ORIGINAL ARTICLE

Prevalence of Antibiotic-Resistant Gram-Negative Bacteria and Susceptibility Patterns in Provincial Hospital, Thailand: A Decade Review

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Background: Antimicrobial resistance is a significant public health issue globally, particularly due to gram-negative bacteria, which lead to treatment failures and increased mortality among infected patients.

Objective: To analyze isolation data of *Acinetobacter baumannii* (AB), *Pseudomonas aeruginosa* (PA), *Escherichia coli* (EC), *Klebsiella pneumoniae* (KP), and *Enterobacter cloacae* (EB), as well as their susceptibility patterns to ceftriaxone, ceftazidime, gentamicin, amikacin, piperacillin-tazobactam, and meropenem.

Materials and Methods: All isolates of AB, PA, EC, KP, and EB were retrospectively collected from pediatric department patients at Pranangklao Hospital between January 1, 2013, and December 31, 2022.

Results: Three thousand sixty-seven isolates were enrolled with 710 for AB, 722 for PA, 743 for EC, 735 for KP, and 157 for EB. The male ratio was 55.9% and the age ranged from one day to 14.9 years. The sources of isolates were respiratory secretions in 57.8%, urine in 21.4%, pus in 10.2%, and blood in 9.7%. The highest carbapenem-resistant rate (%CR) over the decade was observed in AB, with a minimum and maximum of 45.5% and 96.1%, which is consistent with the percentage of MDR/XDR. Notably, the percentage of CR of PA sharply increased from 25.3% in 2017 to 67% in 2018, reaching 82.8% in 2020, while the 10 years percentage of MDR/XDR remained stable at 4.8% to 22%. The percentage of ESBL, for producing strains for EC, KP, and EB ranged from 40.7% to 63.8%, 47.1% to 84.8%, and 41.7% to 84%, respectively, with the percentage CR being extremely low for EC at 0% to 4.3%, for KP at 0% to 16.1%, and for EB at 0% to 12.5%. Ceftazidime, gentamicin, amikacin, and piperacillin-tazobactam remained effective against PA as the 10 years percentage susceptibility at 75.8% to 98%, while these drugs, including meropenem, showed poor susceptibility against AB since 2020 as the percentage of susceptibility ranged from 2.3% to 11.3%. Amikacin and meropenem demonstrated excellent performance for EC, KP, and EB with the percentage of susceptibility at 76% to 100%.

Conclusion: AB and PA represent significant threats in Pranangklao Hospital.

Keywords: Gram-negative bacteria; Antimicrobial resistance; Enterobacterales; Antibiogram; CRE; Drug-resistant bacteria

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Antimicrobial resistance (AMR) represents a significant global public health concern, particularly attributed to gram-negative bacteria (GNB), resulting in the failure of treatment and a rise in mortality rates among infected individuals. The estimated annual fatality from AMR is approximately 700,000 affected patients worldwide, it can reach 10 million people within the next two decades, without appropriate resolution. Moreover, the impact of drug-resistant bacteria infection increased the length of stay (LOS) of hospitalized patients and expenses for antimicrobial utilization leading to economic loss. In Thailand, there were approximately 88,000 cases and 38,000 deaths yearly from AMR infections, respectively causing economic disruption exceeding 40 billion Baht[(1)]. Enterobacterales: *Acinetobacter baumannii*, *Pseudomonas aeruginosa* including carbapenem-resistant Enterobacteriaceae (CRE) and extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae such as ESBL-producing *Escherichia coli* and ESBL-producing *Klebsiella pneumoniae* were the most common hospital-acquired drug-resistant GNBs worldwide including Thailand correlating with National Antimicrobial Resistance Surveillance, Thailand

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(NARST) data[2,3].

The rapidly rising rate of these GNBs is a critical issue that demands evaluation and comprehensive application of strategies for deceleration.

The author aimed to determine the AMR rate for the carbapenem-resistant and multidrug-resistant (MDR)/extensively drug-resistant (XDR), or ESBL producing strain, of *A. baumannii*, *P. aeruginosa*, *E. coli*, *K. pneumoniae*, and *E. cloacae* and the susceptibility patterns to ceftriaxone, ceftazidime, gentamicin, amikacin, piperacillin-tazobactam, and meropenem in Pranangklao Hospital, a provincial hospital of Central Thailand for understanding and applying in the antimicrobial stewardship.

Materials and Methods

Study design and setting

A retrospective cohort study was conducted in all pediatric departments, such as the pediatric intensive care unit (PICU), neonatal intensive care unit (NICU), sick child, and sick newborn department of Pranangklao Hospital, a provincial hospital in Nonthaburi, Thailand. Laboratory electronic data were collected between January 1, 2013, and December 31, 2022. Resistant data and susceptibility patterns to ceftriaxone, ceftazidime, gentamicin, amikacin, piperacillin-tazobactam, and meropenem were collected, including specimen type, and details of patients such as age, gender, and ward of admission. The present study was approved by the Human Ethics Committee, Pranangklao Hospital (Ethical No. PE 6521).

Population

All patients who were admitted to all pediatric departments had positive culture results of any sources identified as *A. baumannii*, *P. aeruginosa*, *E. coli*, *K. pneumoniae*, and *E. cloacae* by the microbiology laboratory. The data were classified as carbapenem-resistant strain and MDR/XDR for *A. baumannii* and *P. aeruginosa*, or ESBL-producing strain for *E. coli*, *K. pneumoniae*, and *E. cloacae*.

Definitions

Carbapenem-resistant strain was defined as resistant to which one of the carbapenem antibiotics such as ertapenem, meropenem, imipenem, and doripenem. The definition of a MDR microorganism was non-susceptible to at least one antimicrobial agent in three or more classes of therapeutic antimicrobial agents, while XDR meant no susceptibility to at least one agent of nearly all, remaining one or two antimicrobial classes for treatment[4,5]. ESBL was defined by resistance to beta-lactam antibiotics such as penicillin, cephalosporins, and monobactam, whereas susceptible to carbapenems and beta-lactamase inhibitors, in vitro. ESBL-producing strains were identified through the utilization of the combined disc method of ceftazidime of 30 μg and clavulanic acid of 10 μg. The presence of ESBL was confirmed when measuring 5 mm or more of the inhibition zone diameter when comparing the combined ceftazidime plus clavulanic acid disc to the ceftazidime disc alone[6]. Furthermore, the Vitex 2 Compact (bioMerieux, Craponne, France) and double disc synergy test (DDST) for cefotaxime, amoxicillin-clavulanic, and ceftazidime disc, were utilized to confirm ESBL production.

Microbiological procedures

The Kirby-Bauer disc diffusion method on Mueller Hinton agar and Vitex 2 Compact (bioMerieux, Craponne, France) were used for antimicrobial susceptibility testing and microorganism identification. Clinical and Laboratory Standards Institute (CLSI) was the standardization of susceptibility and breakpoint interpretation.

Statistical analysis

The IBM SPSS Statistics, version 28.0.1 (IBM Corp., Armonk, NY, USA) was employed for analysis. The qualitative data were presented in the form of frequencies and percentages, facilitating a comprehensive description of the variables under investigation. Statistical significance was assessed using chi-square goodness of fit test. A threshold of p-value of less than 0.05 was adopted to establish the presence of statistically significant findings.

Results

Study population

The total isolate of all five microorganisms in a decade review was 3,067 isolates, from male at 55.9% and a minimum and maximum age of 1 day to 14.9 years. The highest amount of isolate was identified as *E. coli* with 743 isolates (24.2%), followed by *K. pneumoniae* with 735 isolates (24%), *P. aeruginosa* with 722 isolates (23.5%), *A. baumannii* with 710 isolates (23.2%), and *E. cloacae* with 157 isolates (5.1%), respectively. The most common source was the respiratory tract with 1,773 isolates (57.8%) followed by urine with 655 isolates (21.4%), pus with 313 isolates (10.2%), blood with 298 isolates (9.7%), and other fluids/cerebrospinal fluid (CSF) with 28

Table 1. Characteristics of isolates of all five microorganisms

Detail	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	p-value
Total isolate; n (%)	255 (8.3)	289 (9.4)	323 (10.5)	314 (10.2)	389 (12.7)	304 (9.9)	344 (11.2)	270 (8.8)	298 (9.7)	281 (9.2)	3,067 (100)	<0.001
Sex; n (%)												
Male	136 (53.3)	157 (54.3)	156 (48.3)	159 (50.6)	222 (57.1)	162 (53.3)	227 (66.0)	149 (55.2)	170 (57.1)	176 (62.6)	1,714 (55.9)	<0.001
Female	119 (46.7)	132 (45.7)	167 (51.7)	155 (49.4)	167 (42.9)	142 (46.7)	117 (34.0)	121 (44.8)	128 (42.9)	105 (37.4)	1,353 (44.1)	<0.001
Microorganism; n (%)												
A. baumannii	44 (17.3)	44 (15.2)	68 (21.1)	80 (25.5)	109 (28.0)	35 (11.5)	49 (14.2)	81 (30.0)	129 (43.3)	71 (25.3)	710 (23.2)	<0.001
P. aeruginosa	60 (23.5)	49 (17.0)	62 (19.2)	42 (13.4)	83 (21.3)	94 (30.9)	129 (37.5)	64 (23.7)	57 (19.1)	82 (29.2)	722 (23.5)	<0.001
E. coli	69 (27.1)	88 (30.4)	72 (22.3)	96 (30.6)	94 (24.2)	100 (32.9)	74 (21.5)	54 (20.0)	47 (15.8)	49 (17.4)	743 (24.2)	<0.001
K. pneumoniae	54 (21.2)	83 (28.7)	106 (32.8)	71 (22.6)	87 (22.4)	63 (20.7)	81 (23.6)	60 (22.2)	59 (19.8)	71 (25.3)	735 (24.0)	<0.001
E. cloacae	28 (10.9)	25 (8.7)	15 (4.6)	25 (7.9)	16 (4.1)	12 (4.0)	11 (3.2)	11 (4.1)	6 (2.0)	8 (2.8)	157 (5.1)	<0.001
Specimen type; n (%)												
Respiratory	115 (45.1)	145 (50.2)	189 (58.5)	173 (55.1)	246 (63.2)	158 (52.0)	237 (68.9)	161 (59.6)	178 (59.7)	171 (60.9)	1,773 (57.8)	<0.001
Urine	81 (31.8)	80 (27.7)	78 (24.2)	82 (26.1)	59 (15.2)	75 (24.7)	56 (16.3)	47 (17.4)	47 (15.8)	50 (17.8)	655 (21.4)	<0.001
Pus	21 (8.2)	39 (13.5)	23 (7.1)	38 (12.1)	61 (15.7)	45 (14.8)	21 (6.1)	21 (7.8)	22 (7.4)	22 (7.8)	313 (10.2)	<0.001
Blood	31 (12.2)	25 (8.6)	32 (9.9)	19 (6.1)	19 (4.9)	22 (7.2)	29 (8.4)	39 (14.4)	46 (15.4)	36 (12.8)	298 (9.7)	0.005
Other: CSF/fluid	7 (2.7)	0 (0.0)	1 (0.3)	2 (0.6)	4 (1.0)	4 (1.3)	1 (0.3)	2 (0.8)	5 (1.7)	2 (0.7)	28 (0.9)	0.227
Ward; n (%), %DR strain												
NICU	78 (30.6), 56.4	99 (34.2), 48.5	111 (34.4), 63.1	128 (40.8), 70.3	130 (33.4), 76.2	90 (29.6), 42.2	175 (50.9), 48.0	158 (58.5), 63.3	196 (65.8), 71.9	186 (66.2), 50.5	1,351 (44.1), 59.8	<0.001
PICU	39 (15.3), 35.9	28 (9.7), 39.3	49 (15.2), 34.7	28 (8.9), 28.6	42 (10.8), 26.2	39 (12.8), 38.5	47 (13.7), 48.9	17 (6.3), 47.1	8 (2.7), 75.0	8 (2.8), 50.0	305 (9.9), 38.4	<0.001
Sick child	81 (31.8), 30.9	121 (41.9), 18.2	125 (38.7), 30.4	114 (36.3), 22.8	160 (41.1), 23.1	131 (43.1), 15.3	91 (26.4), 29.7	55 (20.4), 23.6	52 (17.4), 28.8	46 (16.4), 19.6	976 (31.8), 23.8	<0.001
Sick newborn	57 (22.3), 45.6	41 (14.2), 29.3	38 (11.7), 31.6	44 (14.0), 47.7	57 (14.7), 38.6	44 (14.5), 47.7	31 (9.0), 48.4	40 (14.8), 40.0	42 (14.1), 52.4	41 (14.6), 39.0	435 (14.2), 42.1	0.150

NICU=neonatal intensive care unit; PICU=pediatric intensive care unit; DR=drug resistant (MDR/CRE) isolates (0.9%), respectively. The ward exhibiting the highest microbiological culture yield and AMR isolate was the NICU with 1,351 isolates (44.1%) for 59.8% of the total (Table 1).

Antimicrobial resistance

Overall, *A. baumannii* demonstrated the highest percentage of carbapenem-resistant strain (%CR) in the range of 45.5% to 96.1%, except for the years 2018 and 2019 when *P. aeruginosa* had a higher %CR. In detail, the %CR in *P. aeruginosa* showed a continuous upward trend since 2016, with a significant surge observed from 2017 with %CR of 25.3% to 2018 with %CR of 67%, reaching its peak in 2020 with %CR of 82.8%, whereas %MDR/XDR was slowly rising from 10% in 2013 to 22% in 2022. Over the past decade, CRE was rarely identified in *E. coli* and *E. cloacae*, occurring in only two years. The highest %CR value recorded for *E. coli* was 4.3% in 2021, while *E. cloacae* demonstrated its highest %CR value of 12.5% in 2022. Regarding *K. pneumoniae*, the %CR ranged from 0% to 16.1%.

Over the 10-year period, the comparison of %ESBL revealed that *K. pneumoniae* exhibited the highest %ESBL and exhibited a gradual upward trend with %ESBL ranging from 47.1% to 84.8%. Conversely, *E. cloacae* showed a decreasing trend in %ESBL, declining from 82.1% in 2013 to 50% in 2022. The %ESBL of *E. coli* remained stable, with values ranging between 40.7% and 63.8% (Figure 1).

Antibiogram

Amikacin showed the best performance for *A. baumannii*, with the highest % susceptibility value of 68.2% in 2014. However, it gradually declined over time, reaching 42.9% in 2018, which was similar to other types of drugs. After 2018, the overall efficacy of all medications decreased in the range of 0% to 26.5% of susceptibility reflecting no efficacy for treatment (Figure 2).

For *P. aeruginosa*, ceftazidime, gentamicin, amikacin, and piperacillin-tazobactam exhibited favorable efficacy over a ten-year period (% susceptibility ranging from 75.8% to 98%). Conversely, meropenem demonstrated satisfactory performance from 2013 to 2017 with the % susceptibility ranging from 60% to 88.1%. However, it subsequently experienced a rapid decline in efficacy with % susceptibility ranging from 17.8% to 35.1%, which correlated with the emergence of carbapenem-resistant strains (Figure 1, 2).

Amikacin and meropenem showed high efficacy, close to 100%, for *E. coli*, *K. pneumoniae*, and *E. cloacae* throughout the 10-year period. Although less effective than the former two drugs, piperacillin-tazobactam demonstrated consistently good performance for *E. coli*, with % susceptibility ranging from 86.2% to 96.3%. However, for *K. pneumoniae*, there was a decreasing trend in % susceptibility, starting at 85.2% in 2013 and declining to 54.9% in 2022 (Figure 2).

Discussion

The emergence of resistant microorganisms is rapidly escalating worldwide, impacting not only individual health but also imposing significant economic burdens. CRE, MDR *Acinetobacter*, MDR *P. aeruginosa*, and ESBL-producing Enterobacteriaceae are urgent threats classified by the Centers for Disease Control and Prevention (CDC)[7]. The antibiotic resistance crisis is driven by overuse, inappropriate prescribing, extensive agricultural use of antimicrobial agents, and the limited availability of new antibiotics[7-9].

This decade review study revealed that *E. coli* was the most frequently isolated organism at 24.2%, closely followed by *K. pneumoniae* at 24%, *P. aeruginosa* at 23.5%, and *A. baumannii* at 23.2%. In contrast, *E. cloacae* had the lowest isolation rate at 5.1%, significantly differing from the others. The predominant specimen type associated with antimicrobial-resistant isolates was respiratory secretions, primarily from the NICU, indicating that respiratory tract infections are a major issue in hospital-related infections within the pediatric department. Intensive care unit (ICU) admissions were identified as a precipitating factor for developing drug-resistant bacteria. Supporting studies have identified significant risk factors for ESBL-producing Enterobacteriaceae infections, including previous ICU admissions, nosocomial infections, indwelling urinary catheters, mechanical ventilation, prior antimicrobial use, previous hospitalizations[10], diabetes mellitus, and travel to high-risk areas[11]. The study conducted in the ICUs of India and Nepal yielded findings indicating the high occurrence of MDR Gram-negative pathogens. Specifically, the prevalence rates were found to be 46.7% in Nepal and 68.8% in India to ventilator-associated pneumonia patients[12,13].

Data analysis in the present study indicated that *A. baumannii* exhibited the highest prevalence of carbapenem-resistant (CRAB) strains among the five Enterobacterales studied, with a concerning upward

Figure 1. Total isolate and antibiotic-resistant profile of all isolates in 10 years.

trend. The observed %CRAB ranged from 45.5% to 96.1%, closely aligning with the prevalence of MDR strains (%MDR), which ranged from 47.7% to 96.1%. Correlating studies, such as one by Hsu et al., estimated that CRAB prevalence in Thailand exceeds 60%[14]. Additionally, Abdeta et al. reported a significant increase in CRAB prevalence from 50% in 2017 to 76.2% in 2021[15]. NARST data also indicated a rising trend in CRAB, from 44.5% in 2015 to 74.3% in 2021[2]. In comparison, national prevalence data from the United States in 2017 reported rates of MDR and carbapenem-non-susceptible (Carb-

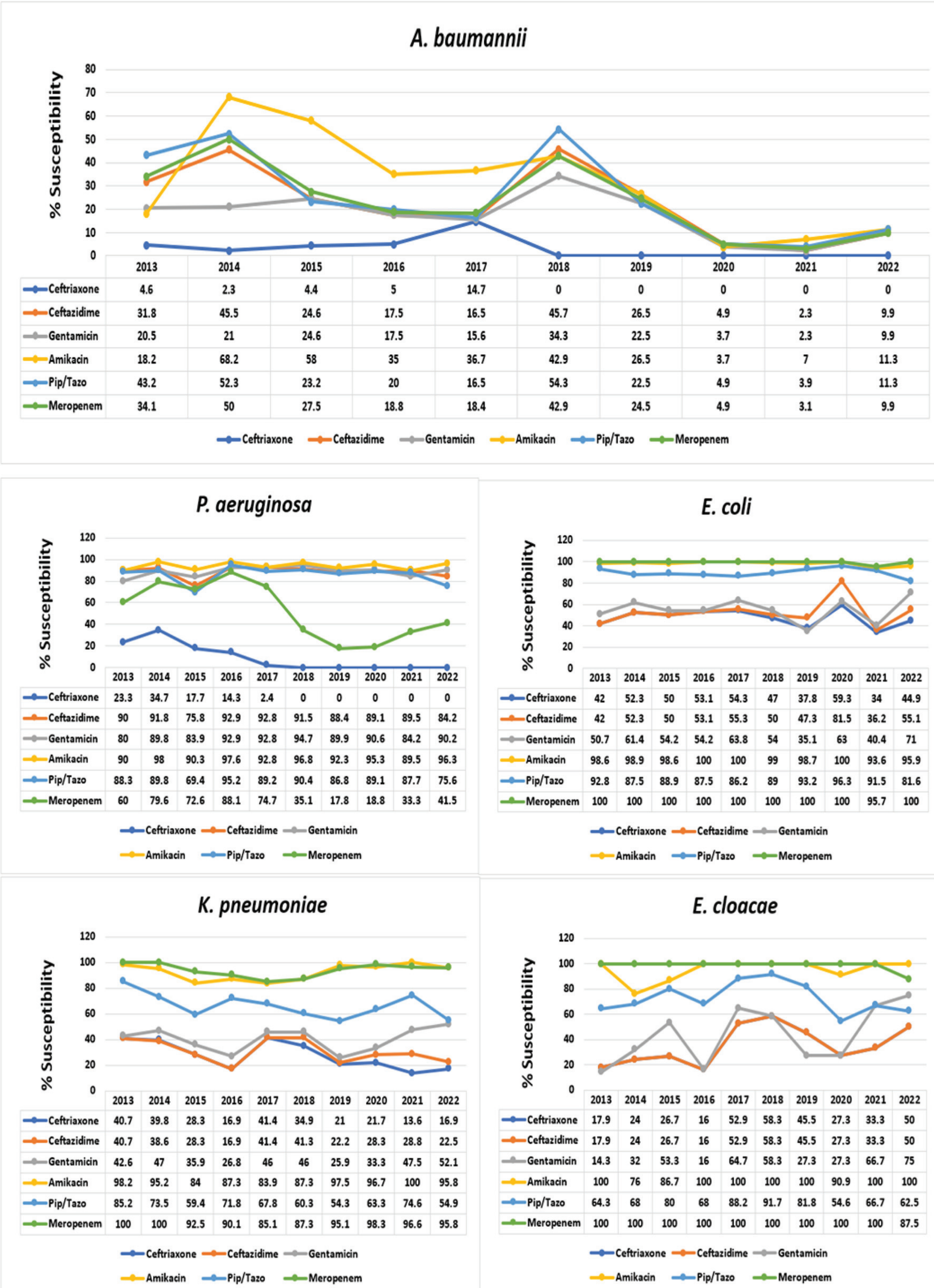

Figure 2. Antimicrobial susceptibility results of all Enterobacterales isolates.

NS) *Acinetobacter* spp. at 42.4% and 34.5%, respectively[16]. Furthermore, Germany's national AMR surveillance system showed a decreasing trend in carbapenem-resistant *A. baumannii* complex (CRABC) infections, with rates declining from 7.6% in 2014 to 3.5% in 2018[17].

Importantly, the prevalence of carbapenem-resistant *P. aeruginosa* (CRPA) surged in recent years, consistent with other studies[18-20]. For instance, CRPA contributed the largest proportion among four carbapenem-resistant GNB in the United States, with *P. aeruginosa* at 60.3%, *A. baumannii* at 22%, and *E. coli* or *K. pneumoniae* at 17.7%[20]. While NARST data showed a stable rate of CRPA from 17.8% in 2015 to 22.1% in 2021[2], this study found that the prevalence of ESBL-producing strains of *E. coli* at 40.7% to 63.8%, *K. pneumoniae* at 47.1% to 84.8%, and *E. cloacae* at 41.7% to 82.1% were higher than reported in other studies, including NARST data from 2000 to 2021 with *E. coli* ESBL13.4% to 46.7%, and *K. pneumoniae* ESBL 24.4% to 49.9%[2]. A five-year review between 2016 and 2020, at a tertiary hospital in Northern Thailand indicated that *E. coli* ESBL prevalence was 42.5%, and *K. pneumoniae* ESBL was 30.2%, primarily found in urine and sputum[21]. However, CRE rates in this study for *E. coli* were 0% to 4.3%, for *K. pneumoniae* were 0% to 16.1%, and for *E. cloacae* were 0% to 12.5%. Those were lower than reported by Xu et al. for Asia with an overall CRE of 37.5% and with *Klebsiella* spp. of 39.3%, *E. coli* of 22%, and *Enterobacter* spp. of 13%[22] and the United Arab Emirates report indicating imipenem-resistance rates of 29.8% in *Klebsiella* spp. and 35.7% in *E. coli*[23]. Compared with NARST data, CRE rates showed a higher trend over time, with *K. pneumoniae* rising from 0.8% in 2000 to 17.9% in 2021, and *E. coli* increasing from 0.6% in 2000 to 5% in 2021[2]. Notably, the increase of carbapenem-resistant *E. cloacae* rose from 0% to 6.3% in 2013 to 2021 to 12.5% in 2022, reflecting the emergence of carbapenem-resistant *E. cloacae* complex (CREC) globally due to intrinsic and acquired AMR mechanisms[24].

The result of the present study indicated that amikacin had the highest activity against all five microorganisms over time, with a prevalence of 40.7% to 84.8% among ESBL-producing strains. These findings align with data from Kandeel, which showed that amikacin had an 85.4% susceptibility rate against ESBL-producing Enterobacteriaceae, with a 22% prevalence among total isolates[10].

Regarding meropenem, this agent maintained good activity against *E. coli* at a 95.7% to 100% susceptibility rate, followed by *E. cloacae* at 87.5% to 100% susceptibility rate, and *K. pneumoniae* at 85.1% to 100% susceptibility rate. However, it exhibited poor performance for *A. baumannii* over the entire decade at 3.1% to 50% susceptibility rate and for *P. aeruginosa* since 2018 with a 17.8% to 41.5% susceptibility rate, correlating with the rising %CR of isolates.

Considering *A. baumannii*, which commonly exhibits intrinsic resistance, the present study found it to be non-susceptible to all antimicrobial agents, with %CR ranging from 45.5% to 96.1% and %MDR/XDR from 47.7% to 96.1%, consistent with findings in Hungary, which is 67.7% MDR strain of *A. baumannii*, with 55.2% susceptible to meropenem[5]. Furthermore, amikacin demonstrated good performance against *P. aeruginosa* with a 96.7% susceptibility rate, while its susceptibility to meropenem was 85.6%.

Interestingly, anti-pseudomonal beta-lactam agents such as piperacillin-tazobactam and ceftazidime, and aminoglycosides such as gentamicin and amikacin, remained effective with a 69.4% to 98% susceptibility rate against *P. aeruginosa*, surpassing meropenem with a 17.8% to 88.1% susceptibility rate over the decade, excluding piperacillin-tazobactam in 2015. This indicates the presence of carbapenem-resistant but cephalosporin-susceptible (Car-R/Ceph-S) *P. aeruginosa* strains, consistent with findings from other studies[5,25].

Ceftriaxone and ceftazidime exhibited low activity against all three Enterobacteriaceae in the present study with the % susceptibility ranging from 13.6% to 59.3%, except for ceftazidime for *E. coli* in 2020, which had an 81.5% susceptibility rate. This reflects the impact of ESBL-producing or plasmid-mediated AmpC enzymes, as well as carbapenemases[11]. Additionally, gentamicin performance was nearly identical to that of third-generation cephalosporins against *E. coli*, *K. pneumoniae*, and *E. cloacae*, suggesting caution in empirical treatment for severely infected inpatients.

In comparison to the NARST data encompassing a comprehensive 12-year review, which was between 2010 and 2021, involving 44 to 92 hospitals, an analysis of the susceptibility patterns of ceftriaxone, ceftazidime, gentamicin, amikacin, piperacillin-tazobactam, and meropenem indicated the persistent trend in the susceptibility rates of these antimicrobial agents against all five microorganisms: *A. baumannii*, *P. aeruginosa*, *E. coli*, *K. pneumoniae*, and *E.*

cloacae, extending throughout the entire decade. In detail, there was no effective agent for *A. baumannii* with amikacin showing the highest activity with a susceptibility rate of 40.1% to 49.4%, while all agents had susceptibility rate over 70% for *P. aeruginosa* and amikacin had the best activity at 76.6% to 91.7% susceptibility rate followed by meropenem at 72.9% to 80.6% susceptibility rate, respectively. Among Enterobacteriaceae, amikacin and meropenem were the most effective with nearly 100% of susceptibility for *E. coli* and *E. cloacae* over time, while meropenem exhibited decreased activity with susceptibility below 90% for *K. pneumoniae* since 2017 and was at 88.9% in 2017 to 82% in 2021 susceptibility rate. Piperacillin-tazobactam may be regarded as a viable treatment option for *E. coli* infections, as it exhibited a favorable susceptibility rate ranging from 86.3% to 89.7%. However, its activity was fair and unreliable against *E. cloacae* at 72.7% to 83.4% susceptibility rate and *K. pneumoniae* at 65.7% to 71.7% susceptibility rate, respectively[2].

Conclusion

In conclusion, AMR is a critical issue at Pranangklao Hospital, particularly concerning *A. baumannii* and *P. aeruginosa*, which show a high proportion of resistance to meropenem. Respiratory tract isolates are the main sources of these resistant organisms. NICU is the key area for implementing control strategies aimed at decelerating the spread and development of AMR.

What is already known about this topic?

AMR is a significant problem worldwide that is difficult to manage. Global incidence has increased. The main cause is the inappropriate use of antimicrobial agents. Multiple strategies can be applied for controlling including antimicrobial stewardship program.

What does this study add?

A ten-year review of data from a provincial hospital in central Thailand, focusing on the isolation of Enterobacterales and their susceptibility to key antimicrobial agents, aims to enhance insights of AMR situation and guide future strategies and control measures.

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Conflicts of interest

The author declares no conflict of interest.

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