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 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, trimethoprimsulfamethoxazole 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.

1: Laboratory Center - Tam Anh Hospital

Date of receipt: October 02, 2022
Date of reviewed completion: November 22, 2022
Accepted date for publication: December 15, 2022
Responsibility for scientific content of the article: Tran Thi Thanh Nga, Head of Laboratory Center - Tam Anh Hospital
Tel: 0908185491. E-mail: bstntnah@gmail.com.

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.
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**

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

Antibiotic resistance rates of common bacteria

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

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>63.1</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>58.8</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>55.6</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>53.1</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>52.2</td>
</tr>
<tr>
<td>Ampicillin/sulbactam</td>
<td>50.8</td>
</tr>
<tr>
<td>Ceftriazone</td>
<td>47.7</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>46.3</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>38.9</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>38.9</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>35.8</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>22.2</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>16.7</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>11.9</td>
</tr>
<tr>
<td>Cefepime</td>
<td>7.9</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>4.9</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>2.5</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>1.5</td>
</tr>
<tr>
<td>Amikacin</td>
<td>0</td>
</tr>
<tr>
<td>Imipenem</td>
<td>0</td>
</tr>
<tr>
<td>Meropenem</td>
<td>0</td>
</tr>
<tr>
<td>Tigecycline</td>
<td>0</td>
</tr>
</tbody>
</table>

*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)

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

*Staphylococcus aureus* is more than 30% resistant to the antibiotics benzylpenicillin, erythromycin, clindamycin, oxacillin, tetracycline, still sensitive to levofloxacin antibiotics; < 10% resistance to rifampicin, 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)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>42.9</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>40.7</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>40.7</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>35.7</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>33.3</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>33.3</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>28.6</td>
</tr>
</tbody>
</table>

*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)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzylpenicillin</td>
<td>91.7</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>83.3</td>
</tr>
<tr>
<td>Oxacillin</td>
<td>83.3</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>66.7</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>58.3</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>50</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>41.7</td>
</tr>
<tr>
<td>Fusidic acid</td>
<td>37.5</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>25</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>8.3</td>
</tr>
<tr>
<td>Rifampicin</td>
<td>8.3</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>0</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>0</td>
</tr>
</tbody>
</table>

*Staphylococcus haemolyticus* is more resistant to benzylpenicillin, erythromycin, clindamycin, oxacillin, tetracycline, still sensitive to levofloxacin; > 20% resistance to rifampicin, vancomycin; fusidic acid; nitrofurantoin; linezolid; teicoplanin; tigecycline. The rate of MRSA is 59.6%.
**Staphylococcus hemolyticus** 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)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigecycline</td>
<td>100</td>
</tr>
<tr>
<td>Ticarcillin/clavulanic acid</td>
<td>80</td>
</tr>
<tr>
<td>Ticarcillin</td>
<td>80</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>71.4</td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>55.6</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>50</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>45.5</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>45.5</td>
</tr>
<tr>
<td>Cefepime</td>
<td>44.4</td>
</tr>
<tr>
<td>Amikacin</td>
<td>33.3</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>33.3</td>
</tr>
<tr>
<td>Meropenem</td>
<td>28.6</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>27.3</td>
</tr>
<tr>
<td>Imipenem</td>
<td>27.3</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>27.3</td>
</tr>
<tr>
<td>Colistin</td>
<td>0</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>100</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>83.3</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>71.4</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>61.5</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>61.5</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>57.1</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>57.1</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>38.5</td>
</tr>
<tr>
<td>Ertaopenem</td>
<td>38.5</td>
</tr>
<tr>
<td>Meropenem</td>
<td>28.6</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>28.6</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>23.1</td>
</tr>
<tr>
<td>Imipenem</td>
<td>23.1</td>
</tr>
</tbody>
</table>
**Antibiotic** | **Resistance (%)**
---|---
Cefepime | 16.7
Nitrofurantoin | 16.7
Levofloxacin | 16.7
Trimethoprim/sulfamethoxazole | 15.4
Tigecycline | 14.3
Amikacin | 0
Tobramycin | 0

**Enterobacter cloacaeresistance > 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)**

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

**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 carapenem is resistant to *K. pneumoniae*, *A. baumannii*, in recent years apart from *A. baumannii*, we have noticed an increasing resistance of *K. pneumoniae* bacteria. with carapenem, at Cho Ray Hospital, which is a terminal hospital with many severe patients, the rate of carapenem 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 carapenem 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 carapenem family antibiotics, from (30%) in 2014 to (77%) in 2018 with imipenem and meropenem. Thus, there is an increase in carapenem resistance of homologous *K. pneumoniae* bacteria in different hospitals. Most of these bacteria strains are resistant due to carapenemase 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\textsuperscript{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 \textit{K. pneumoniae}, \textit{P. aeruginosa} and \textit{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 \textit{Escherichia coli}, \textit{Staphylococcus aureus}, \textit{Klebsiella pneumoniae}, \textit{Staphylococcus haemolyticus}, \textit{Pseudomonas aeruginosa}, \textit{Enterococcus faecalis}, \textit{Enterobacter cloacae}, \textit{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.

**REFERENCES**

2. Pham Thi Ngoc Thao, Tran Van Ngoc, Tran Thi Thanh Nga. Determination of minimum inhibitory concentrations of MIC\textsubscript{90} of bacteria causing hospital-acquired pneumonia at Cho Ray Hospital. Grassroots level project acceptance 2015.