

BACTERIAL INFECTION MODEL AND ANTIBIOTIC RESISTANCE AT THE NEW PRIVATE HOSPITAL

Tran Thi Thanh Nga¹, Nguyen Van Tan Minh¹, Nguyen Thanh Tai¹, Nguyen Thi Van¹

Summary

Objectives: Survey of bacterial pathogens and antibiotic resistance at Tam Anh Hospital in 2021.

Material and methods: Retrospective method. Bacteria were isolated from specimens at the Department Microbiology of Laboratory center at Tam Anh Hospital in 2021 which were identified and tested drug susceptibility by Vitek 2. By CLSI standards.

Results: Distribution of pathogenic strains: In 2021, 880 strains of bacteria were isolated, 8 types of most common bacteria were *Escherichia coli* (46%), *Staphylococcus aureus* (16.8%), *Klebsiella pneumoniae* (14.3%), *Staphylococcus haemolyticus* (6%), *Pseudomonas aeruginosa* (4.3%), *Enterococcus faecalis* (3.9%), *Enterobacter cloacae* (2.9%), *Acinetobacter baumannii* (2.3%).

Antibiotic resistance: *Escherichia coli* was resistant to most second and third generation cephalosporins, trimethoprim/sulfamethoxazole, fluoroquinolone, still sensitive to carbapenems, piperacillin/tazobactam, amikacin, tigecyclin, cefepime, ceftazidim, gentamycin, tobramycin, nitrofurantoin. The ESBL rate was 36%. *Staphylococcus aureus* was resistant > 30% to bezilpenicillin, erythromycin, clindamycin, oxacillin, tetracycline, still sensitive to levofloxacin; rifamycin, vancomycin; fusidic acid; nitrofurantoin; linezolid; teicoplanin; tigecycline. The MRSA rate is 59.6%. *Klebsiella pneumoniae* was resistant > 30% to cephalosporin, fluoroquinolone, ampicillin/sulbactam, piperacillin/tazobactam, nitrofurantoin, moxifloxacin. For meropenem were resistant 18%, ertapenem 19%. The ESBL rate was 19%. *Staphylococcus haemolyticus* was resistant > 30% to fluoroquinolone, bezilpenicillin, erythromycin, fusidic acid, oxacillin, trimethoprim/sulfamethoxazole. Tetracycline, still sensitive to moxifloxacin, rifamycin, nitrofurantoin, gentamicin, linezolid, teicoplanin, tigecycline, vancomycin.

Pseudomonas aeruginosa was resistance > 30% to cephalosporin, aminoglycoside, fluoroquinolone, tigecyclin, cefepime, was resistance > 20% to meropenem, ceftazidime, imipenem, piperacillin/tazobactam, especially not resistance to colistin. *Acinetobacter baumannii* was resistance > 50% to cephalosporin, aminoglycoside, carbapenem, piperacillin/tazobactam, ticarcillin/clavulanic acid, trimethoprim/sulfamethoxazole still sensitive to colistin, tigecycline; tobramycin.

Conclusion: The common bacteria in at Tam Anh Ho Chi Minh Hospital in 2021 were *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Staphylococcus haemolyticus*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Enterobacter cloacae*, *Acinetobacter baumannii*. In the current situation of multidrug resistant bacteria, understanding the distribution of sepsis pathogens and updating their antibiotic resistance will be a great help to clinicians in the antibiotic selection to treat as well as contribute to reduce antibiotic resistance.

Keywords: Antibiotic resistance.

BACKGROUND

Multi-antibiotic resistant bacteria is a concern of the whole world, including Vietnam. The correct identification of the causative organism and the antibiotic sensitivity of the bacteria makes the treatment more accurate.

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Thi Thanh Nga, Head of Laboratory Center - Tam Anh Hospital

Tel: 0908185491. E-mail: bstntah@gmail.com.



Reasonable and economical, minimizing multi-resistance of bacteria and at the same time helping doctors to treat empirically before the results of antibiogram are available. This study is aimed to:

- Identify common pathogenic bacteria at Tam Anh Hospital in Ho Chi Minh City.
- Rate of resistance to antibiotics of common bacterial strains.
- Contributing to antimicrobial stewardship program data and hospital antibiotic guideline.

MATERIAL AND METHODS

Retrospective, data collection of positive culture results of specimens from March 2012 to December 2021.

Methods of implementation:

- Identification and performance of antibiogram using Vitek II Compact by BioMerieux.
- BioMerieux's BacT/Alert 3D automatic blood culture machine system.
- According to CLSI 2020 (Clinical and Laboratory Standards Institute).

RESULTS

Distribution of infectious agents: In 2021, from March to December, 880 strains of bacteria were isolated, the most in urine (n = 173), sputum (n = 99), pus (94), fluid (n = 50), blood (n = 42), in which the 8 most common bacteria are distributed as shown in Table 1.

Table 1. Distribution of common bacteria at Tam Anh Hospital in Ho Chi Minh City, Ho Chi Minh in 2021

No	Bacteria	Positive (n = 880)	Rate (%)
1	<i>Escherichia coli</i>	236	46.0%
2	<i>Staphylococcus aureus</i>	86	16.8%
3	<i>Klebsiella pneumoniae</i>	73	14.3%
4	<i>Staphylococcus haemolyticus</i>	31	6.0%
5	<i>Pseudomonas aeruginosa</i>	22	4.3%
6	<i>Enterococcus faecalis</i>	20	3.9%
7	<i>Enterobacter cloacae</i>	15	2.9%
8	<i>Acinetobacter baumannii</i>	12	2.3%

Antibiotic resistance rates of common bacteria

Table 2. Antibiotic resistance rate of *Escherichia coli* bacteria (n = 236)

Antibiotic	Resistance (%)
Cefazolin	63.1
Piperacillin	58.8
Trimethoprim/sulfamethoxazole	55.6
Ciprofloxacin	53.1
Levofloxacin	52.2
Ampi/sulbactam	50.8
Ceftriaxone	47.7
Cefpodoxime	46.3
Cefuroxime	38.9
Moxifloxacin	38.9
Cefotaxime	35.8
Gentamicin	22.2
Ceftazidime	16.7
Tobramycin	11.9
Cefepime	7.9
Piperacillin/tazobactam	4.9
Ertapenem	2.5
Nitrofurantoin	1.5
Amikacin	0
Imipenem	0
Meropenem	0
Tigecycline	0

Escherichia coli resistant >30% to most of the 2nd and 3rd generation cephalosporin antibiotics, trimethoprim/sulfamethoxazole, fluoroquinolone, still sensitive to carbapenem, piperacillin/tazobactam, amikacin, tigecyclin, cefepime, ceftazidim, gentamycin, tobramycin groups, nitrofurantoin. The ESBL rate is 36%.

Table 3. The antibiotic resistance rate of *Staphylococcus aureus* bacteria (n = 86)

Antibiotic	Resistance (%)
Benzylpenicillin	93.8
Erythromycin	72.9
Clindamycin	68.8
Oxacillin	62.5
Tetracycline	54.2
Gentamicin	25
Trimethoprim/sulfamethoxazole	16.7
Ciprofloxacin	14.6
Moxifloxacin	14.6
Levofloxacin	10
Rifampicin	6.3
Vancomycin	0
Fusidic acid	0
Nitrofurantoin	0
Linezolid	0
Teicoplanin	0
Tigecycline	0

Staphylococcus aureus is more than 30% resistant to the antibiotics bezilpenicillin, erythromycin, clindamycin, oxacillin, tetracycline, still sensitive to levofloxacin antibiotics; < 10% resistance to rifamycin, vancomycin; fusidic acid; nitrofurantoin; linezolid; teicoplanin; tigecycline. The rate of MRSA is 59.6%.

Table 4. Antibiotic resistance rate of *Klebsiella pneumoniae* bacteria (n = 73)

Antibiotic	Resistance (%)
Ciprofloxacin	42.9
Cefpodoxime	40.7
Cefuroxime	40.7
Nitrofurantoin	35.7
Cefotaxime	33.3
Moxifloxacin	33.3
Cefazolin	28.6

Ampicillin/sulbactam	28.6
Piperacillin/tazobactam	28.6
Levofloxacin	26.7
Ceftazidime	23.8
Trimethoprim/sulfamethoxazole	21.4
Ertapenem	19.5
Meropenem	17.9
Gentamicin	16.7
Ceftriaxone	14.3
Cefepime	13.3
Imipenem	7.1
Amikacin	6.7
Tobramycin	6.7
Tigecycline	3.7

Klebsiella pneumoniae is 30% resistant to cephalosporins, fluoroquinolones, ampicillin/sulbactam, piperacillin/tazobactam, nitrofurantoin, moxifloxacin antibiotics. Particularly, meropenem is resistant to 18%, ertapenem 19%. Also sensitive to antibiotics imipenem, amikacin, tobramycin, tigecycline. The ESBL rate is 19%.

Table 5. Antibiotic resistance rate of *Staphylococcus haemolyticus* (n = 31)

Antibiotic	Resistance (%)
Benzylpenicillin	91.7
Erythromycin	83.3
Oxacillin	83.3
Tetracycline	66.7
Ciprofloxacin	58.3
Levofloxacin	50
Trimethoprim/sulfamethoxazole	41.7
Fusidic acid	37.5
Clindamycin	25
Moxifloxacin	8.3
Rifampicin	8.3
Nitrofurantoin	0
Gentamicin	0



Antibiotic	Resistance (%)
Linezolid	0
Teicoplanin	0
Tigecycline	0
Vancomycin	0

Staphylococcus heamolyticus is > 30% resistant to fluoroquinolone antibiotics, bezilpenicillin, erythromycin, fusidic acid, oxacillin, trimethoprim/sulfamethoxazole tetracycline, also sensitive to the antibiotics moxifloxacin, rifamycin, nitrofurantoin, gentamicin, linezolid, teicoplanin, tigecycline, vancomycin.

Table 6. Antibiotic resistance rate of *Pseudomonas aeruginosa* (n = 22)

Antibiotic	Resistance (%)
Tigecycline	100
Ticarcillin/clavulanic acid	80
Ticarcillin	80
Piperacillin	71.4
Levofloxacin	55.6
Cefotaxime	50
Ciprofloxacin	45.5
Gentamicin	45.5
Cefepime	44.4
Amikacin	33.3
Tobramycin	33.3
Meropenem	28.6
Ceftazidime	27.3
Imipenem	27.3
Piperacillin/tazobactam	27.3
Colistin	0

Pseudomonas aeruginosa was resistance > 30% to cephalosporin, aminoglycoside, fluoroquinolone, tigecyclin, cefepime, was resistance > 20% to meropenem, ceftazidime, imipenem, piperacillin/tazobactam, especially not resistance to colistin.

Table 7. Antibiotic resistance rate of *Enterococcus faecalis* bacteria (n = 20)

Antibiotic	Resistance (%)
Tetracycline	90
Erythromycin	80
Gentamicin	70
Ciprofloxacin	20
Nitrofurantoin	20
Levofloxacin	20
Linezolid	10
Benzylpenicillin	0
Teicoplanin	0
Tigecycline	0
Vancomycin	0

Enterococcus faecalis bacteria was resistance > 30% to tetracycline, erythromycin, gentamicin, sensitive to quinolone, nitrofurantoin, linezolid, still sensitive to benzylpenicillin, teicoplanin, tigecycline, vancomycin.

Table 8. Antibiotic resistance rate of *Enterobacter cloacae* (n = 15)

Antibiotic	Resistance (%)
Cefazolin	100
Ceftriaxone	83.3
Cefuroxime	71.4
Ceftazidime	61.5
Piperacillin/tazobactam	61.5
Cefpodoxime	57.1
Cefotaxime	57.1
Ciprofloxacin	38.5
Ertapenem	38.5
Meropenem	28.6
Moxifloxacin	28.6
Gentamicin	23.1
Imipenem	23.1

Antibiotic	Resistance (%)
Cefepime	16.7
Nitrofurantoin	16.7
Levofloxacin	16.7
Trimethoprim/sulfamethoxazole	15.4
Tigecycline	14.3
Amikacin	0
Tobramycin	0

Enterobacter cloaca resistance > 30% to cephalosporin, piperacillin/tazobactam, ciprofloxacin, ertapenem, sensitive to gentamicin, cefepime, levofloxacin, trimethoprim/sulfamethoxazole, tigecycline, amikacin, tobramycin.

Table 9. Antibiotic resistance rate of *Acinetobacter baumannii* (n = 12)

Antibiotic	Resistance (%)
Ticarcillin/clavulanic acid	100
Ticarcillin	100
Cefepime	75
Levofloxacin	75
Meropenem	66.7
Ceftazidime	62.5
Ciprofloxacin	62.5
Piperacillin/tazobactam	62.5
Cefotaxime	50
Imipenem	37.5
Piperacillin	33.3
Trimethoprim/sulfamethoxazole	25
Gentamicin	12.5
Colistin	0
Tigecycline	0
Tobramycin	0

Acinetobacter baumannii was resistance > 50% to cephalosporin, aminoglycoside, carbapenem, piperacillin/tazobactam, ticarcillin/clavulanic acid, trimethoprim/sulfamethoxazole still sensitive to colistin, tigecycline; tobramycin.

DISCUSSION

Antibiotic resistance in hospitals is a global problem, especially in Asian countries, including Vietnam. Through surveying the rate of resistant and resistant bacteria at Tam Anh General Hospital, the city is a new non-public hospital, but antibiotic resistance of common bacteria accounts for about > 30%, so antibiotic resistance is increasing, especially carbapenem resistant to *K. pneumoniae*, *A. baumannii*, in recent years apart from *A. baumannii*, we have noticed an increasing resistance of *K. pneumoniae* bacteria. with carbapenem, at Cho Ray Hospital, which is a terminal hospital with many severe patients, the rate of carbapenem resistance of *K. pneumoniae* 2014 (30%), increased resistance in 2019 (70%). At Tam Duc Heart Hospital, which is a non-public cardiology hospital, it regularly receives treatment for elderly patients with many chronic diseases associated with the rate of carbapenem resistance of *K. pneumoniae* in 2018 (35%), In the first 6 months of 2019, resistance increased (60%). At Bach Mai Hospital, statistics reported from the Department of Microbiology in 2018 showed that *K. pneumoniae* was the second most common cause of infection (19%) in the ICU. The level of resistance of *K. pneumoniae* tends to increase with most antibiotics, especially resistance to carbapenem family antibiotics, from (30%) in 2014 to (77%) in 2018 with imipenem and meropenem. Thus, there is an increase in carbapenem resistance of homologous *K. pneumoniae* bacteria in different hospitals. Most of these bacteria strains are resistant due to carbapenemase production mechanism.

Besides multi-resistant gram-negative bacteria, the status of MRSA (Methicillin-resistant *Staphylococcus aureus*) is increasing by > 60%. In the past, vancomycin was considered the treatment of choice for MRSA pneumonia. However, in recent years, treatment failure for MRSA infections has been associated with vancomycin MICs



≥ 1.5 mg/L or patients with low vancomycin trough concentrations. Therefore, the Institute of Clinical Laboratory Standards (USA) reduced the susceptibility breakpoint for vancomycin of MRSA from 4 to 2 mg/L^{1,3,10}.

At Tam Anh General Hospital in Ho Chi Minh City. Ho Chi Minh City is a new non-public hospital, the number of inpatients is not much, so the resistance to carbapenem is $< 30\%$ against *K. pneumoniae*, *P. aeruginosa* and *A. baumannii* bacteria $> 30 - 60\%$. Particularly, MRSA 60%.

CONCLUSIONS

- Common types of bacteria in infections at Tam Anh Hospital in Ho Chi Minh City in 2021 were *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Staphylococcus haemolyticus*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Enterobacter cloacae*, *Acinetobacter baumannii*.

- In the current situation of multidrug-resistant bacteria, understanding the distribution of infectious agents and updating their antibiotic resistance will be of great help to clinicians in this regard. choice of antibiotic treatment as well as contribute to reducing the current multidrug resistance.

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