	89	94	100	86
Imipenem	98	100	97	100	100	100
Meropenem				100	100	100
Vancomycin	100	100	100	100	100	100
Teicoplanin	100	100	100	100	100	100

Table 18. Antibiotic susceptibility (%) of *Enterococcus* spp.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Penicillin G	51	63	41	76	84	67
Ampicillin	57	58	55	78	83	73
Vancomycin	96	96	96	96	100	91
Teicoplanin	94	100	97	94	100	88
Imipenem	95	96	88	83	88	80

especially multi-drug resistant enterobacteriaceae, *Pseudomonas aeruginosa* and *Acinetobacter* spp are worrisome. Innovation of new antibiotics to overcome these resistant bacteria as well as the employment of strategies to promote appropriate use of antibiotics in order to delay the rate of antibiotic resistance are desperately needed.

The prevalence of MRSA of more than 50 per cent among *S. aureus* strains isolated in hospital-acquired infections in 2000 suggests that glycopeptide should be an appropriate empiric antibiotic for presumed *S. aureus* infections acquired during hospitalization. Observation of the increasing prevalence of MRSA in causing community-acquired infections of up to 10 per cent in 2000 is quite alarming. Practicing clinicians should be alert to the possibility of failure in treating community-acquired *S. aureus* infection with isoxazolyl penicillins such as cloxacillin which has been an appropriate empiric antibiotic for staphylococcal infections acquired in communities over the past several decades. Although the overall prevalence of VRE was low and stable over a 3-year period,

Table 17. Antibiotic susceptibility (%) of *S. aureus*, MRSA.

Antibiotic	1997			2000		
	Total	CAI	HAI	Total	CAI	HAI
Vancomycin	100	100	100	100	100	100
Teicoplanin	95	100	94	100	100	100
Fosfomycin	89	92	71	78	86	77
Co-trimoxazole	30	33	30	15	21	14

Table 19. Antibiotic susceptibility (%) of *Streptococcus pneumoniae*.

Antibiotic	1997		2000	
	Total	Total	Total	Total
Penicillin G	68		58	
Ampicillin	85		77	
Cefazolin	88		96	
Cefotaxime	98		96	
Ceftriaxone	95		84	
Vancomycin	100		100	
Teicoplanin	100		100	
Imipenem	100		100	

there was a trend of vancomycin resistance among isolates of enterococci causing hospital-acquired infections. Vancomycin resistant enterococci could be an emerging pathogen in the near future due to increasing inappropriate use of broad spectrum antibiotics and an increase in consumption of glycopeptides for treating MRSA infections. Prevalence of penicillin resistant *S. pneumoniae* was also observed to be on the rise and this should be closely monitored.

In conclusion, approximately 50 per cent of infections in hospitalized patients in Thailand were hospital-acquired infections. Urinary tract and lower respiratory tract were common sites of infection. Eighty per cent of infections were caused by gram negative bacteria. Gram negative bacteria causing infections in 2000 were more resistant to most commonly used antibiotics compared with those in 1997. The prevalence of gram positive bacteria causing hospital-acquired infections had significantly increased. The trend of more higher resistance in most gram positive bacteria in 2000 was not clearly observed.

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การติดเชื้อแบคทีเรียในผู้ป่วยที่รับไว้รักษาในโรงพยาบาลในประเทศไทย พ.ศ. 2540 และ พ.ศ. 2543

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คณะผู้วจัยได้ศึกษาผู้ป่วยที่รับไว้รักษาในโรงพยาบาลเนื่องจากการติดเชื้อแบคทีเรียและผู้ป่วยที่มีการติดเชื้อแบคทีเรียขณะที่รักษาตัวอยู่ในโรงพยาบาลในโรงพยาบาลจำนวน 36 แห่งในเดือนมิถุนายน พ.ศ. 2540 และจำนวน 37 แห่งในเดือนกุมภาพันธ์ พ.ศ. 2543 โดยสำรวจความทุกข์ของเชื้อแบคทีเรียที่เป็นสาเหตุของการติดเชื้อและความทุกข์ของการตื้อต่ออย่างด้านจุลชีพของแบคทีเรียตั้งแต่ล้า ผลการศึกษาพบว่าประมาณร้อยละ 50 ของการติดเชื้อแบคทีเรียจำนวน 8,164 ครั้งใน พ.ศ. 2540 และ 6,725 ครั้งใน พ.ศ. 2543 เป็นการติดเชื้อที่เกิดขึ้นในโรงพยาบาล ต่ำแห่งที่มีการติดเชื้อได้บ่อย คือระบบปัสสาวะและระบบการหายใจช่วงล่าง ประมาณร้อยละ 80 ของการติดเชื้อเกิดจากเชื้อแบคทีเรียกรัมลบ การติดเชื้อในโรงพยาบาลมีแนวโน้มว่าจะเกิดจากเชื้อแบคทีเรียกรัมบวกมากขึ้น เชื้อแบคทีเรียกรัมลบที่พบใน พ.ศ. 2543 มีแนวโน้มตื้อต่ออย่างด้านจุลชีพขนาดที่เข้มข้นมากกว่าเชื้อแบคทีเรียกรัมลบที่พบใน พ.ศ. 2540 ส่วนความไวต่อยาด้านจุลชีพของเชื้อแบคทีเรียกรัมบวกที่พบใน พ.ศ. 2540 และ 2543 ไม่มีความแตกต่างกันอย่างมีนัยสำคัญ

คำสำคัญ : การติดเชื้อแบคทีเรีย, ผู้ป่วยที่รับไว้รักษาในโรงพยาบาล

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