Antimicrobial Susceptibility of Community and Hospital Acquired Bacteria

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Objectives : *To study the antibiotic susceptibility of common community- and hospital-acquired bacteria in Thailand.*

Material and Method : *Eight common bacterial pathogens were studied in 24 hospitals across Thailand in 2002-2003. Isolates of clinically proven infections were tested for their susceptibility by agar-based disc diffusion method.*

Results : *A total of 9,091 isolates of target bacteria were studied. Community and hospital acquired bacteria accounted for 54.9% and 45.1% respectively. Community acquired Escherichia coli, Klebsiella pneumoniae, Acinetobacter spp., Enterobacter spp., Staphylococcus aureus were more susceptible to antimicrobials compared to hospital acquired strains. The difference in susceptibility of community-acquired vs hospital acquired Pseudomonas aeruginosa, Coagulase-negative staphylococci and Enterococcus spp. was less impressive indicating the spread of hospital strains into the community. Bacteria isolated from the blood stream were more susceptible to antimicrobials compared to those from the lower respiratory tract, urinary tract and surgical sites. Acinetobacter spp. and Enterococcus spp. were less susceptible to antimicrobials compared to others.*

Conclusion : *Decreased susceptibility to antimicrobials was found in all bacteria tested. The susceptibility to commonly used antimicrobials of community-acquired bacteria decreased to a critical level indicating the widespread resistant bacteria to the community.*

Keywords *: Antimicrobial susceptibility, Community-acquired bacteria, Hospital-acquired bacteria*

J Med Assoc Thai 2005; 88 (Suppl 10): S14-25
Full text. e-Journal: *http://www.medassocthai.org/journal*

Prevalence of antimicrobial-resistant organisms has continued to increase globally over the past decades, particularly pathogenic bacteria isolated in secondary and tertiary-care hospitals[1,2]. Generally, hospital isolates are associated with higher antimicrobial resistance than community isolates[3,4]. Data on antimicrobial-resistant isolates in Thailand is limited. Pathogenic and non-pathogenic strains of community and hospital strains are usually reported together.

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A surveillance network on antimicrobial resistance has been conducted by the National Antimicrobial Resistance Surveillance of Thailand (NARST). Department of Medical Sciences, Ministry of Public Health. The organization collects data on antimicrobial susceptibility of laboratory-based isolates from participating microbiology laboratories across Thailand. A national multi-centered hospital-based study on patients with proven bacterial infections during 1997-2000 was done[3]. The present study investigated the susceptibility of bacterial isolates from culture-proven community and hospital-acquired infections in medium

- and large-sized hospitals nationwide.

Material and Method

A prospective, descriptive, multi-centered, hospital-based study was done in 24 secondary to tertiary-care hospitals across Thailand from July 2002 to October 2003. The participating hospitals included various public (provincial, regional, university) and private hospitals with 120-2,500 bed capacities in different parts of Thailand. Eight target bacteria including *Escherichia coli, Klebsiella pneumoniae, Enterobacter* spp., *Pseudomonas aeruginosa, Acinetobacter* spp., *Staphylococcus aureus, coagulase-negative Staphylococci* and *Enterococcus* spp. were collected, 50 isolates of each, specifically from patients with culture-proven community or hospital-acquired infections. Diagnosis of community-acquired and hospital-acquired infections were based on standard clinical and laboratory diagnostic criteria. Isolates of colonization or contamination were excluded from the present study. The bacteria were tested for susceptibility against selected antimicrobial agents with standard semi-quantitative agar-based disc diffusion method. Interpretation of inhibition zone was based on 2003 NCCLS break-point criteria. Microbiological and clinical data of study patients were recorded in a preset case record form, subsequently analyzed and reported.

Table 1. Distribution of isolates stratified by type of infections and hospitals

Hospitals	Isolates		Community-**acquired infections (%)**	Hospital-**acquired infections (%)**
	No	**%**		
Regional	3,920	43.1	49.5	50.5
Provincial	3,855	42.4	65.8	34.2
University	943	10.4	29.9	70.1
Private	373	4.1	61.4	38.6
Total	9,091	100	54.9	45.1

Table 2. Number and proportion of target organisms by types of infections

Gram negative Bacteria	Total	CI*		NI*	
		No	%	No	%
Acinetobacter spp.	1094	368	33.6	726	66.4
Enterobacter spp	1005	488	48.6	517	51.4
E. coli	1403	960	68.4	443	31.6
K. pneumoniae	1240	730	58.9	510	41.1
P. aeruginosa	1287	477	37.1	810	62.9
Total	6029	3023	50.1	3006	49.9
Gram positive bacteria					
S. aureus	1526	975	63.9	551	36.1
Coagulase-negative *staphylococci*	909	625	68.8	284	31.2
Enterococcus spp.	627	365	58.2	262	41.8
Total	3062	1965	64.2	1097	35.8
Overall	9091	4988	54.9	4103	45.1

CI = community acquired infection
NI = nosocomial infection

Statistical analysis

Statistical analysis was performed using computerized software SPSS for Windows version 11.0. Continuous and categorical variables were expressed as number and percentages respectively. Comparison of significant differences was considered when p value < 0.05.

Results

A total of 9,091 pathogenic bacterial isolates of 8 genera were collected from July 2002 to October 2003 from 24 study hospitals (Table 1), most of which were regional and provincial hospitals. The organisms were more frequently isolated from patients with community than hospital-acquired infections, (54.9 vs 45.1%). University hospitals, compared to the others, had a larger proportion of bacteria from hospital-acquired infections. This difference was statistically significant ($p < 0.01$).

The majority of isolates were collected from patients in medicine and surgery departments. Gram-positive organisms were associated with hospital-acquired infections more often than community-acquired infections (64.2 and 36.7%). Both types of infections were comparable in Gram-negative organisms (49.9 and 50.1%).

Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, coagulase-negative *staphylococci* and *Enterococcus* spp. were more commonly isolated from patients with community-acquired infections than hospital-acquired infections. *Acinetobacter* spp., *Enterobacter* spp. and *P. aeruginosa* were more commonly associated with hospital-acquired infections, as shown in Table 2.

Target pathogens were most commonly isolated from patients with lower respiratory or urinary

Table 3. Sites of infections

Sites	Episodes	
	No	%
Lower respiratory tract	3,013	33.1
Urinary tract	2,363	26.0
Skin & Soft tissue	1,808	19.9
Blood stream	783	8.6
Surgical wound	552	6.1
Others	572	6.3

Table 4. Susceptibility of bacteria from different sites of infection to ceftazidime

	Sites*							
	LRT		UT		BS		SS	
Organisms (no)	No	%	No	%	No	%	No	%
Acinetobacter (917)	666	39.6	163	52.8	39	48.7	49	28.6
Enterobacter spp.(741)	349	59.9	259	45.2	32	75.0	101	81.2
E. coli (1,118)	144	75	791	86.6	98	90.8	85	85.9
K. pneumoniae (1,017)	620	80	283	70.7	75	72.0	39	84.6
P. aeruginosa (1,032)	702	74.6	220	45.5	28	78.6	82	87.6

*LRT1 = lowere respiratory tract, UT = urinary tract, BS = blood stream, SS = surgical site

Table 5. Susceptibility of bacteria from different sites of infection to amikacin

	Sites							
	LRT		UT		BS		SS	
Organisms (no)	No	%	No	%	No	%	No	%
Acinetobacter (917)	666	46.1	163	47.2	39	53.8	49	36.7
Enterobacter spp.(741)	349	79.9	259	57.1	32	93.8	101	88.1
E. coli (1,118)	144	86.8	791	90.6	98	94.9	85	96.5
K. pneumoniae (1,017)	620	87.1	283	79.5	75	81.3	39	76.9
P. aeruginosa (1,032)	702	85.3	220	50.9	28	78.6	82	90.2

tract infections. The less common sites were skin and soft tissue, surgical site and blood stream infections as illustrated in Table 3.

Figures 1-7 illustrate the results of susceptibility testing of different target pathogens to selected antimicrobial agents. Data showed percentages of isolates susceptible to test antimicrobial agents. Types of infections include community-acquired (CI) and nosocomial infection (NI).

Isolates from hospital-acquired infections had higher rates of resistance to antimicrobial agents, compared to those from community-acquired infections e.g., 15.6-79.7% and 23.8-95.0% of *Escherichia coli* with hospital-acquired and community-acquired infections respectively were susceptible to antimicrobial agents tested, except imipenem. Susceptibility of *Escherichia coli* to the antimicrobial agents was at low to moderate levels, e.g., ampicillin 21.2%, cotrimoxazole 34.5%, 1st and 2nd generation cephalosporins 67.1-76.5%, ciprofloxacin 65.1% and gentamicin 72.1%. The other Gram negative isolates in the present study had a similar pattern to *Escherichia coli*.

Over 95% of all Gram negative isolates were sensitive to imipenem, except *Acinetobacter* spp. and *Pseudomonas aeruginosa* (76.1 and 84.7% respectively). All Gram-positive isolates were highly susceptible to vancomycin (≥ 95%). Some Gram-positive isolates were moderately susceptible to specific antimi-

Table 6. Susceptibility of bacteria from different sites of infection to ciprofloxacin

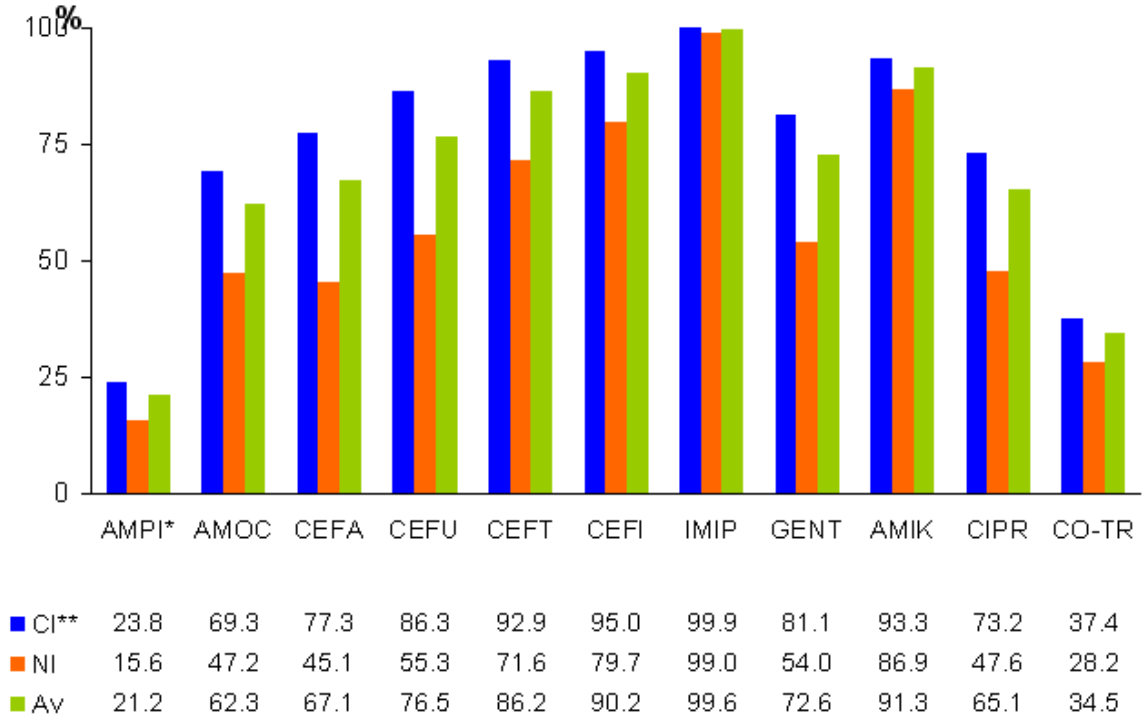
	Sites							
	LRT		UT		BS		SS	
Organisms (no)	No	%	No	%	No	%	No	%
Acinetobacter (917)	666	42.2	163	39.9	39	61.5	49	36.7
Enterobacter spp.(739)	349	74.8	258	45.7	32	87.5	100	93.0
E. coli (1,118)	144	68.1	791	62.2	98	79.6	85	57.6
K. pneumoniae (1,017)	620	63.7	283	58.3	75	81.3	39	74.4
P. aeruginosa (1,032)	702	76.6	220	39.10	28	71.4	82	80.5

Table 7. Susceptibility of bacteria from different sites of infection to imipenem

	Sites							
	LRT		UT		BS		SS	
Organisms (no)	No	%	No	%	No	%	No	%
Acinetobacter (917)	666	70.7	163	84.0	39	82.1	49	79.6
Enterobacter spp.(706)	328	97.6	249	99.2	30	100	99	99.0
E. coli (1,076)	142	99.3	761	99.9	91	100	82	98.8
K. pneumoniae (979)	603	99.5	271	99.3	68	100	37	100
P. aeruginosa (1,032)	702	81.8	220	81.4	28	85.7	82	91.5

Table 8. Susceptibility of bacteria from different sites of infection to vancomycin

	Sites							
	LRT		UT		BS		SS	
Organisms (no)	No	%	No	%	No	%	No	%
S.aureus (725)	400	100	66	100	124	100	135	100
Coagulase- negative staphylococci (643)	75	98.7	202	99.0	343	99.7	23	95.8
Enterococcus spp. (485)	56	100	357	96.7	41	95.3	31	93.9



*AMPI = ampicillin, AMOC = amoxycillin/clavulanate, CEFA = cefazolin,
CEFU = cefuroxime, CEFT = ceftazidime, CEFI = cefipime, IMIP = imipenem, GENT = gentamicin, AMIK = amikacin,
CIPR = ciprofoxacin,
CO-TR = co-trimoxazole
**CI = community Infection , NI = nosocomial Infection

Fig. 1 Susceptibility of *Escherichia coli* to antimicrobial agents tested

crobial agents in this study, eg., 87.9% of coagulase-negative *staphylococci* was sensitive to teicoplanin.

Methicillin-resistant *S. aureus* (MRSA) in the present study comprised 30.3% of total *Staphylococcus aureus* isolates and were associated with both community and hospital-acquired infections. Similar to other organisms in the present study, community isolates were more susceptible to antimicrobial agents than hospital isolates

Susceptibility and sites of infections

Susceptibility of isolates to antimicrobials was different from site to site of infections. Overall, causative agents of respiratory and urinary tract were less susceptible to antimicrobial agents than those of blood stream and surgical site. Results are shown in Tables 4-8.

Gram-positive isolates, except *Enterococcus* spp., were highly susceptible to vancomycin. Enterococci from surgical sites were associated with lower susceptibility to vancomycin (93.9%) than other sites. Vancomycin-resistant *Staphylococcus aureus* was not detected in the present study due to susceptibility to the test method. Disc diffusion test was not used for the detection of vancomycin-intermediate sensitive or resistant organisms.

As previously mentioned, susceptibility to imipenem of *Escherichia coli*, *Klebsiella pneumoniae* and *Enterobacter* spp. did not differ regarding sites of infections, community or hospital-acquired infections. Conversely, susceptibility of *Pseudomonas aeruginosa* and *Acinetobacter* spp. to imipenem were different between types and sites of infections. Hospital-acquired isolates had lower susceptibility to imipenem

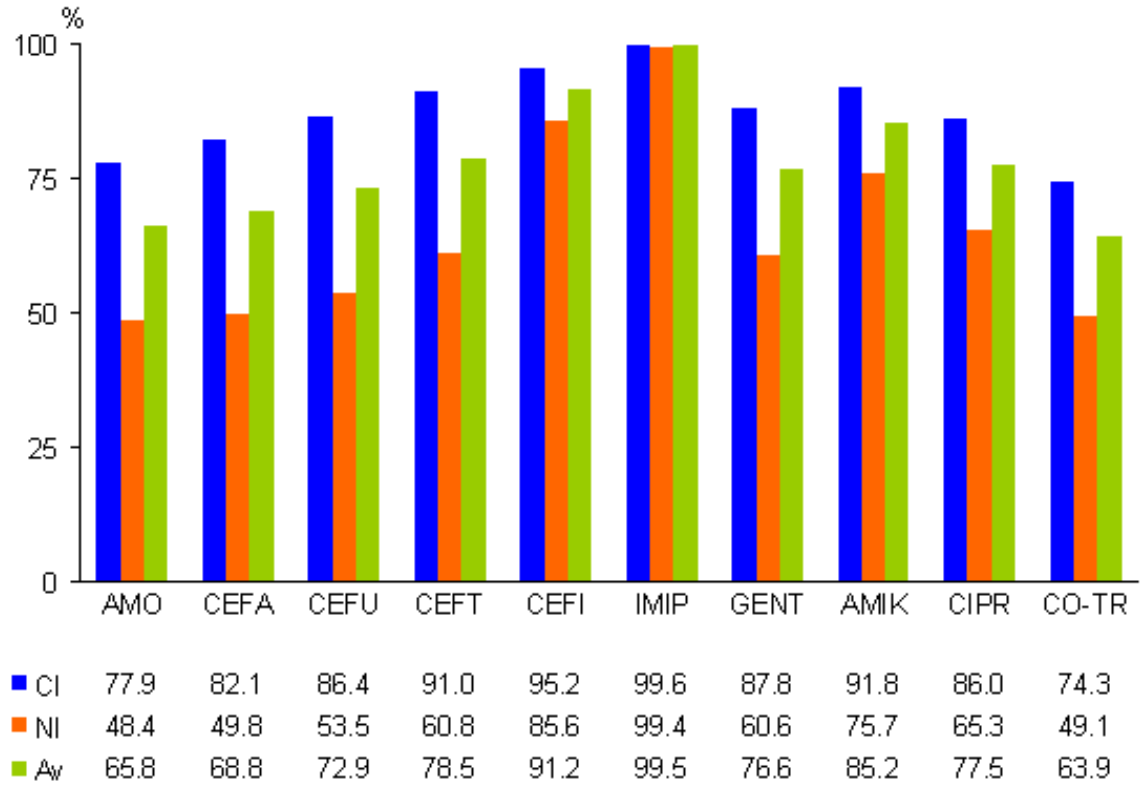


Fig. 2 Susceptibility of *Klebsiella pneumoniae* to antimicrobial agents tested

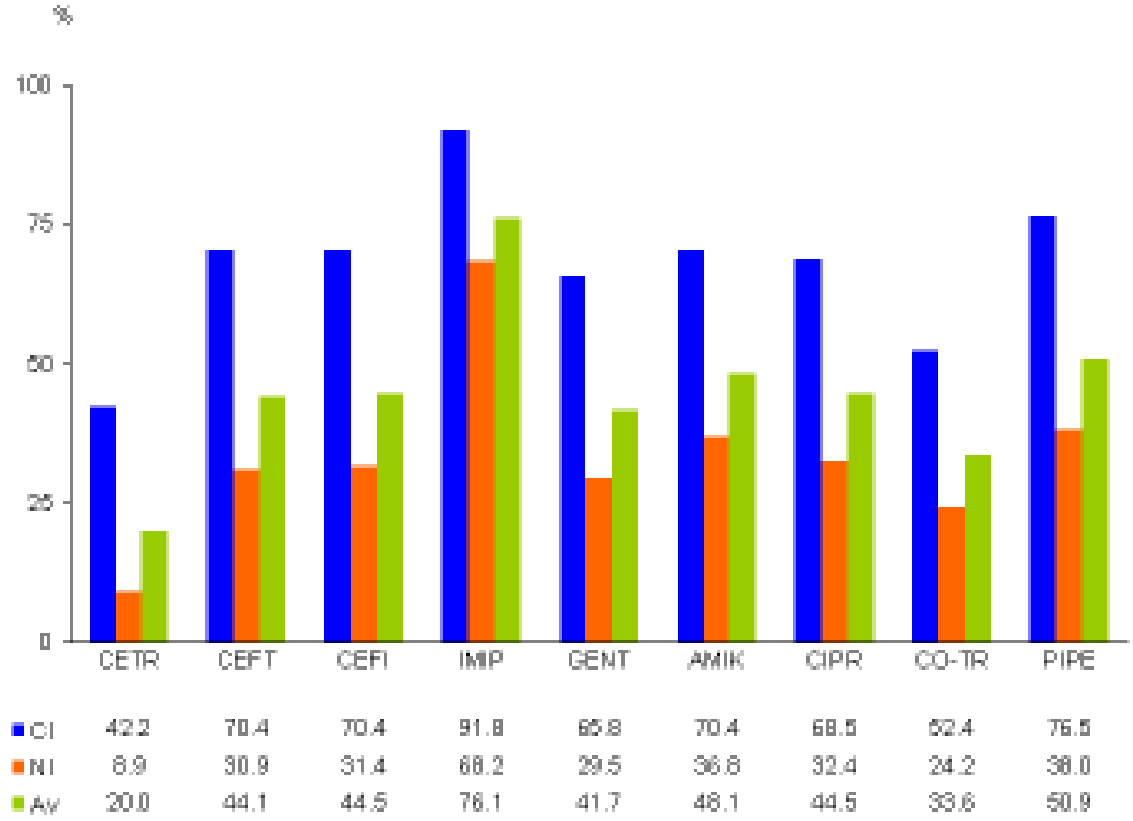
than community isolates. Isolates from respiratory, urinary tract were less susceptible to imipenem than those from blood and surgical sites.

Discussion

Antimicrobial-resistant organisms are associated with overuse or inappropriate use of antimicrobial agents. Commonly found antimicrobial-resistant organisms include methicillin-resistant *Staphylococcus aureus* (MRSA), drug-resistant *Streptococcus pneumoniae* (DRSP), extended-spectrum b-lactamase (ESBL) producing *Enterobacteriaceae*, multidrug-resistant *Mycobacterium tuberculosis* (MDR-TB), fluconazole-resistant *Candida* spp., vancomycin-intermediate and resistant *S. aureus* (VISA, VRSA)[1,2,5-8]. Despite an increase of antimicrobial-resistance over time, widespread overuse of antimicrobial agents in patients with critical illnesses, advanced stage of diseases, malignancy, immunocompromisd states, was not uncommon[8]. Data on susceptibility of common antimicrobial-resistant organisms are crucial for clinicians, hospital epidemiologists and administrators to manage patient-care, infection control, and antimicrobial agent utilization in health-care facilities. Therefore, the present study on selected target bacterial agents commonly found in secondary to tertiary-care hospitals in Thailand, demonstrating a high prevalence of antimicrobial-resistance should alert the medical community on the seriousness of the problem.

Bacterial isolates in the present study represent etiologic agents in proven community and hospital-acquired infections. In addition, the isolates were classified community and hospital-acquired strains, in middle and large-sized hospitals across the country. The results could represent the susceptibility of pathogenic bacterial of the country.

When compared to the susceptibility report by The National Antimicrobial-Resistance Surveillance, Thailand (NARST) in 2002,[1] the presented data reported lower levels of susceptibility to antimicrobial agents than those of NARST from the similar level of hospitals and in the same year, except *Escherichia coli*,



CETR = ceftriaxone, CEFT = ceftazidime, CEFI = cefipime, IMIP = imipenem,
GENT = gentamicin, AMIK = amikacin, CIPR = ciprofoxacin,
CO-TR = co-trimoxazole, PIPE = piperazcillin

Fig. 3 Susceptibility of *Acinetobacter* spp. to antimicrobial agents tested

Klebsiella pneumoniae and *Staphylococcus aureus*. The latter was more or similarly susceptible to antimicrobial agents, when compared to NARST data, as follows :

Susceptibility of *Acinetobacter* spp. in the present study vs NARST 2002 to ceftazidime 44.1 vs 60.0% , amikacin 48.1 vs 57.0%, imipenem 76.1 vs 78.0%,, of *Enterococcus* spp. to ampicillin 64.4 vs 76.0%, gentamicin 53.4 vs 54.0%. Susceptibility of *Escherichia coli* in the present study and NARST 2002 to ceftriaxone 86.2 vs 80.0% , gentamicin 72.6 vs 73.0%, of *Klebsiella pneumoniae* to ceftazidime 78.5 vs 72.0% , gentamicin 76.6 vs 73.0%, of *Staphylococcus aureus* to oxacillin 69.5 vs 66.0%, respectively.

When considering empirical antimicrobial therapy against *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Enterobacter* spp, *Enterococcus* spp. and coagulase-negative *staphylococci*, doctors should be aware of a higher level of antimicrobial-resistance than NARST report. These data should guide the choice of specific antimicrobials for better therapeutic results.[4]

Similar to other susceptibility reports in Thailand and worldwide, hospital-acquired isolates are associated with higher levels of antimicrobial-resistance than community-acquired isolates[9,10]. Isolates from respiratory, urinary tracts appeared more resistant than those from blood and surgical site. Nonetheless, susceptibility of Gram- positive isolates to vancomycin was not different between sites and types of infections. This finding may be associated with a limited value of disc diffusion to detect vancomycin intermediate sensitive and vancomycin-resistant *staphylococci* and *enterococci*.

In other reports, vancomycin-resistant *Sta-*

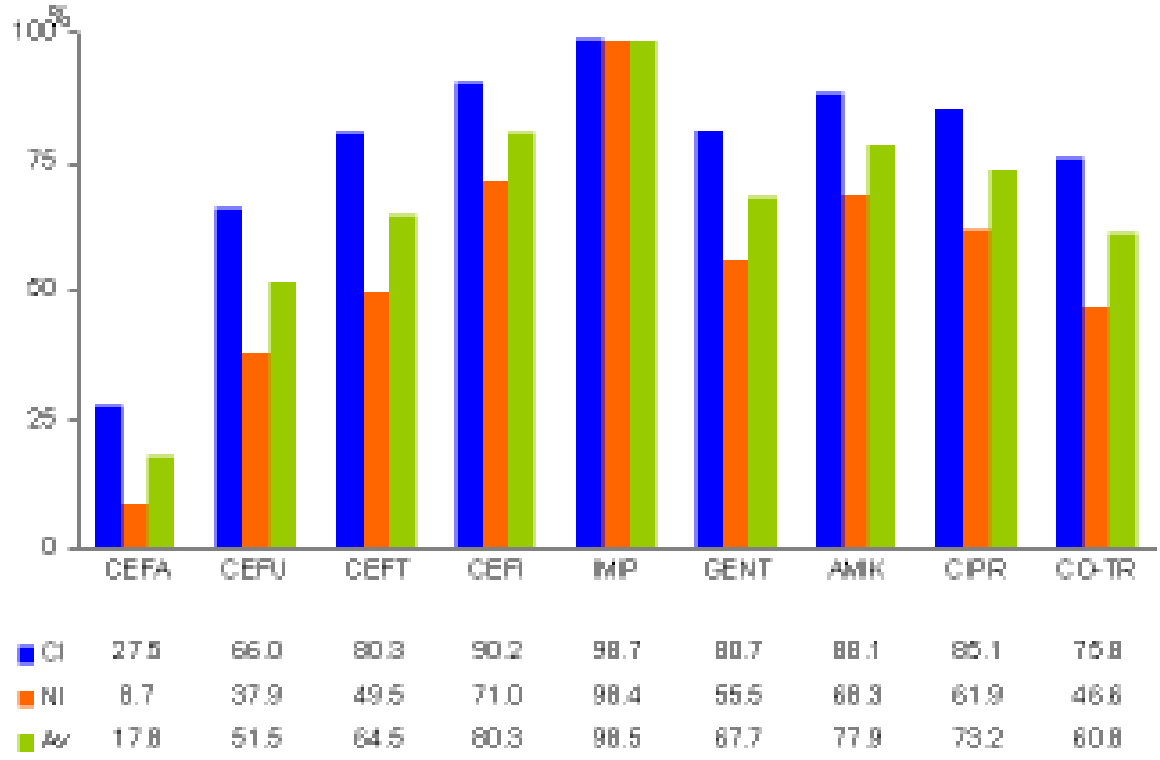


Fig. 4 Susceptibility of *Enterobacter* spp. to antimicrobial agents tested

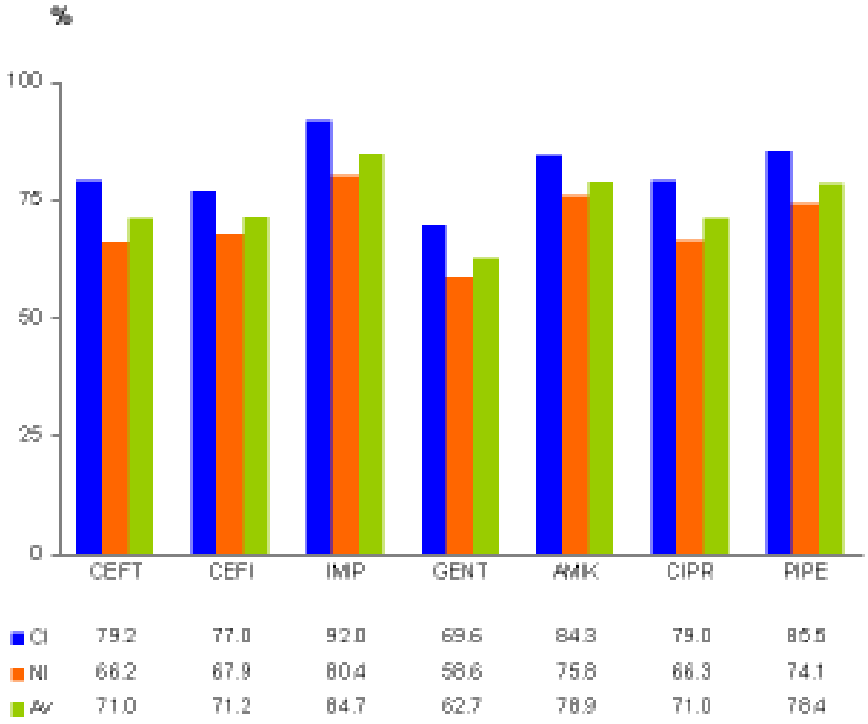
phylococcus aureus and *Enterococcus* spp. in Thailand are less commonly found than those in the United States[2]. In the present study, methicillin-resistant *Staphylococcus aureus* in Thailand appears to be less common than in the United States 30.5 vs 57.1%, respectively[11]. However, the rate of Gram- positive antimicrobial-resistance in Thailand has been increasing over time. Prevalence of antimicrobial-resistant Gram negative bacteria in Thailand was higher than in the United States[10,11] eg., in 2002, 3rd generation cephalosporins-resistant *Escherichia coli* 13.8 vs 6.3%, ciprofloxacin-resistant *Pseudomonas aeruginosa* 39.0 vs 32.8%.

Conclusions

High levels of antimicrobial-resistance among bacterial isolates from community and hospital-acquired infections in middle to large-sized hospitals across Thailand were found in the present study. Isolates causing hospital-acquired infections were more resistant to antimicrobial agents than those with community-acquired infections.

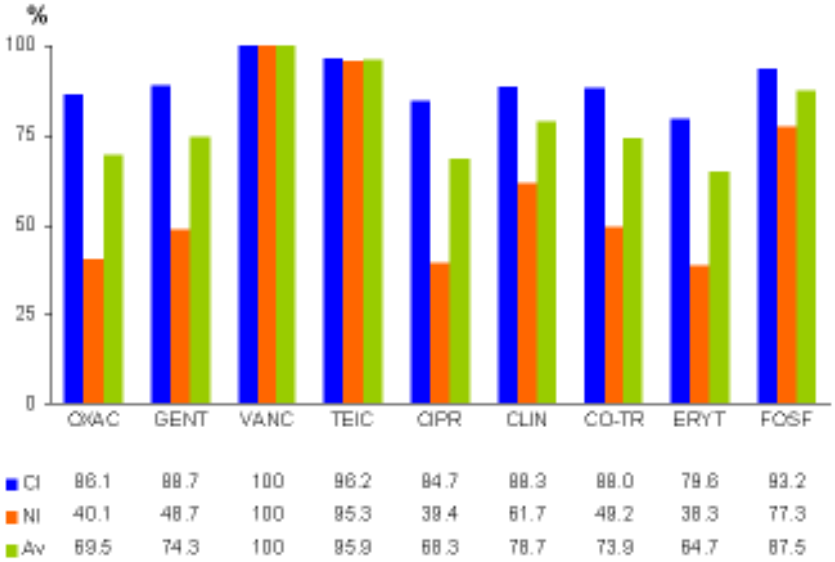
Acknowledgement

The authors wish to thank infection control nurses, microbiologists who participated in this study and Mahidol University for funding.



CEFT = ceftazidime, CEFI = cefipime, IMIP = imipenem, GENT = gentamicin, AMIK = amikacin, CIPR = ciprofoxacin, PIPE = piperacillin

Fig. 5 Susceptibility of *Pseudomonas aeruginosa* to antimicrobial agents tested



OXAC = oxacillin, GENT = gentamicin, VANC = vancomycin, TEIC = teicoplanin, CIPR = ciprofoxacin, CLIN = clindamycin, CO-TR = co-trimoxazole, ERYT = erythomycin, FOSF = fosfomycin

Fig. 6 Susceptibility of *Staphylococcus aureus* to antimicrobial agents tested

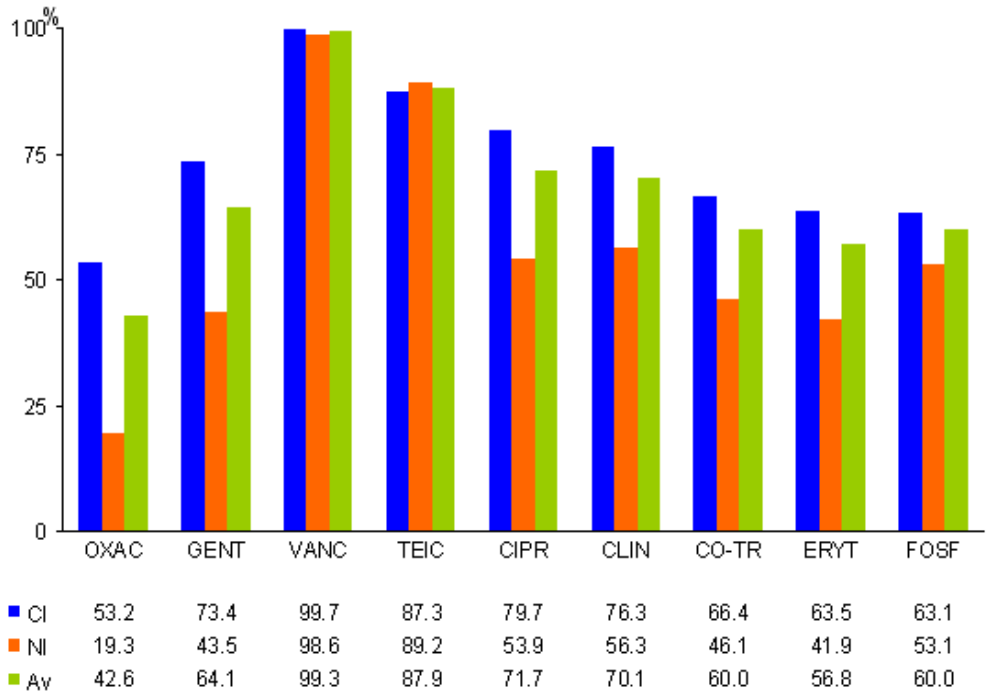


Fig. 7 Susceptibility of coagulase negative *staphylococci* to antimicrobial agents

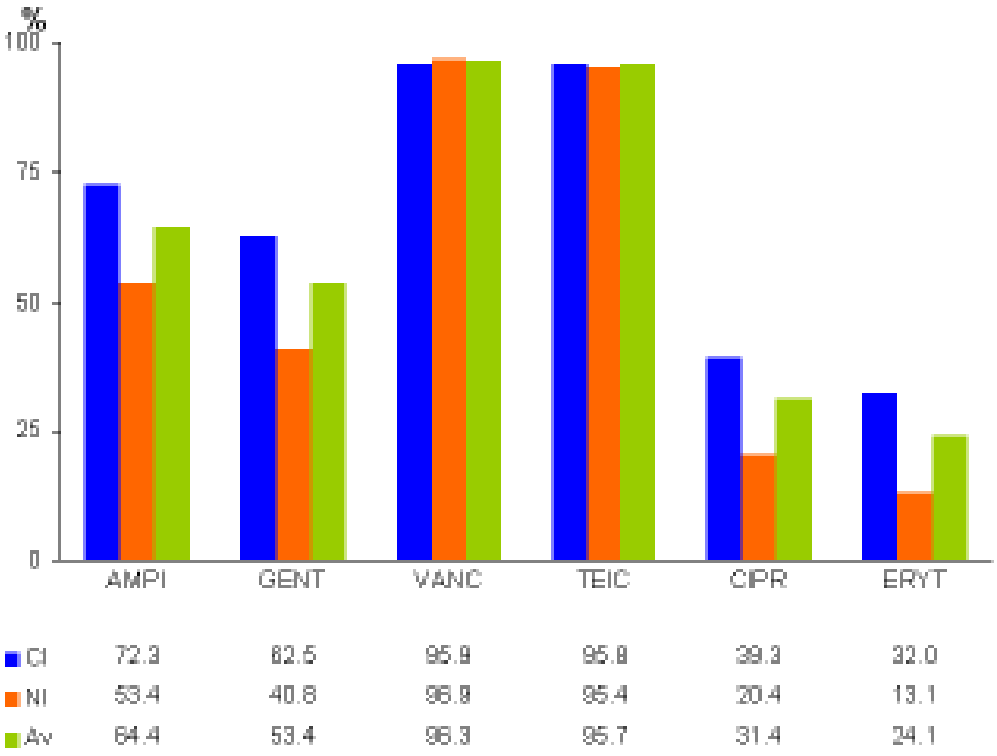


Fig. 8 Susceptibility of *Enterococcus* spp. to antimicrobial agents

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ความไวต่อยาต้านจุลชีพของแบคทีเรียก่อโรคในชุมชนและในโรงพยาบาล

สมหวัง ด่านชัยวิจิตร, ยงค์ รงค์รุ่งเรือง, เชิดศักดิ์ ธีระบุตร, มาลัย วรจิตร, ดวงพร จินตโนทัยถาวร

วัตถุประสงค์ *: ศึกษาความไวต่อยาต้านจุลชีพของแบคทีเรียก่อโรคในชุมชนและในโรงพยาบาลที่พบบ่อยในประเทศไทย*

วัสดุและวิธีการ *: ศึกษาแบคทีเรียก่อโรคที่พบบ่อย 8 ชนิด โดยศึกษาในโรงพยาบาล 24 แห่งในประเทศไทย ระหว่าง พ.ศ. 2545 และ พ.ศ. 2546 โดยใช้วิธี agar-based disc diffusion*

ผลการศึกษา *: ศึกษาแบคทีเรียรวม 9,091 สายพันธุ์ เป็นแบคทีเรียก่อโรคในชุมชนและในโรงพยาบาล 54.9% และ 45.1% ตามลำดับ. แบคทีเรียก่อโรคในชุมชน Escherichia coli, Klebsiella pneumoniae, Acinetobacter spp, Enterobacter spp, และ Staphylococcus aureus มีความไวต่อยาต้านจุลชีพมากกว่าแบคทีเรียก่อโรคในโรงพยาบาล ส่วนความไวต่อยาต้านจุลชีพของแบคทีเรียก่อโรคในชุมชนและในโรงพยาบาลของ Pseudomonas aeruginosa, coagulase-negative Staphylococci และ Enterococcus spp. ไม่มีความแตกต่างกันมากนัก แสดงว่าเชื้อดื้อยาได้แพร่เข้าสู่ชุมชนแล้ว แบคทีเรียที่แยกได้จากเลือดจะไวต่อยาต้านจุลชีพมากกว่าที่แยกได้จากทางเดินปัสสาวะ, ทางเดินหายใจและแผลผ่าตัด. Acinetobacter spp. และ Enterococcus spp. ไวต่อยาต้านจุลชีพน้อยกว่าแบคทีเรียอื่น*

สรุป *: ความไวต่อยาต้านจุลชีพลดลงในแบคทีเรียทุกสายพันธุ์ที่ตรวจ แบคทีเรียก่อโรคในชุมชนที่ไวต่อยาต้านจุลชีพน้อยแสดงว่ามีการแพร่ของเชื้อก่อโรคเหล่านี้เข้าสู่ชุมชน*