DOI: 10.18421/1986-8103.2026.20.1.22

Acinetobacter baumannii - a modern challenge in clinical microbiology

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Abstract

Acinetobacter baumannii bacteria is gram-negative, multidrug-resistant opportunistic bacterium. It is on the list of critical priorities that require new antibiotics and one of the leading causes of hospital infections in the 21st century. A PCR test is essential for precise identification. The results of antibiotic sensitivity tests showed that there is resistance to a large number of antibiotics. The only sensitivity was shown on the Costylin E test. The most common route of transmission is contact with colonized or infected patients, contaminated surfaces or medical devices, especially ventilators. Infections caused by *Acinetobacter baumanni* are primarily hospital-acquired infections.

Keywords: Acinetobacter baumannii, multidrug-resistant, Costilin, hospital infection

Introduction

Acinetobacter baumannii bacterium was named after the American bacteriologists Paul and Linda Baumann. It is a gram-negative, multidrug-resistant opportunistic bacterium that is considered among the most important multidrug-resistant pathogens in modern medicine. (1) It holds a special place within the group of causative agents of serious infections better known by the acronym "ESKAPE", which includes microorganisms responsible for most infections associated with health care. It is marked as a "red alert" pathogen, it means it is on the list of critical priorities that require new antibiotics. (2) It was first recognized as a clinically significant pathogen during the 1960s and 1970s, especially in intensive care units. During the 1990s, it was confirmed as a common cause of infection in wounded soldiers in Iraq, where it was nicknamed "iraqibacter". The specific conditions of the wartime environment, including the dry and hot desert climate and the limited possibilities of implementing infection prevention measures, contributed to the development and spread of antimicrobial resistance. (3) Today, *Acinetobacter baumannii* is considered as one of the leading causes of hospital infections in the 21st century. Numerous studies are focused on their epidemiology, resistance mechanisms and possibilities of controlling the spread of this pathogen. Clinical isolates of *Acinetobacter baumannii* show a high level of resistance to antibiotics, with resistance to carbapenems being one of the most significant and globally widespread problems. (4,5)

Objectives

Infections caused by *Acinetobacter baumannii* are associated with approximately 400,000 deaths annually globally. We analyzed a large number of data that we obtained outside of hospital conditions. (6) We focused on multidrug-resistant bacteria with a special focus on *Acinetobacter baumanni*. We came to the conclusion that the risk of infection is significantly higher in the hospital environment compared to the general population, which makes this bacterium a serious problem for healthcare institutions. Patients hospitalized in intensive care units, patients on mechanical ventilation, people with chronic diseases (such as diabetes, HIV infection or chronic lung diseases) and patients with malignant diseases are particularly at risk. (7) The goal of numerous modern researches is to clarify the entry routes of multidrug-resistant strains of *Acinetobacter baumannii* into the hospital environment, as well as identification potential natural reservoirs of this microorganism. Epidemics of infections are most often associated with contamination of the hospital environment and the transfer of bacteria within healthcare institutions. (8)

Methodology

The presence of *Acinetobacter baumannii* is confirmed by microbiological analysis of clinical samples, after which a sensitivity test to antimicrobial drugs is carried out.

A PCR test is essential for precise identification. PCR is a molecular test for rapid identification of the genus and species of *Acinetobacter baumannii* as well as the detection of antibiotic resistance genes. CR stands for "carbapenem resistant", and CP stands for "carbapenemase producing". The designation CP means that carbapenemases production has been proven in the isolate. CP complements the CR designation in isolates that produce carbapenemases. The common designation of isolates is CR (bacteria designation) - CP. When we confirm that the isolate is resistant to carbapenem and that it produces carbapenemase, we give the isolate a label for this, because it has priority over the CR label over the results of the antibiogram. CRAb is the label of the isolate that confirms that it is *Acinetobacter baumannii* and that it is resistant to carbapanems, and in this case complete isolation of the patient is recommended. CRAb-CP is the designation for carbapenemase-secreting *Acinetobacter baumannii* isolates, and complete patient isolation is required in these patients. In both cases, consultation with an infectious disease specialist or a clinical microbiologist is recommended. (9)

In our research, 7 microbiological samples were confirmed of *Acinetobacter bumannii*. Antibiotics to which we performed sensitivity tests are Tobramycin, Amikacin, Gentamicin, Ciprofloxacin, Meropenem and Imipenem. The results of antibiotic sensitivity tests showed that there is resistance to a large number of antibiotics. The only sensitivity was shown on the Costylin E test.

Li-Kuang and colleagues analyzed clinical isolates of *Acinetobacter baumannii*. They found that 73.6% of such isolates were resistant to quinolones (ciprofloxacin and levofloxacin), 71.3% to sulfonamides, and more than half (50–70%) to cephalosporins (cefazidime and cefepime), b-lactamase/beta-lactamase inhibitor combinations (tazobactam-piperacillin) and carbapenems (doripenem, imipenem, and meropenem). It should be noted that only 26.7% showed resistance to the glycine antibiotic tigecycline. (10) Studies conducted in Saudi Arabia and Greece also had a high degree of bacterial resistance, about 89%, to the above-mentioned antibiotics. Some studies indicate that costillin is the only remaining choice for the treatment of infections caused by *Acinetobacter baumannii* because its resistance is less than 7.9%, however, the bad news is that this bacterium is starting to develop worldwide resistance to costillin. No costillin resistance was observed in Taiwan in this study. (11,12)

Said D. and colleagues published a study in which they analyzed 43,948 clinical isolates of *Acinetobacter baumannii* using data from the German antimicrobial resistance control system from 2014 to 2018. It is interesting to note that the proportion of carbapenem resistance in clinical isolates of the complex *Acinetobacter baumannii* decreased from 7.6% in 2014 to 3.5% in 2018. Compared to other regions worldwide, the proportions of carbapenem resistance among clinical isolates of *Acinetobacter baumannii* are relatively low in Germany and have been declining in recent years. This is the result of continued efforts in antibiotic stewardship and infection prevention and control to prevent the spread of carbapenem-resistant *Acinetobacter baumannii* complex in Germany. (13)

The results we obtained through our research in Sarajevo Canton confirmed the opinion that it is primarily a hospital-acquired infection.

A study on *Acinetobacter baumannii* was done at the Microbiology Department at IQ Medical Center Hospital in Durangapur, Western India. A large number of samples were examined, including 15,800 hospital samples, of which 289 were positive, of which 115 (39.79%) were isolated from the endotracheal tube in intensive care. The prevalence of *Acinetobacter baumanni* in clinical samples in hospital conditions is from 5.1% to 12.4%, while the percentage is higher in intensive care units. The distribution according to sample type is that the frequency of respiratory was the highest 40-50%, followed by blood 10-20%, wound or pus 10-25%, urine 10-25% and cerebrospinal fluid less than 10%. (14)

This bacterium has developed exceptional resistance thanks to various mechanisms, including the production of enzymes that inactivate antibiotics, the presence of efflux pumps that actively

expel antibiotics from the bacterial cell, as well as reduced permeability of the outer membrane for the passage of drugs due to the presence of very small pores. This bacteria is very dangerous because it can quickly develop and transmit genetic resistance. (15)

A particularly worrying form is carbapenem-resistant *Acinetobacter baumannii* (CRAB-Carbapenem-Resistant Acinetobacter baumannii). It is estimated that more than a million infections caused by this bacterium occur annually, with a mortality rate of approximately 35%. CRAB strains show resistance to almost all available antibiotics, including carbapenems. Carbapenems are highly effective antibiotics. They are used to treat infections caused by bacteria that are multi-resistant to drugs, especially in hospitalized patients. They are broad-spectrum drugs that are used as the last line in the treatment of severe infections caused by multidrug-resistant bacteria.

Due to the seriousness of the threat it represents, CRAB is at the top of the list of pathogens for which, according to the World Health Organization, priority development of new antimicrobial drugs is necessary. (16)

Results

Acinetobacter baumannii has a pronounced ability to colonize and infect open wounds, and is a frequent cause of surgical wound infections, bacteremia (sepsis) and pneumonia. It is most often isolated from the endotracheal tube in intensive care, but it is often isolated from infections of the urinary system, especially in patients with a urinary catheter, as well as from skin and eye infections. It is estimated that the mortality of patients with *Acinetobacter baumannii* infection in intensive care units can be over 75%, especially if the entry point of the bacteria is the respiratory or vascular system. (17) The most common route of transmission is contact with colonized or infected patients, contaminated surfaces or medical devices, especially ventilators. The bacterium has the ability to form a biofilm that is extremely resistant to disinfectants and antibiotics, which makes eradication even more difficult.

Acinetobacter baumannii can obtain on the patient's skin without visible signs of illness, which allows the bacterium to be transmitted unnoticed between patients and health care workers. (18)

The irrational and indiscriminate use of antimicrobial drugs significantly contributes to the development, survival and spread of multidrug-resistant isolates of the bacterium *Acinetobacter baumannii.* This leads to the selection of strains with adaptive mechanisms of bacterial resistance to a large number of antibiotics.

These infections cause severe and often fatal outbreaks in hospitals and long-term care facilities. There are questions to which we are still seeking answers. Although the hospital environment is considered the main reservoir of this pathogen, it is still an open question whether *Acinetobacter baumanni* has a natural habitat outside healthcare institutions. (19)

Conclusion

Infections caused by *Acinetobacter baumanni* are primarily hospital-acquired infections. The occurrence of this infection outside of hospital conditions is present, but to a significantly lesser extent.

The lack of adequate programs for the rational use of antibiotics (AMS - Antimicrobial Stewardship Programs) leads to the excessive use of broad-spectrum antibiotics and the accelerated development of antimicrobial resistance. At the same time, insufficiently developed measures for the prevention and control of hospital infections in everyday clinical practice significantly contribute to the spread of multidrug-resistant strains of *Acinetobacter baumannii*.

Effective hospital infection control measures must include on time identification and isolation of colonized patients, continuous education of health personnel, as well as strict implementation of hand hygiene. Special focus should be placed on proper cleaning and disinfection of hospital premises, medical equipment and devices used in patient care. Strict hand hygiene, washing with soap and water or using an alcohol disinfectant before and after contact with patients or medical equipment is of crucial importance for healthcare personnel.

In daily clinical practice, it is necessary to insist on the prevention of infections, constant epidemi-

ological control, especially in intensive care units, and on a rational and responsible policy of prescribing antimicrobial drugs.

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