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Distribution of Pathogenic Bacteria and Drug Resistance in ICU of a Newly Built Hospital

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Objective: This study investigated the distribution and resistance patterns of pathogens in the intensive care unit of a newly established hospital in Guizhou Province to promote the rational use of antibiotics to reduce multidrug resistance.

Methods: A retrospective analysis was conducted on the distribution of pathogens and changes in drug resistance in the ICU of a newly built hospital in Guizhou Province from March 2019 to December 2023. WHONET 5.6 was used to analyze the results.

Results: A total of 2444 culture samples were received, predominantly sputum (34.66%) and blood (23.36%) samples, with a steady annual increase in specimen types. A total of 572 pathogenic strains were isolated, predominantly from respiratory specimens (54.02%), including 345 Gram-negative bacteria (60.31%), 135 Gram-positive cocci (23.60%), and 92 fungi (16.08%). The most frequent pathogens included Acinetobacter baumannii (30.77%), Candida albicans (11.71%), and Klebsiella pneumoniae (9.97%). Drug sensitivity tests indicated a fluctuating resistance rate of Acinetobacter baumannii over the past five years. Staphylococcus aureus displayed strong in vitro activity against vancomycin, tigecycline, and linezolid, with no resistant strains identified. The detection rates of carbapenem-resistant Acinetobacter baumannii (CR-AB), carbapenem-resistant Pseudomonas aeruginosa (CR-PA), methicillin-resistant Staphylococcus aureus (MRSA), and strains producing extended-spectrum beta-lactamases (ESBL) were 86.78%, 26.79%, 32.45%, 70.27%, and 23.54%, respectively.

Conclusion: Compared with other countries in the world, China has increased its data on the prevalence of MDR pathogens and antibiotic resistance.The high resistance rate of Acinetobacter baumannii in the ICU underscores the need for effective infection control measures. Enhanced monitoring of CR-AB, ESBL-producing bacteria, and MRSA is essential, along with improved management of antibacterial drugs and the pursuit of new therapeutic options.

Keywords: new-built hospital, intensive care unit, pathogens, multidrug-resistant bacteria, antimicrobial resistance

Introduction

The majority of patients admitted to the Intensive Care Unit (ICU) are in a critical state, with multiple complications, weakened immune systems, a history of invasive surgeries, and extensive use of broad-spectrum antibiotics during treatment. Consequently, the risk of hospital-acquired infections is significantly elevated.[1,2] Co-infection is the main reason for the increase of mortality and economic burden of ICU patients.[3] Pathogenic spectrum and bacterial resistance patterns in ICU are different in different regions and hospitals.[4] Accurate analysis of the characteristics of pathogens in ICU is helpful to guide clinical decision-making. In this study, the distribution and drug resistance of pathogenic bacteria in ICU of a newly-built hospital in Guizhou province were studied for five years, so as to provide reference for hospital infection management and rational use of antibiotics.Compared with other countries in the world, China has increased its data on the prevalence of MDR pathogens and antibiotic resistance.The results of this investigation provide significant insights into the prevention of nosocomial infections and the appropriate use of antibiotics.

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Methods

Specimens were isolated from ICU patients in a newly-built hospital in Guizhou Province from March 2019 to December 2023. Samples were isolated from patients in the intensive care unit of a newly built hospital in Guizhou Province from March 2019 to December 2023. The number of hospital beds is 20, and the hospital type is a tertiary comprehensive hospital. In the study, 2500 patients aged ≥ 18 were admitted.Taking sputum, urine, blood, secretions and other culture samples received by the clinical laboratory as research materials, when the same strain with the same drug sensitivity results was cultivated for many times in the same part of the same patient, only the first strain was counted.

Inclusion Criteria

According to the "Diagnostic Criteria for Hospital Infections (Trial)" issued by the Health Commission in 2001, it is determined that: (1) There are three types of tubing, including endotracheal intubation or tracheostomy tube, urinary catheter, and central venous catheter, or at least one of them should be carried. (2) The placement time is greater than 24 hours. (3) Infections with a clear incubation period occur after exceeding the average incubation period after admission to the ICU. (4) Infections without a clear incubation period that occur 48 hours after admission to the ICU. (5) The patient had infectious diseases at the time of admission, and new pathogens were detected from the primary or secondary lesions during hospitalization, or new infections occurred in other parts of the patient's body (excluding the migration focus of chronic infection, such as sepsis migration focus).

Exclusion Criteria

(1) The patient has a pre-existing or latent infection or infectious disease at the time of admission, which is a community-acquired infection and does not belong to hospital acquired infections. (2) Bacteria cultured in open wounds or secretions without any clinical symptoms or signs belong to bacterial colonization and are not classified as hospital acquired infections.(3) Chronic infectious diseases occurs acutely in the hospital, but no new pathogen is found. It can be diagnosed as infectious diseases, but it does not belong to hospital infection. (4) The patient's check-in time has not exceeded 48 hours.

Strain Identification

Pathogenic bacteria culture and drug sensitivity refer to the 4th edition of the National Operating Rules for Clinical Inspection. After the collected patient samples are qualified, the bacteria identification and drug sensitivity test are carried out by VITEK-2 COMPACT automatic microbial identification instrument of French Bio-Media Company, and the number of strains and plants are counted. Pathogen identification and drug sensitivity results refer to CLSI guidelines. Drug resistance rate = number of drug-resistant strains/number of tested strains ×100%.

Definition

MDR refers to resistance to three or more antibiotics simultaneously.[5] MDR mainly includes methicillin-resistant Staphylococcus aureus (MRSA), VRE, carbapenem resistant Escherichia coli (CREC), Klebsiella pneumoniae (CRKP), Pseudomonas aeruginosa (CRPA), and Acinetobacter baumannii (CRAB).

Statistical Analysis

Raw data were first processed using Whonet 5.6 software and then calculated using GraphPad Prism 9. The comparison between groups was conducted using the chi square test, Statistical significance was confirmed if the two-tailed P-value was <0.05.

Results

Trend Analysis of Culture Sample Distribution and Pathogen Detection from 2019 to 2023

From 2019 to 2023, a total of 2444 culture samples were received, with respiratory tract samples (847, accounting for 34.66%) and blood samples (571, accounting for 23.36%) being the main samples. Pathogens detected in drainage culture (373), urine culture (347), and other culture samples (306) accounted for 15.26%, 14.20%, and 12.52%, respectively, as shown in Figure 1. From 2019 to 2023, the number of various types of culture specimens showed a continuous increasing trend, as shown in Figure 2; A total of 572 positive specimens were cultured from 2019 to 2023, including 10 in 2019, 65 in 2020, 83 in 2021, 122 in 2022 and 292 in 2023. There are 309 respiratory specimens, 152 blood specimens, 39 drainage specimens, 25 urine specimens and 47 other specimens, as shown in Figure 3. From 2019 to 2023, the proportion of positive culture specimens in respiratory tract decreased first and then increased, the proportion of positive culture specimens in blood increased, and the proportion of positive culture specimens in drainage fluid decreased as a whole, as shown in Figure 4.

Pathogen Distribution and Trends in ICU Isolates from 2019 to 2023

Distribution of pathogens A total of 572 strains of pathogens were isolated and identified from 2019 to 2023, including 345 strains of Gram-negative bacilli (60.31%), 135 strains of Gram-positive cocci (23.60%) and 92 strains of fungi (16.08%). The

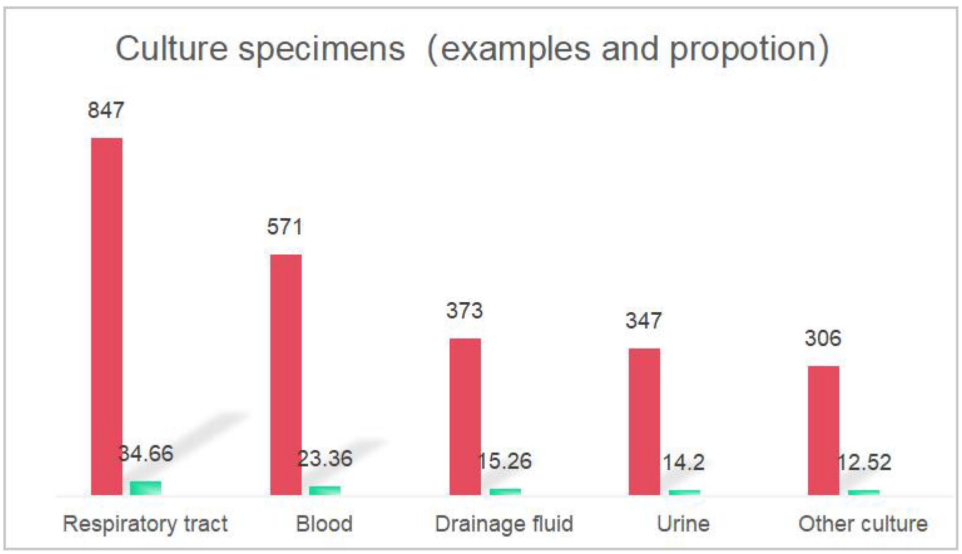

Figure 1 Source and proportion of total culture specimens.

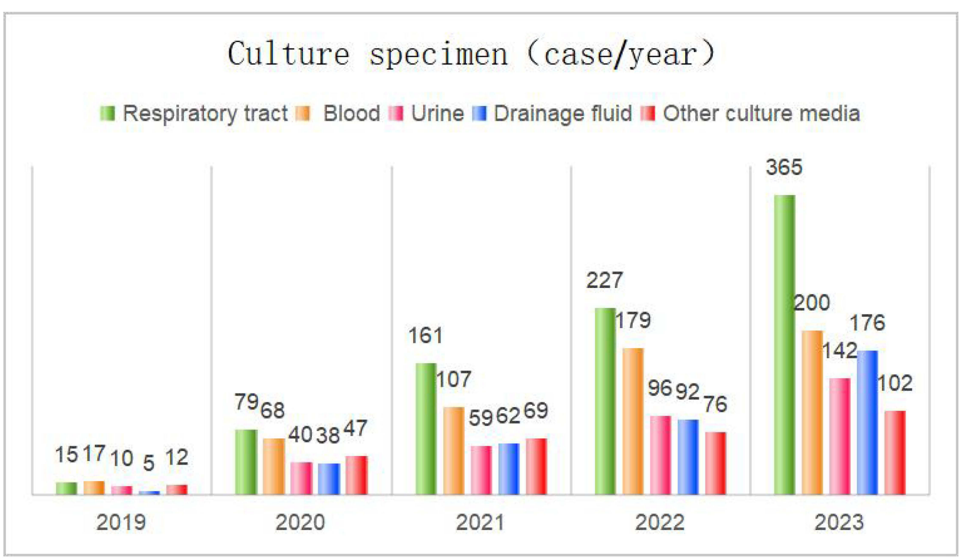

Figure 2 Cases of each culture specimen/year.

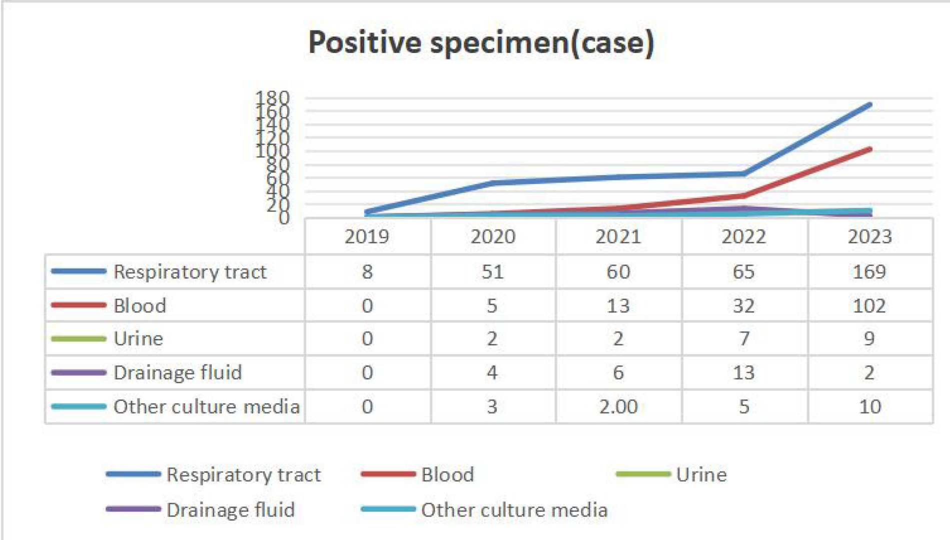

Figure 3 Source and distribution of positive specimens.

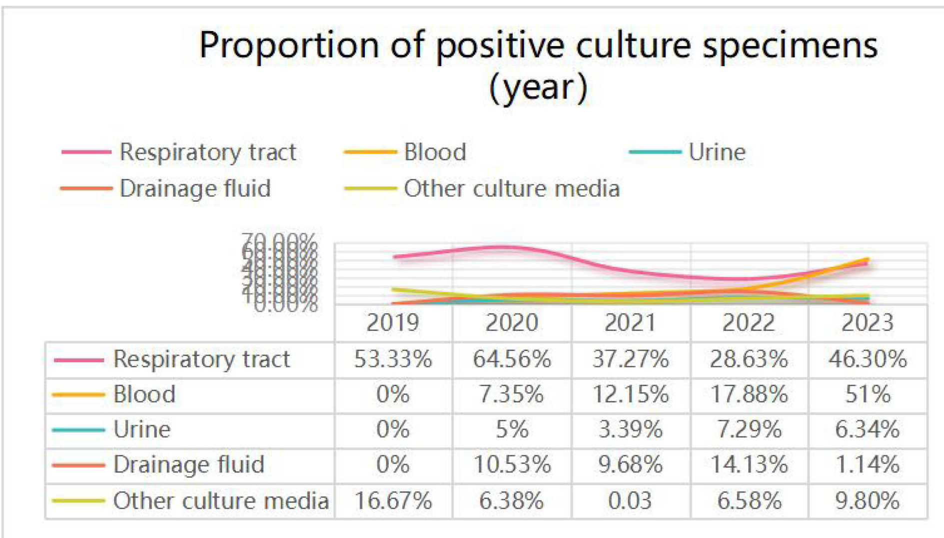

Figure 4 Proportion of positive specimens/year.

first five common pathogens were Acinetobacter baumannii (30.77%), Candida albicans (11.71%), Klebsiella pneumoniae (9.97%), Escherichia coli (9.09%) and Pseudomonas aeruginosa (8.04%). In 2020, the proportion of Acinetobacter baumannii (47.69%) and Candida albicans (20.00%) was relatively high, and it showed a downward trend in the following years, with statistical significance (P<0.05). The proportion of human staphylococcus (4.92%) increased in 2022, and the difference was statistically significant (P<0.05). The composition ratio of Staphylococcus aureus increased year by year, and the difference was not statistically significant (P> 0.05). Between 2019 and 2023, the number of positive samples is equal to the number of identified pathogens. Further research is needed to determine if multiple pathogens were detected simultaneously in the samples.The number of positive samples, especially in 2019 (only 10), is very small. This phenomenon is related to the early stages of hospital opening and the types of patients admitted at that time. The hospital is newly built, and these samples are from ICU inpatients. See Table 1.

Table 1 Distribution and Composition of Pathogens in ICU from 2019 to 2023 [n (%)]

Pathogenic Bacteria	2019 (n=10)	2020 (n=65)	2021 (n=83)	2022 (n=122)	2023 (n=292)	Total (n=572)	$\chi2$	*P*
Gram negative								
Acinetobacter baumannii	3 (30.00)	31 (47.69)	33 (39.76)	33 (27.05)	76 (26.03)	176 (30.77)	7.637	0.035
Pseudomonas aeruginosa	1 (10.00)	4 (6.15)	8 (9.64)	11 (9.02)	22 (7.53)	46 (8.04)	0.854	0.673
Escherichia coli	1 (10.00)	2 (3.07)	7 (8.43)	12 (9.83)	30 (10.27)	52 (9.09)	2.764	0.532
Klebsiella pneumoniae	2 (20.00)	1 (1.54)	6 (7.23)	9 (7.38)	39 (13.36)	57 (9.97)	5.946	0.124
Other	0 (0.00)	0 (0.00)	5 (6.02)	7 (5.74)	2 (0.68)	14 (2.45)	4.584	0.209
Gram positive								
Staphylococcus aureus	0 (0.00)	3 (4.62)	5 (6.02)	12 (9.84)	13 (4.45)	33 (5.77)	2.663	0.534
Staphylococcus epidermidis	0 (0.00)	6 (9.23)	3 (3.61)	6 (4.92)	17 (5.82)	32 (5.59)	3.037	0.432
Enterococcus faecalis	0 (0.00)	1 (1.54)	3 (3.61)	1 (0.82)	6 (2.05)	11 (1.92)	2.423	0.523
Staphylococcus haemolyticus	0 (0.00)	1 (1.54)	1 (1.20)	8 (6.56)	17 (5.82)	27 (4.72)	5.356	0.124
Staphylococcus hominis	0 (0.00)	0 (0.00)	0 (0.00)	6 (4.92)	14 (4.79)	20 (3.49)	7.834	0.124
Other	0 (0.00)	0 (0.00)	3 (3.61)	5 (4.10)	4 (1.37)	12 (2.09)	3.345	0.346
Fungus								
Candida albicans	2 (20.00)	13 (20.00)	6 (7.23)	8 (6.56)	38 (13.01)	67 (11.71)	10.263	0.016
Candida glabrata	1 (10.00)	2 (3.07)	0 (0.00)	2 (1.64)	7 (2.40)	12 (2.09)	5.256	0.122
Candida krusei	0 (0.00)	1 (1.54)	1 (1.20)	1 (0.82)	3 (1.03)	6 (1.05)	0.365	0.769
Other	0 (0.00)	0 (0.00)	2 (2.41)	1 (0.82)	4 (1.37)	7 (1.22)	2.255	0.563

Antibiotic Resistance Patterns of Acinetobacter Baumannii from 2019 to 2023

Acinetobacter baumannii showed a high resistance rate to most of the tested drugs from 2019 to 2023, and the resistance rate to ampicillin, sulbactam, ciprofloxacin, imipenem, cefepime, ceftazidime and ceftriaxone was 64.47% ~ 100%. Except in 2019, the resistance rate to tobramycin, gentamicin and compound sulfamethoxazole was 54.54%~87.88%. In the next few years, the drug resistance rate of Acinetobacter baumannii generally showed a trend of increasing first and then decreasing. This shows that when treating the infection caused by this bacterium, clinical workers in newly-built hospitals begin to pay attention to the rational use of antibiotics, and reduce the abuse of antibiotics by formulating strict drug use norms and strengthening supervision. In the future, we need to continue to use antibiotics rationally in clinical practice to avoid abuse and reduce bacterial resistance to antibiotics. See Table 2 for details.

Trends in Antibiotic Resistance of Staphylococcus Aureus from 2019 to 2023

From 2019 to 2023, the resistance rate of Staphylococcus aureus to oxacillin and penicillin G was 33.33%~91.67%. No resistant strains of Staphylococcus aureus were found to quinuputine/daffoptine, linezolid, tigecycline and vancomycin, showing strong in vitro activity. In the past five years, the number of Staphylococcus aureus detected and the drug resistance rate generally increased first and then decreased, indicating that the drug resistance of Staphylococcus aureus to some antibiotics has been controlled in recent years through continuous monitoring and adjustment of treatment programs. However, it still shows high sensitivity to quinuputine/daffoptine, linezolid, tigecycline, vancomycin and other antibiotics, which provides certain selectivity for clinical treatment. It is necessary to closely monitor the changing trend of Staphylococcus aureus and the effectiveness of related antibiotics in order to formulate a more scientific treatment plan. See Table 3 for details.

Improvement in Antibiotic Resistance of Candida Albicans from 2019 to 2023

Among Candida albicans, the drug resistance rate of cefazolin decreased from 50% to 28.95%, piperacillin-tazobactam from 16.67% in 2021 to 5.26% in 2023, ceftazidime from 16.67% to 5.26%, piperacillin from 15.38% to 7.89%, and gentamicin. This shows that the drug resistance against Candida albicans has been effectively controlled and managed.

Table 2 Drug Resistance Rate of Acinetobacter Baumannii in ICU from 2019 to 2023 [n (%)]

Antimicrobial Agents	2019 (n=3)	2020 (n=31)	2021 (n=33)	2022 (n=33)	2023 (n=76)	Total (n=176)
Ceftriaxone	3 (100.00)	29 (93.55)	33 (100.00)	29 (87.88)	52 (68.42)	146 (82.95)
Ceftazidime	3 (100.00)	29 (93.55)	33 (100.00)	29 (87.88)	54 (71.05)	148 (84.09)
Cefepime	3 (100.00)	29 (93.55)	33 (100.00)	29 (87.88)	49 (64.47)	143 (81.25)
Imipenem	3 (100.00)	26 (83.87)	33 (100.00)	29 (87.88)	45 (59.21)	136 (77.27)
Meropenem	0 (00.00)	3 (9.68)	–	–	–	3 (1.70)
Ampicillin sulbactam	2 (66.67)	28 (90.32)	32 (96.97)	27 (81.82)	50 (65.79)	139 (78.98)
Ciprofloxacin	3 (100.00)	29 (93.55)	33 (100.00)	27 (81.82)	52 (68.42)	144 (81.82)
Levofloxacin	0 (00.00)	14 (45.16)	8 (24.24)	16 (48.48)	48 (63.16)	86 (48.86)
Compound sulfamethoxazole	3 (100.00)	18 (58.06)	23 (69.70)	18 (54.54)	45 (59.21)	107 (60.79)
Gentamicin	0 (00.00)	24 (77.42)	29 (87.88)	18 (54.54)	40 (52.63)	111 (63.06)
Tobramycin	0 (00.00)	16 (51.61)	29 (87.88)	18 (54.54)	48 (63.16)	111 (63.06)
BB-K8	2 (66.67)	3 (9.68)	1 (3.03)	2 (6.06)	2 (2.63)	10 (5.68)
Minocycline	0 (00.00)	4 (12.90)	2 (6.06)	1 (3.03)	16 (21.05)	23 (13.06)
Polymyxin b	0 (00.00)	0 (00.00)	0 (00.00)	0 (00.00)	5 (6.58)	5 (2.84)

Notes: Drug sensitivity was not detected or could not be counted.

Table 3 Drug Resistance Rate of Staphylococcus Aureus in ICU from 2019 to 2023 [n (%)]

Antimicrobial Agents	2019 (n=0)	2020 (n=3)	2021 (n=5)	2022 (n=12)	2023 (n=13)	Total (n=33)
Penicillin g	0 (0.00)	2 (66.66)	4 (80.00)	11 (91.67)	8 (61.53)	25 (75.75)
Oxacillin	0 (0.00)	1 (33.33)	2 (40.00)	6 (50.00)	1 (7.69)	10 (30.30)
Compound sulfamethoxazole	0 (0.00)	0 (00.00)	2 (40.00)	4 (33.33)	2 (15.38)	8 (24.24)
Moxifloxacin	0 (0.00)	1 (33.33)	1 (20.00)	3 (25.00)	2 (15.38)	7 (21.21)
Ciprofloxacin	0 (0.00)	1 (33.33)	1 (20.00)	3 (25.00)	3 (23.07)	8 (24.24)
Levofloxacin	0 (0.00)	1 (33.33)	1 (20.00)	3 (25.00)	3 (23.07)	8 (24.24)
Tetracycline	0 (0.00)	1 (33.33)	3 (60.00)	4 (33.33)	4 (30.76)	12 (36.36)
Erythromycin	0 (0.00)	2 (66.66)	3 (60.00)	2 (16.66)	0 (0.00)	7 (21.21)
Rifampin	0 (0.00)	0 (0.00)	1 (20.00)	1 (8.33)	0 (0.00)	2 (6.06)
Vancomycin	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Tigecycline	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Linezolid	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Gentamicin	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	0 (0.00)	1 (3.03)
Quinupptin/Dafupu	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (00.00)

The data in the past five years showed that the drug resistance rate of Candida albicans showed a downward trend, which may be attributed to the effective implementation and improvement of hospital management measures for infection control and antibiotic use. By constantly monitoring and adjusting the treatment plan, we can better deal with the drug resistance of Candida albicans and ensure the treatment effect and safety of patients. See Table 4 for details.

Detection Rate of Multidrug-Resistant Bacteria in ICU

From 2019 to 2023, carbapenem-resistant Acinetobacter baumannii (CR-AB), Escherichia coli producing extended-spectrum β -lactamases (ESBLs-EC), methicillin-resistant Staphylococcus aureus (MRSA), carbapenem-resistant Pseudomonas aeruginosa (CR-PA) and Klebsiella pneumoniae producing extended-spectrum β -lactamases (ESBLs-KP). The difference in the detection rates of CR-AB and MRSA in five years was statistically significant ($P < 0.05$), as shown in Table 5.

Discussions

Hospital infection in ICU, especially multi-drug resistant bacteria infection, has always been a difficult problem for medical staff.[6] Considering that there are some differences in the distribution of pathogens in ICU of different regions or

Table 4 Drug Resistance Rate of Candida Albicans in ICU from 2019 to 2023 [n (%)]

Antimicrobial Agents	2019 (n=2)	2020 (n=13)	2021 (n=6)	2022 (n=8)	2023 (n=38)	Total (n=67)
Cefazolin	1 (50.00)	4 (30.77)	3 (50.00)	2 (25.00)	11 (28.95)	21 (77.66)
Ceftazidime	0 (0.00)	1 (7.69)	1 (16.67)	1 (12.50)	2 (5.26)	5 (7.46)
Cefepime	0 (0.00)	1 (7.69)	0 (0.00)	0 (0.00)	3 (7.89)	4 (5.97)
Meropenem	0 (0.00)	2 (15.38)	0 (0.00)	1 (12.50)	2 (5.26)	5 (7.46)
Imipenem	0 (0.00)	1 (7.69)	0 (0.00)	1 (12.50)	6 (15.79)	8 (11.94)
Piperacillin tazobactam	0 (0.00)	1 (7.69)	1 (16.67)	0 (0.00)	2 (5.26)	4 (5.97)
Piperacillin	0 (0.00)	2 (15.38)	0 (0.00)	1 (12.50)	3 (7.89)	5 (7.46)
Ciprofloxacin	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (5.26)	2 (2.99)
Levofloxacin	0 (0.00)	0 (0.00)	0 (0.00)	1 (12.50)	3 (7.89)	4 (5.97)
Gentamicin	1 (50.00)	0 (0.00)	1 (16.67)	0 (0.00)	1 (2.63)	3 (4.48)
Tobramycin	0 (0.00)	1 (7.69)	0 (0.00)	1 (12.50)	2 (5.26)	4 (5.97)
BB-K8	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (5.26)	2 (2.99)

Table 5 Detection Rate of Multidrug-Resistant Bacteria in ICU from 2019 to 2023 [n (%)]

Pathogenic Bacteria	2019	2020	2021	2022	2023	$\chi 2$	*P*
CR-AB	3 (100.00)	26 (83.87)	33 (100.00)	30 (90.91)	25 (32.90)	59.241a	0.000b
ESBLs-EC	1 (100.00)	2 (100.00)	5 (71.43)	7 (58.33)	5 (71.43)	2.023a	0.731b
MRSA	0 (0.00)	1 (33.33)	2 (40.00)	3 (25.00)	2 (2.6)	16.61a	0.001b
CR-PA	0 (0.00)	1 (25.00)	4 (50.00)	2 (18.18)	1 (25.00)	2.282a	0.319b
ESBLs-KP	1 (50.00)	1 (100.00)	2 (33.33)	1 (11.11)	1 (11.11)	6.107a	0.191b

Notes: A: Pearson χ^2 test; B: fisher exact probability test.

hospitals, especially the newly-built hospitals have increased the risk of nosocomial infection due to the particularity of new employees, new managers and new environment,[7] the results of this study have certain guiding significance for the prevention and control management of nosocomial infection and the application of antibacterial drugs in newly-built hospitals in Guizhou.

In our previous study, Acinetobacter baumannii, Escherichia coli, Staphylococcus aureus, Candida albicans, and other pathogens were the most common.[8] The results of this study are the same. In this study, ICU specimens were mainly collected from respiratory tract, blood, and drainage fluid, and Gram negative bacteria were the main pathogens detected, which is similar to other previous research reports.[9,10] The reason is that Gram-negative bacteria widely exist in hospital environment, easy to survive in humid environment, belonging to conditional pathogenic bacteria, easy to infect severe patients with low immunity, invasive operation or long-term high-level antibacterial drugs.The number of main strains detected in ICU at the initial stage of the establishment of the hospital in 2019 was relatively small, which may be related to the fact that fewer patients were admitted and the rate of specimens sent for inspection was low. From 2020 to 2023, the main strains changed and were relatively fixed. The first strain in three years was Acinetobacter baumannii, and the other strains mainly included Candida albicans, Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa and Staphylococcus aureus. Possible reasons: With the complexity and diversification of ICU patients' diseases and the application of broad-spectrum antibiotics in our hospital, the microecological dominant flora of patients and the colonization bacteria in ward environment changed, and the cleaning and disinfection of ward environment were strengthened, reducing.[11] In this study, Candida albicans accounted for the second place in lower respiratory tract infection, which was related to the decline of patients' systemic defense ability and abuse of antibiotics. Candida albicans is a common conditional pathogenic fungus, which is generally small in normal body and does not cause disease. When the immune function of the body declines or the pathogen invades the abnormal host site, it can cause serious infection. Clinical monitoring of Candida albicans should be strengthened.

The results showed that Acinetobacter baumannii had a high detection rate and strong drug resistance. Except for a few antimicrobial agents such as polymyxin B, minocycline and amikacin, Acinetobacter baumannii showed a high drug resistance rate for most of the tested drugs, which was basically similar to the results reported by Jiang

Zhongji.[2] The drug resistance of Acinetobacter baumannii to carbapenems became more and more severe and became the main multi-drug resistant bacteria in our hospital[12]. Methicillin-resistant Staphylococcus aureus (MRSA) first increased and then decreased in five years, which indicated that the drug resistance against MRSA was effectively controlled and managed. Staphylococcus aureus is the most commonly isolated gram-positive bacteria in ICU of our hospital. In the past five years, the detected number and drug resistance rate generally increased at first and then decreased. The drug resistance rate to penicillin G and oxacillin was 33.33%~91.67%, which was higher than that reported by Song Qifeng.[13] Quinuputine/daffoptine, linezolid, tigecycline and vancomycin showed strong in vitro activity against Staphylococcus aureus, which could be used as the preferred drugs for treatment.[14] The number of patients in the newly-built ICU in our hospital increased with the extension of the opening time. Clinicians should be alert to the environmental colonization and infection outbreak of Acinetobacter baumannii, and the emergence of highly drug-resistant strains warned that drug resistance monitoring and control should be strengthened.

The analysis in Table 5 shows that the distribution and drug resistance characteristics of pathogenic bacteria are different due to the influence of different regions and hospitals, and the overall detection rates of CR-AB, CR-PA, MRSA, ESBLs-EC and ESBLs-KP are quite different during the five years since the hospital was established. Especially CR-AB and ESBLs-EC, the detection rate remained at a high level all the year round. The possible reason is that most drug-resistant genes of Acinetobacter baumannii can be directly obtained from the external environment through the mechanism of horizontal gene transfer, which is faster than gene mutation[15] and can cause opportunistic infections of skin, blood, urinary tract and other soft tissues.[16] In addition to patients' related infection specimens, high drug-resistant strains such as Acinetobacter baumannii can often be detected in ICU ventilator, monitor, stethoscope, bedside supplies, door handles, computer keyboards and other hospital environments and medical staff, and these strains are environmentally polluted. Escherichia coli is very virulent and easy to cause infections in various organs and tissues of patients.[17,18] The newly-built ICU patients in our hospital are mainly elderly people, and the elderly patients are vulnerable to external pathogenic microorganisms due to the decline of their own immune function. Invasive operations that destroy the basic defense barrier of human body will make ESBLs-producing strains colonize the mucosal surface and release them into the blood regularly, which will increase[19] the risk of infection of ESBLs-producing bacteria. Therefore, the invasive operations should be reduced as much as possible, the aseptic concept and operating procedures should be strictly followed, and the necessity of indwelling catheter should be assessed daily, and extubation should be carried out as soon as possible. The prevention and control of multidrug-resistant bacteria in ICU should not be limited to one medical institution or one department, but should involve all medical institutions, departments and even the whole society. At present, ICU pays more and more attention to fungal infection, but the positive results of fungal culture are relatively rare. Because there are few fungal samples in this study, systematic analysis is not made, and further analysis is needed after expanding the samples in the future.

This article provides a comprehensive examination and evaluation of pathogenic bacteria in the newly established ICU hospital over the past five years. The research results are crucial for elucidating the characteristics of pathogenic bacteria and the changing distribution of antibiotic resistant bacteria. The results of this study provide valuable guidance for the rational use of antibiotics in clinical practice.

Despite its findings, some limitations of the present study should be noted. Due to the fact that the newly built hospital is still in the early stages of operation and the retrospective analysis sample size is limited. We recognize that sample size may affect the generalizability and statistical power of our results. Although we have made efforts to collect sufficient data, future research can consider using larger sample sizes to improve the reliability of the research results. Due to time and resource constraints, we are limited to specific research designs. We acknowledge this limitation and suggest that future research can explore more diverse designs to validate our findings. Our research was conducted in specific environments or conditions, which may not be applicable to all populations or backgrounds. Future research needs to be further compared in different environments.

Conclusions

In summary, the study of pathogen distribution in newly built hospital ICUs reveals a notable prevalence of Acinetobacter baumannii, accounting for 30.77% of isolates, and a concerning 86.78% carbapenem resistance rate.

This highlights the urgency for clinical practitioners to address these severe infections and the inadequacies of current infection control strategies. Additionally, significant resistance rates were found in other critical pathogens, including MRSA (32.45%) and ESBL-producing bacteria (70.27%), emphasizing the need for enhanced monitoring and management. It is vital to implement effective infection control measures, including rigorous prevention strategies, consistent pathogen surveillance, strict isolation protocols, and responsible antibiotic use, to safeguard patient health and curb infection spread. Future research should focus on developing new antibiotics and exploring alternative treatments to address the challenges posed by multidrug-resistant bacteria. Despite limitations due to the initial phase of the hospital's operation and a limited sample size, the findings underscore the importance of rational antibiotic use and stringent antimicrobial management to reduce resistance and nosocomial infections in ICUs.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This was a retrospective analysis and all data were obtained anonymously through an electronic medical record information system. The ethical approval was obtained from the review by the Medical Ethics Committee of Zunyi Medical University, No. Zunyi Lunshen (2020) 1-055. All participants provided written informed consent prior to participation in the study.This study was in compliance with the Declaration of Helsinki.

Author Contributions

Hui Zeng, Rong Liu, Chuanli Cheng contributed equally to this work and should be considered co-first authors. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflict of interest.

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