Epidemiologic Study of Nosocomial Bacterial Infection of Pediatric Patients at BMA Medical College and Vajira Hospital

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Background: *Nosocomial infection is a global public health problem, particularly by multi-drug resistant bacteria, increasing morbidity, mortality, and health care costs. The distribution of pathogens and antimicrobial sensitivity patterns change with time and vary among hospitals.*
Objective: *To determine and compare the bacterial pathogens causing nosocomial infections in pediatric patients and their susceptibility patterns between January 2000-December 2002 and January 2003-December 2005.*
Material and Method: *The bacterial pathogens and antimicrobial susceptibilities of children diagnosed as nosocomial infections at BMA Medical College and Vajira Hospital between January 2000 - December 2002 and January 2003- December 2005 were comparatively analyzed.*
Results: *1,863 and 1,884 isolates were identified in 2000-2002 and 2003-2005, respectively. The common sites of infections were bloodstream (28.6%), lower respiratory tract (15.3%), skin and soft tissue (14.9%), and urinary tract (12.5%). The major isolated gram positive pathogens were S. aureus, coagulase negative Staphylococcus and Enterococus. The major gram negative pathogens were E. coli, P. aeruginosa, K. pneumoniae, Enterobacter spp. and Acinetobacter spp. Compared between 2000-2002 and 2003-2005, methicillin resistant S. aureus (MRSA) was decreased from 4.3% to 1.5% P. aeruginosa from 13.3% to 7.5%, Enterobacter spp. from 4.2% to 2.4%, Serratia spp. from 1.3% to 0.3%, but methicillin resistant coagulase negative Staphylococcus was increased from 5.6% to 10.5% and K. pneumoniae from 5.5% to 7.7%, ($p < 0.05$). All gram positive cocci remained sensitive to vancomycin and linezolid. In 2003-2005, gram negative rods were less sensitive to 3rd and 4th generation cephalosporins and aminoglycosides than in 2000-2002. Sensitivity of gram negative rods to 3rd and 4th generation cephalosporins were not significantly different except Enterobacter spp. and Serratia spp., which were more sensitive to 4th generation cephalosporin ($p < 0.05$). Most gram negative pathogens (80-100%) were sensitive to ciprofloxacin except Acinetobacter spp. (61%). Carbapenems sensitivity were 100% except 92-100% for Enterobacter and 67-86% for P.aeruginosa, Acinetobacter spp. and Serratia spp.*
Conclusion: *The bacterial pathogens causing nosocomial infections and their susceptibility patterns change with time, so periodic surveillance are essential as a guide for more proper empirical therapy especially in serious or life threatening infections that need urgent appropriate antibiotics.*

Keywords: *Nosocomial bacterial infection, Epidemiologic study, Children, Susceptibility patterns*

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Nosocomial infection, a global public health problem, particularly caused by multi-drug resistant bacteria, increases morbidity, mortality, duration of hospitalization, health care costs, and work load of public health personnel[1,2]. The increased survival of immunocompromised patients, more use of invasive devices and misuse of antimicrobial agents contribute to antimicrobial resistance among bacterial pathogens causing nosocomial infections. Ignorance of infectious control practices increases the transmission of resistant organisms[3].

Although there were previous studies of nosocomial infections and their antimicrobial susceptibility patterns[4-12], the distribution of pathogens and antimicrobial sensitivity change with time and vary among hospitals[13]. The objectives of the present study were to determine and compare the bacterial pathogens causing nosocomial infections and their susceptibility patterns in children at BMA Medical College and Vajira Hospital, the tertiary hospital, between 2000-2002 and 2003-2005.

Material and Method

The present study was approved by Ethical Committee of Bangkok Metropolitan Administration. Inclusion criteria were children 15 years old or under, diagnosed as nosocomial infection and culture from clinical specimen grew bacteria. Nosocomial bacterial infection was defined as identification of bacteria from specimen with signs and symptoms of the site of infection, occurring more than 48 hours after admission[1]. Bacterial isolates without signs and symptoms of the suspected site of infection (bacterial colonization) were excluded.

Bacterial isolates and susceptibility patterns of pediatric patients with nosocomial bacterial infections admitted at BMA Medical College and Vajira Hospital between January 2000-December 2002 and January 2003-December 2005 were reviewed and comparatively analyzed. Antimicrobial susceptibility tests were performed by the disk diffusion method as recommended by the National Committee for Clinical Laboratory Standards (NCCLS)[14].

Statistical analysis

Statistical analysis was performed by Stata version 7.0. Categorical data was expressed as percent and compared between the two groups by Chi-square test. Continuous data were expressed as mean $\pm$ SD and compared between the two groups by student's t-test. A p-value < 0.05 was considered statistically significant.

Results

1,863 and 1,884 isolates were identified in 2000-2002 and 2003-2005, respectively. The most common sites of infections of both periods were bloodstream (28.6%), lower respiratory tract (15.3%), skin and soft tissue (14.9%), and urinary tract (12.5%) respectively as shown in Table 1. The causative pathogens were shown in Table 2. Isolates of gram positive and gram negative bacteria were 751 (40.3%) and 1,112 (59.7%) in 2000-2002 compared with 846 (44.9%) and 1,038 (55.1%) in 2003-2005. The most frequently iso-

Table 1. Sites of infections

Sites of infections	2000-2002		2003-2005		p-value
	numbers	%	numbers	%	
Bloodstream	459	28.1	488	29.0	0.57
Lower respiratory tract	248	15.2	260	15.4	0.87
Skin & soft tissue	226	13.9	269	16.0	0.09
Urinary tract	222	13.6	193	11.5	0.07
Surgical wound	124	7.6	115	6.8	0.37
Gastrointestinal tract	122	7.5	158	9.4	0.04*
Eye & ear	78	4.8	72	4.3	0.49
Intra-abdomen	53	3.2	25	1.5	0.001*
CSF	21	1.3	19	1.1	0.60
Others	78	4.8	84	5.0	0.79
Total	1,631	100.0	1,683	100.0	-

* $p < 0.05$ by Chi-square test

lated organisms were *E. coli, S. aureus, P. aeruginosa*, coagulase negative *Staphylococcus* (CoNS) and *K. pneumoniae*. CoNS was increased from 241 isolates (12.9%) to 350 isolates (18.6%) but *S. aureus* was decreased from 318 isolates (17.1%) to 287 isolates (15.2%), $p < 0.05$.

Table 3 shows the percentage of susceptibility patterns of gram positive bacteria. In 2000-2002 and 2003-2005, 25.5% and 10.1% of *S. aureus* were methicillin resistant *S. aureus* (MRSA), 43.6% and 56.6% of CoNS were methicillin resistant coagulase negative *Staphylococus* (MR-CoNS). All gram positive cocci remained sensitive to vancomycin and linezolid. Table 4 shows the percentage of susceptibility patterns of gram negative bacteria. In 2003-2005, most gram negative rods were less sensitive to 3rd and 4th generation cephalosporins and aminoglycosides than in 2000-2002. Sensitivity of gram negative rods to 3rd and 4th generation cephalosporins were not significantly different except *Enterobacter* spp. and *Serratia* spp., which were more sensitive to 4th generation cephalosporin ($p < 0.05$). Most gram negative pathogens (80-100%) were sensitive to ciprofloxacin except *Acinetobacter* spp. (61%). Sensitivity of gram negative pathogens to carbapenems were 100% except 92-100% for *Enterobacter* and 67-86% for *P.aeruginosa*, *Acinetobacter* spp. and *Serratia* spp. Extended spectrum beta-lactamase enzymes (ESBLs) producing gram negative bacilli (GNB) were markedly increased from 8 isolates (0.4%) in 2000-2002 to 116 isolates (6.2%) in 2003-2005, $p < 0.05$. Almost all pathogens in this group were *E. coli.* and *K. pneumoniae.* In addition, they all were all sensitive to carbapenems. ESBLs-producing *E. coli* increased from three isolates (0.9%) to 63 isolates (19.9%) and ESBLs-producing *K. pneumoniae* increased from one isolate (1%) to 43 isolates (29.5%). Between 2003-2005, three isolates (0.2%) of multi-drug resistant-*A. baumannii* were found in infants diagnosed as multi-lobar pneumonia, resisted to nearly all antibiotics except colistin. Treatment with colistin and sulperazon resulted in poor response and death.

Discussion

S. aureus, CoNS, and gram negative bacilli

Table 2. Causative bacteria

Causative bacteria	2000-2002		2003-2005		p-value
	numbers	%	numbers	%	
Gram-positive	751	40.3	846	44.9	-
S. aureus - MSSA	237	12.7	258	13.7	0.37
- MRSA	81	4.3	29	1.5	<0.001*
CoNS - MS-CoNS	136	7.3	152	8.1	0.36
- MR-CoNS	105	5.6	198	10.5	<0.001*
Enterococus	90	4.8	94	5.0	0.78
Others	102	5.5	115	6.1	-
Gram negative	1,112	59.7	1,038	55.1	-
E. coli	323	17.3	317	16.8	0.68
P. aeruginosa	248	13.3	141	7.5	<0.001*
K. pneumoniae	102	5.5	146	7.7	0.01*
Enterobacter spp.	79	4.2	46	2.4	0.002*
Acinetobacter spp.	70	3.8	84	4.5	0.28
Salmonella spp.	32	1.7	28	1.5	0.63
P. mirabilis	26	1.4	20	1.1	0.41
Serratia spp.	24	1.3	6	0.3	0.001*
Citrobacter spp.	11	0.6	16	0.8	0.46
Others	197	10.6	234	12.4	-
Total	1,863	100.0	1,884	100.0	-

* $p < 0.05$ by Chi-square test
MSSA; methicillin sensitive *Staphylococcus aureus*, MRSA; methicillin resistant *Staphylococcus aureus*
MS-CoNS; methicillin sensitive coagulase negative *Staphylococcus*
MR-CoNS; methicillin resistant coagulase negative *Staphylococcus*

Table 3. Isolates and percentage of susceptible gram positive organisms

Causative bacteria		Penicillin	Ampicillin	Oxacillin	Gentamicin	Fosfomycin	Fucidic acid	Teicoplanin	Vancomycin	TMP/SMX	Ciprofloxacin	Clindamycin	Erythromycin	Linezolid
MSSA	2000-2002	197 (6)	-	237 (100)	237 (99)	237 (97)	78 (100)	18 (100)	236 (100)	237 (98)	209 (97)	237 (96)	235 (88)	-
	2003-2005	254 (4)	-	258 (100)	257 (100)	252 (98)	257 (99)	123 (82)	258 (100)	158 (100)	205 (79)	238 (95)	257 (72)	59 (100)
	p	0.33	-	-	0.11	0.48	0.38	0.04*	-	0.07	<0.001*	0.60	<0.001*	-
MRSA	2000-2002	72 (0)	-	81 (0)	81 (20)	79 (75)	16 (88)	10 (100)	81 (100)	80 (44)	76 (32)	79 (54)	81 (16)	-
	2003-2005	28 (0)	-	29 (0)	29 (14)	29 (69)	28 (93)	17 (88)	29 (100)	16 (19)	22 (9)	25 (28)	28 (11)	10 (100)
	P	-	-	-	0.47	0.53	0.57	0.26	-	0.06	0.03*	0.02*	0.52	-
MS-CoNS	2000-2002	115 (17)	-	136 (100)	134 (93)	134 (66)	55 (93)	101 (100)	122 (100)	133 (77)	113 (98)	133 (89)	130 (76)	-
	2003-2005	150 (11)	-	152 (100)	151 (95)	150 (47)	150 (91)	59 (95)	152 (100)	96 (70)	128 (99)	147 (90)	151 (83)	41 (100)
	P	0.16	-	-	0.48	0.001*	0.65	0.02*	-	0.23	0.52	0.79	0.15	-
MR-CoNS	2000-2002	88 (3)	-	105 (0)	104 (45)	105 (58)	44 (70)	6 (50)	105 (100)	104 (49)	86 (83)	103 (59)	96 (39)	-
	2003-2005	1986 (1)	-	198 (0)	198 (32)	198 (51)	166 (61)	186 (88)	186 (100)	90 (59)	150 (85)	166 (41)	150 (28)	39 (100)
	P	0.22	-	-	0.03*	0.25	0.27	0.01*	-	0.16	0.68	0.004*	0.07	-
Enterococus	2000-2002	84 (83)	9 (89)	-	87 (69)	-	-	82 (99)	90 (100)	-	-	-	-	-
	2003-2005	18 (78)	86 (93)	-	93 (69)	-	-	93 (100)	94 (100)	-	-	-	-	22 (100)
	P	0.62	0.66	-	1.00	-	-	0.33	-	-	-	-	-	-

* $p < 0.05$, number of isolates (%), TMP/SMX; Trimethoprim/sulfamethoxazole

especially *E. coli*, *P. aeruginosa* and *K. pneumoniae* were the predominant pathogens causing nosocomial infections in the present study, similar to previous reports[5,6,8,11] with difference in rank order of occurrence. CoNS was the most isolated pathogen in 2003-2005 (18.6%) same as the previous studies of Mongkolrattanothai K et al (33%)[5] and Chang MR et al (27.7%)[8]. The significantly increased CoNS and MR-CoNS may be a result of an increased survival of very low birth weight (VLBW) preterm infants who have long hospital stay, with intravascular catheters and parenteral nutrition predisposing to bloodstream infection[15,16]. CoNS is a common skin inhabitant, so differentiating bacteremia from colonization may be difficult. True bacteremia was suspected in newborns with intravenous catheter or shunt, two or more positive blood cultures of CoNS, signs and symptoms with laboratory data compatible with sepsis, and resolve with appropriate antibiotics or catheter removal[17].

Other gram positive cocci in the present study seemed to be less problematic. *S. aureus* and MRSA were decreased from 17.1% and 4.3% in 2000-2002 to 15.2% and 2.9% in 2003-2005. This may have resulted from the awareness and improvement of infectious control measures, especially hand washing. All gram positive cocci remained sensitive to vancomycin and linezolid. However, worldwide reports of increasing of MRSA[4,6,7,10,11], vancomycin intermediate-resistant *S. aureus* (VISA)[18,19], vancomycin resistant *S. aureus* (VRSA)[20] and vancomycin resistant *Enterococus* (VRE)[4,9,11] alarmed the clinicians for the importance of infectious control and proper antibiotic usage.

In 2003-2005, gram negative rods especially *E. coli* and *K. pneumoniae* were less sensitive to 3rd and 4th generation cephalosporins and aminoglycosides than in 2000-2002 the same as those reported by Chang MR et al[8] and Gaynes R et al[12]. These may be because of selective pressure resistance from increased use of these groups of antibiotics. However, most gram negative organisms in the present study remained sensitive to ciprofloxacin and carbapenems similar to previous studies[6,8,10]. These might be the result of the preserved use of these antibiotics for severe or multi-drug-resistant GNB infections. *Enterobacter* spp. and *Serratia* spp. were resistant to 3rd generation cephalosporin (ceftazidime) but remained good sensitive to 4th generation cephalosporin (cefepime) and carbapenems, compatible with previous report[6], explained by the production of derepressed chromosomally encoded AmpC cepharosporinase.

Table 4. Isolates and percentage of susceptible gram negative organisms

Causative bacteria		Ampicillin	Amoxycillin/Clav	Piperacillin/Tazo	Cefotaxime	Ceftazidime	Sulperazon	Cefepime	Amikacin	Gentamicin	Netilmicin	Imipenem	Meropenem	Ciprofloxacin	TMP/SMX
E. coli	2000-2002	307 (21)	285 (71)	20 (90)	263 (92)	321 (89)	20 (85)	304 (97)	322 (93)	320 (78)	20 (90)	20 (100)	20 (100)	181 (83)	306 (37)
	2003-2005	310 (19)	309 (47)	33 (76)	309 (77)	312 (77)	34 (53)	169 (76)	314 (85)	313 (73)	33 (61)	34 (100)	34 (100)	268 (77)	309 (41)
	p	0.54	<0.001*	0.21	<0.001*	<0.001*	0.02*	<0.001*	<0.001*	0.14	0.02*	-	-	0.12	0.31
P. aeruginosa	2000-2002	-	-	211 (81)	-	248 (78)	232 (81)	169 (80)	248 (86)	248 (67)	233 (89)	233 (81)	233 (84)	197 (86)	-
	2003-2005	-	-	123 (87)	-	141 (84)	135 (80)	139 (88)	141 (87)	103 (46)	135 (70)	135 (67)	135 (80)	137 (90)	-
	p	-	-	0.16	-	0.15	0.82	0.06	0.78	<0.001*	<0.001*	0.002*	0.33	0.28	-
K. pneumoniae	2000-2002	89 (0)	80 (65)	21 (19)	80 (73)	101 (70)	23 (87)	94 (89)	102 (75)	102 (72)	23 (35)	23 (100)	23 (100)	80 (90)	88 (59)
	2003-2005	132 (0)	131 (55)	37 (27)	138 (67)	145 (68)	38 (34)	90 (67)	146 (63)	139 (66)	38 (21)	39 (100)	39 (100)	139 (86)	131 (60)
	p	-	0.15	0.49	0.36	0.74	<0.001*	<0.001*	0.05	0.32	0.23	-	-	0.39	0.88
Enterobacter spp.	2000-2002	68 (1)	62 (10)	14 (64)	65 (78)	82 (67)	14 (71)	70 (91)	79 (77)	79 (66)	14 (43)	14 (93)	14 (93)	70 (90)	67 (69)
	2003-2005	39 (5)	39 (13)	11 (82)	41 (68)	46 (76)	12 (92)	30 (90)	46 (76)	42 (76)	11 (82)	12 (92)	12 (100)	40 (90)	39 (69)
	p	0.20	0.64	0.32	0.05	0.29	0.18	0.88	0.90	0.26	0.48	0.92	0.35	-	-
Acinetobacter spp.	2000-2002	29 (4)	29 (41)	41 (66)	24 (38)	70 (74)	50 (86)	48 (75)	70 (64)	70 (53)	49 (55)	49 (71)	49 (82)	65 (63)	28 (57)
	2003-2005	18 (7)	21 (33)	70 (60)	26 (15)	84 (62)	75 (67)	81 (58)	84 (63)	56 (57)	75 (68)	75 (80)	75 (76)	83 (61)	21 (57)
	p	0.65	0.56	0.53	0.06	0.12	0.02*	0.05	0.90	0.65	0.14	0.25	0.43	0.80	1.00
Salmonella spp.	2000-2002	32 (84)	21 (95)	-	32 (100)	32 (100)	-	30 (100)	32 (100)	28 (86)	-	-	-	20 (100)	32 (63)
	2003-2005	28 (39)	25 (76)	-	26 (96)	26 (96)	-	20 (95)	28 (100)	25 (80)	-	-	-	28 (89)	28 (57)
	p	<0.001*	0.08	-	0.25	0.25	-	0.22	-	0.56	-	-	-	0.13	0.64
P. mirabilis	2000-2002	26 (38)	21 (95)	-	19 (89)	26 (96)	-	23 (96)	26 (100)	26 (80)	-	-	-	17 (88)	26 (42)
	2003-2005	19 (63)	18 (89)	-	20 (100)	20 (100)	-	15 (100)	20 (95)	20 (85)	-	-	-	19 (95)	19 (63)
	p	0.10	0.49	-	0.13	0.37	-	0.43	0.25	0.66	-	-	-	0.45	0.16
Serratia spp.	2000-2002	-	-	20 (95)	-	24 (38)	21 (100)	12 (92)	24 (50)	24 (33)	21 (33)	21 (86)	21 (86)	16 (69)	16 (81)
	2003-2005	-	-	5 (80)	-	6 (33)	5 (80)	6 (67)	6 (67)	5 (80)	6 (33)	5 (80)	5 (80)	5 (80)	5 (80)
	p	-	-	0.27	-	0.82	0.04*	0.18	0.46	0.05	1.00	0.74	0.74	0.63	0.96
Citrobacter spp.	2000-2002	11 (0)	9 (33)	-	11 (27)	10 (90)	-	11 (91)	11 (100)	11 (100)	-	8 (100)	8 (100)	8 (100)	11 (45)
	2003-2005	16 (0)	16 (6)	-	16 (88)	16 (88)	-	11 (91)	16 (81)	16 (75)	-	6 (100)	6 (100)	16 (81)	16 (81)
	p	-	0.08	-	0.001*	0.88	-	1.00	0.13	0.07	-	-	-	0.19	0.05

* $p < 0.05$

number of isolates (%), Amoxycillin/Clav; Amoxycillin/Clavulanic acid, Piperacillin/Tazo; Piperacillin/Tazobactam, Sulperazon; Cefoperazone/Sulbactam, TMP/SMX; Trimethoprim/sulfamethoxazole

In the present study, ESBLs-producing bacteria were significantly increased in the latter period. ESBLs production rate was more prevalent in *K. pneumoniae* than *E. coli*, same as previous studies[6,11,21]. Although ESBLs are theoretically inhibited by -lactamase inhibitors, the present study and several studies[6,10,21] found that ESBLs producing bacteria were resistant to -lactam- -lactamase inhibitor combinations but sensitive to carbapenems, indicating that carbapenems are the reliable drugs of choice for serious or life-threatening infections caused by ESBLs-producing bacteria.

Acinetobacter spp. resisted to several classes of antibiotics. Sensitivity of *Acinetobacter* spp. to carbapenems were 76-80%, and sensitivity to cefoperazone/sulbactam was significantly decreased from 86% in 2000-2002 to 67% in 2003-2005, the same as in previous studies[6,10]. Between 2003-2005, there were three isolates of multi-drug resistant-*A. baumannii* (MDR-*A. baumannii*) which resisted to several classes of antibiotics include carbapenems (carbapenem resistant *A. baumannii*, CRAB) except colistin. Nosocomial infections caused by MDR-*A. baumannii*, CRAB, pandrug-resistant *A. baumannii* have been reported in recent years[22,23].

Although emergence of resistance is a result of selective pressure from increased use and misuse of antimicrobial agents, spread of antimicrobial resistant bacteria are caused by spreading of already resistant strains to another patients more than the emergence of new resistant strains in individual cases[24]. Periodic surveillance for early detection of new resistant strains combined with other infectious control measures include hand washing, aseptic and sterile technique, appropriate antibiotic use, and education for personnel can reduce the incidence of nosocomial infections.

Conclusion

The bacterial pathogens causing nosocomial infections and their susceptibility patterns change with time, so periodic surveillance are essential as a guide for more proper empirical therapy especially in serious or life threatening infections that need urgent appropriate antibiotics. Surveillance for new resistant strains combined with other infectious control measures is useful for prevention of nosocomial infections.

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ระบาดวิทยาการติดเชื้อแบคทีเรียในโรงพยาบาลของผู้ป่วยเด็กที่วิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล

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***ภูมิหลัง**: การติดเชื้อในโรงพยาบาลเป็นปัญหาทางสาธารณสุขทุกแห่งทั่วโลก เชื้อก่อโรคมักเกิดจากเชื้อแบคทีเรียที่ดื้อยาหลายขนาน ก่อให้เกิดภาวะแทรกซ้อนและการเสียชีวิตเพิ่มมากขึ้น อีกทั้งยังสิ้นเปลืองค่าใช้จ่ายในการดูแลรักษา ชนิดของเชื้อก่อโรคและแบบแผนความไวต่อยาปฏิชีวนะเปลี่ยนแปลงตามระยะเวลา และแตกต่างกันในแต่ละโรงพยาบาล*

***วัตถุประสงค์**: ศึกษาชนิดของเชื้อแบคทีเรียก่อโรคติดเชื้อในผู้ป่วยเด็กในโรงพยาบาล และแบบแผนความไวต่อยาปฏิชีวนะ ระหว่างมกราคม พ.ศ. 2543 - ธันวาคม พ.ศ. 2545 เปรียบเทียบกับ มกราคม พ.ศ. 2546 - ธันวาคม พ.ศ. 2548*

***วัสดุและวิธีการ**: วิเคราะห์เปรียบเทียบชนิดและแบบแผนความไวต่อยาปฏิชีวนะของเชื้อแบคทีเรียก่อโรคในเด็กซึ่งติดเชื้อในโรงพยาบาลที่วิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล ระหว่างมกราคม พ.ศ. 2543 - ธันวาคม พ.ศ. 2545 เปรียบเทียบกับ มกราคม พ.ศ. 2546 - ธันวาคม พ.ศ. 2548*

***ผลการศึกษา**: ระหว่าง พ.ศ. 2543- 2545 และ พ.ศ. 2546- 2548 พบผลเพาะเชื้อขึ้นเชื้อจำนวน 1,863 และ 1,884 ตัวอย่างตามลำดับ ตำแหน่งติดเชื้อที่พบบ่อยคือ กระแสเลือด (ร้อยละ 28.6) ทางเดินหายใจส่วนล่าง (ร้อยละ 15.3) ผิวหนังและเนื้อเยื่ออ่อน (ร้อยละ 14.9) และทางเดินปัสสาวะ (ร้อยละ 12.5) เชื้อก่อโรคกรัมบวกที่สำคัญ คือ S. aureus, coagulase negative Staphylococcus, Enterococus เชื้อก่อโรคกรัมลบที่สำคัญ คือ E. coli, P. aeruginosa, K. pneumoniae, Enterobacter spp. and Acinetobacter spp. เปรียบเทียบระหว่าง พ.ศ. 2543- 2545 และ พ.ศ. 2546- 2548 พบ S. aureus ที่ดื้อยา methicillin ลดลงจากร้อยละ 4.3 เป็นร้อยละ 1.5 P. aeruginosa จากร้อยละ 13.3 เป็นร้อยละ 7.5 Enterobacter spp. จากร้อยละ 4.2 เป็นร้อยละ 2.4 Serratia spp. จากร้อยละ 1.3 เป็นร้อยละ 0.3 แต่พบเชื้อ coagulase negative Staphylococcus ที่ดื้อยา methicillin เพิ่มขึ้นจากร้อยละ 5.6 เป็นร้อยละ 10.5 และ K. pneumoniae จากร้อยละ 5.5 เป็นร้อยละ 7.7 ($p< 0.05$) เชื้อทรงกลมกรัมบวกทั้งหมดยังไวต่อ vancomycin และ linezolid ใน พ.ศ. 2546- 2548 เชื้อทรงแท่งกรัมลบไวต่อยา cephalosporins กลุ่ม 3 และ 4 และ aminoglycosides ลดลงเมื่อเทียบกับใน พ.ศ. 2543- 2545 เชื้อทรงแท่งกรัมลบไวต่อยา cephalosporins กลุ่ม 3 และ 4 ไม่แตกต่างกัน ยกเว้น Enterobacter spp. และ Serratia spp. ซึ่งไวต่อยา cephalosporins กลุ่ม 4 มากกว่า ($p < 0.05$) เชื้อก่อโรคกรัมลบส่วนใหญ่ยังไวต่อยา ciprofloxacin ร้อยละ 80-100 ยกเว้น Acinetobacter spp. ไวเพียงร้อยละ 61 เชื้อก่อโรคไวต่อยา carbapenems ร้อยละ 100 ยกเว้น Enterobacter ไวร้อยละ 92-100 P.aeruginosa, Acinetobacter spp. และ Serratia spp. ไวร้อยละ 67-86*

***สรุป**: เชื้อแบคทีเรียที่เป็นสาเหตุของโรคติดเชื้อในโรงพยาบาลและแบบแผนความไวต่อยาปฏิชีวนะเปลี่ยนแปลงตามกาลเวลา ดังนั้นการเฝ้าระวังการเปลี่ยนแปลงเป็นระยะช่วยให้สามารถเลือกใช้ยาปฏิชีวนะในการรักษาเบื้องต้นได้เหมาะสมมากยิ่งขึ้น โดยเฉพาะการติดเชื้อรุนแรงหรือเสี่ยงต่อการเสียชีวิตซึ่งจำเป็นต้องได้รับยาปฏิชีวนะที่เหมาะสมอย่างทันท่วงที*