TURKISH REPUBLIC OF NORTH CYPRUS
NEAR EAST UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

BACTERIOLOGICAL AND CLINICAL CHARACTERISTICS OF ACINETOBACTER SPECIES ISOLATED FROM CLINICAL SAMPLES IN NEAR EAST UNIVERSITY HOSPITAL

ZAHRA ABDI RAHMAN MOHAMOUD

MASTER OF SCIENCE THESIS

MEDICAL MICROBIOLOGY AND CLINICAL MICROBIOLOGY PROGRAM

SUPERVISOR

PROF. DR. NEDIM ÇAKIR

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APPROVAL

The Directorate of Health Sciences Institute, / INSTITUTE OF GRADUATE STUDIES

This study has been accepted by the Thesis Committee in Medical and Clinical Microbiology Program as a Master of Science Thesis.

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STATEMENT (DECLARATION)

Hereby, I declare that this thesis study is my study, I had no unethical behaviors in all stages from the planning of the thesis until writing there, I obtained all the information in this thesis in academic and ethical rules, I provided reference to all of the information and comments which could not be obtained by this thesis study and took these references into the reference list; and, had no behavior of breaching patent rights and copyright infringement during the study and writing of this thesis.

ZAHRA ABDIRAHMAN MOHAMOUD

Signature:

Date:

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In the name of Allah, First and Foremost praise is to ALLAH, the Almighty, the greatest of all, on whom ultimately we depend for sustenance and guidance. I would like to thank Almighty Allah for giving me the opportunity, determination, and strength to do my research and write my thesis completely. His continuous grace and mercy was with me throughout my life and ever more during the tenure of my research.

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ZAHRA ABDIRAHMAN MOHAMOUD

ÖZET

Acinetobacter baumannii türlerinin neden olduğu hastane enfeksiyonları hastanelerde daha yaygın hale gelmektedir. Bu türler arasında sıklıkla tedavi seçeneklerini ciddi şekilde sınırlayan çoklu ilaca dirençli kökenler tespit edilmektedir..

Amaç:

Bu çalışma, Yakın Doğu Üniversitesi Hastanesi'nde klinik örneklerden izole edilen Acinetobacter türlerinin tespiti, izolasyonu ve identifikasyonu ve bunların çeşitli, antibiyotiklere duyarlılıkları amacıyla planlanmıştır.

Gereç ve Yöntemler:

Sunulan bu tez, Kuzey Kıbrıs Türk Cumhuriyeti'ndeki (KKTC) Yakın Doğu Üniversitesi hastanesindeki mikrobiyoloji laboratuvarında gerçekleştirildi. Çalışma için toplam 100 örnek toplandı (Eylül 2020-Mayıs 2021). Çeşitli hastane bölümlerinde yatan hastaların kan, idrar, balgam, aspirasyon sıvısı ve yara materyalleri örneklendi. Bu klinik örnekler rutin klinik mikrobiyolojik kültür yöntemleriyle çalışılarak çeşitli mikroorganizmalar üretildi. Üreyen mikroorganizmalardan Gram negarif kokobasil görünümlü olanlar VITEK 2 GN kartı (bioMérieux) ve Vitek 2 otomatik sistemi (bioMérieux) kullanılarak tür identifikasyonları yapıldı. AST NO 93 kartı, bu izolatların antibiyotiklere duyarlılığını test etmek için kullanıldı. Sonuçlar değerlendirildi.

Bulgular/ Sonuçlar:

Çalışmada izole edilen Acinetobacter suşlarına ait toplam 100 adet örneğin, antibiyotik duyarlılık sonuçları değerlendirildi.
Acinetobacter köenlerimizde en yüksek direnç Meropenem (%87 (90,62), gentamisin (%81 (92,0), siprofloksasin (%79 (90,80) ve Amikasin'e karşı (%75 (78,1) idi. En düşük direnç ise Netilmicin (%19), Trimethoprim/Sulfamethoxazole (%30 (78,94) ve Piperacillin/Tazobaktam (%38 (97,43), karşı gelişti.

Tartışma

Acinetobacter baumannii ve Acinetobacter türleri enfeksiyonları, hastane enfeksiyonlarının önemli bir yüzdesinden sorumludur. Bunların çoğu cerrahi servisler, Anestezi ve yoğun bakım üniteleri (YBÜ) ile ilgilidir. Çoğu antibiyotik *Acinetobacter baumannii*'ye dirençlidir.

Çalışmamızda piperacillin/Tazobaktam ve netilmisin'i en etkili antibiotikler olarak saptadık. Kliniklerde sık kullanılan meropenem, gentamisin ve siprofloksasin ise en dirençli olanlardı.
Hastane ortamlarında, Acinetobacter türleri genellikle fermente etmeyenler arasında bulunur. Mikrobiyal direnç felaketini önlemek için akılcı antibiyotik kullanımı kritik öneme sahiptir. GSBL'lerin kesin olarak tanımlanmasını ve karakterizasyonunu doğrulamanın tek yolu moleküler yaklaşımlardır. Ancak, tüm laboratuvarların bu prosedürlere erişimi yoktur.

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Bu bulgular kesinlikle Acinetobacter hastalarının patojenitesini ve uygun yönetimini anlamaya yardımcı olacak ve böylece uygunsuz antibiyotik kullanımını azaltacaktır.

***Anahtar Kelimeler*:**
Acinetobacter türleri. Çoklu İlaç Dirençli, Kültür, Duyarlılık testi, *Acinetobacter baumannii*, Yoğun Bakım Ünitesi(YBÜ).

Thesis Title: Bacteriological and clinical characteristics of Acinetobacter species isolated from clinical samples in Near East university hospital

Name of the student: Zahra Abdi Rahman Mohamoud
Mentor: Prof. Dr. Nedim Çakir
Department: Medical Microbiology and Clinical Microbiology

ABSTRACT

Nosocomial infections caused by *Acinetobacter baumannii* strands are becoming more common in hospitals. The occurrence of multidrug-resistant strands has been detected, which severely limits treatment options. The study's goal was to figure out the infection rate and susceptibility spectrum of *Acinetobacter baumannii*, Acinetobacter species isolated from patients in Surgical units, ICU, Anesthesia and other different departments of the hospital.

Aim: This study was conducted for determination, isolation and identification of Acinetobacter Species isolated from clinical samples in Near East University Hospital. Acinetobacter species strains that were isolated from urine, blood, aspirational fluid, sputum samples, and study their antimicrobial susceptibility testing.

Materials and Methods: The current study was conducted in the microbiology laboratory at the Near East University hospital in the Turkish Republic of Northern Cyprus (TRNC). A total of 100 samples for the study was executed Retrospectively and Prospectively Between (October 2019 and May 2021) the material consisted of *Acinetobacter baumannii* isolates and Acinetobacter species were isolated from blood, urine, sputum, aspirational fluid and wound material samples of hospitalized patients from various hospital departments. Microbiological substrates were used to cultivate the isolated bacterial strains. The VITEK 2 GN card (bioMérieux) and Vitek 2 automated system (bioMérieux) were used to identify isolates to species. The AST NO

93 card was used to test the susceptibility of certain bacteria to antibiotics. When it comes to carbapenem resistance, in order to detect and evaluate the Acinetobacter species and their Antibiotic results.

Results: A total of 100 samples of the Acinetobacter Species strains were isolated while the result of the microbiological culture method show that there are samples that showed the antibiotic susceptibility for these isolates as following thus, the highest resistance in our Acinetobacter strains was against Meropenem (87% (90,62), Gentamycin (81% (92,0), Cefepime (80% (91,95), Ciprofloxacin (79% (90,80), and Amikacin (75% (78,1). The lowest resistance developed against Netilmicin (19%) Trimethoprim/sulfamethoxazole (30% (78,94) and Piperacillin/Tazobactam 38% (97,43) of the isolates respectively.

Conclusions: *Acinetobacter baumannii* and Acinetobacter species infections account for a substantial percentage of nosocomial infections. The majority of them are related to surgical wards, Anesthesia and intensive care units (ICUs). Most antibiotics are resistant to *Acinetobacter baumannii*. Colistin and carbapenems showed the highest percentage of sensitivity.

In hospital settings, Acinetobacter species are commonly found among nonfermenters. To avoid a microbial resistance disaster, rational antibiotic use is critical. Molecular approaches are the sole way to confirm the precise identification and characterization of ESBLs. However, not all laboratories have access to these procedures.

These findings will certainly help understand the pathogenicity and proper management of Acinetobacter patients, thus decreasing the improper use of antibiotics.

Keywords: (A. Spp) Acinetobacter species, Multi Drug Resistant, Culture, (AST) Antibiotic Susceptibility test, *Acinetobacter baumannii*, Intensive Care Unit (ICUs).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A. Spp	**Acinetobacter *Species***
A.B	**Acinetobacter *Baumannii***
R	**Resistant**
S	**Sensitive**
WHO	**World Health Organization**
A.Baylyi	***Acinetobacter Baylyi***
Acb complex	**Acinetobacter calcoaceticus-baumannii complex**
DDST	**Double Disk Synergy Test**
CAUTI	**Catheter Associated Urinary Tract Infection**
PPE	**Personal Protective Equipment**
CU	**Chaperone-Usher**
TLR	**Toll-Like Receptor**
EMB	**Eosin Methylene Blue**
AK	**Amikacin**
CN	**Gentamicin**
LEV	**Levofloxacin**
CRO	**Ceftriaxone**
MEM	**Meropenem**
CIP	**Ciprofloxacin**
SXT	**Trimethoprim/Sulfamethoxazole**
AST	**Antibiotic Susceptibility Test**

ESBL	**Extend Spectrum Beta-Lactamase**
MDR	**Multi Drug Resistance**
G-ve	**Gram-Negative**
UTIs	**Urinary Tract Infections**
µm	**Micrometers**
LPS	**Lipopolysaccharide**
IL	**Inter-Lukens**
ICU	**Intensive Care Unit**
OPD	**Outdoor Patient**
In Patient	**Indoor Patient**

CHAPTER ONE
INTRODUCTION

SUMMARY

Acinetobacter is a complicated genus with a history of dispute over the existence of several species. The species can cause soft tissue and urinary tract infections, as well as nosocomial infections such aspiration pneumonia and catheter-associated bacteremia. Acinetobacter spp. infections acquired in the community are becoming more common. The organism's environmental tenacity, resilience to desiccation, and evasion of host immunity increase Acinetobacter transmission and consequent illness. The virulence qualities of Acinetobacter spp. are mostly due to their ability to evade quick clearance by the innate immune system, successfully allowing for a high bacterial density that stimulates the LPS–Toll-like receptor. That causes sepsis via the lipopolysaccharide (LPS)–Toll-like receptor4 (TLR4) pathway. Capsular polysaccharide is a key virulence component that allows bacteria to evade the immune system, whereas LPS causes septic shock. Antibiotic resistance, on the other hand, is the key determinant of clinical outcome. The administration of initially effective medication is critical to improving survival, resulting in a threefold reduction in 30-day mortality.

Unfortunately, early commencement of successful therapy is a major therapeutic issue due to the high incidence of this organism possessing an extreme drug resistance (XDR) phenotype. New preventative and therapeutic approaches for Acinetobacter spp. are needed due to its high rate of antibiotic resistance and poor results (up to 70% death rate from infections caused by XDR strains in some case series). Acinetobacter spp. alternatives are critically needed.

1.1. INTRODUCTION

Acinetobacter species are gram-negative, non-fermenting bacteria that are commonly coccobacillary and belong to the Moraxellaceae family. There are 34 species in the genus, 25 of which have legitimate names and 9 of which are called for their chromosomal group, with *A. baumannii* being the most important in human infections. *A. baumannii* is a member of the *A. calcoaceticus-A. baumannii complex*, which includes *A. calcoaceticus* (genomic species 1, an environmental species with limited clinical significance), *A. baumannii* (genomic species 2), *A. pittii* (genomic species 3), and *A. nosocomialis* (genomic species 13TU), all of which are genetically related and phenotypically difficult to distinguish. When compared to other genetic species, *A. baumannii* has been linked to increased antibiotic resistance and higher mortality in bacteremic individuals. Acinetobacter species are saprophytic, widespread, and have emerged as a significant nosocomial pathogen due to their capacity to survive in a hospital setting on a variety of surfaces, a variety of dry and wet surfaces.(1) Pneumonia, which is most typically associated with endotracheal tubes or tracheostomies, endocarditis, and other human illnesses caused by Acinetobacter species include: In patients, meningitis, skin and wound infections, and peritonitis are common peritoneal dialysis, urinary tract infection, and bacteremia. Antibiotic susceptibility patterns of Acinetobacter might vary a lot across the country and even within the same hospital at different times. The distinctions in the case of Acinetobacter, a periodic resistance test is required. surveillance of these infections in order to get the best results selection of treatment. Because multidrug resistance patterns of clinical Acinetobacter strains are unpredictable, knowing the institutionally widespread susceptibility profiles is critical. As a result, a simplified phenotypic identification approach was used to identify Acinetobacter species from diverse clinical samples, and the antibiotic sensitivity pattern of these isolates was determined.

It's unclear when the first Acinetobacter organisms were isolated (1, 2). Gram-negative coccobacilli that were most likely Acinetobacter were isolated as early as 1914 and again throughout the 1940s, but were previously known as Mima polymorphia (now *Acinetobacter lwoffii*), Herellea vaginicola (now *Acinetobacter baumannii* or *Acinetobacter calcoaceticus*), Bacterium anitratum, B5W, and *Moraxella lwoffii* (1, 2). It was once difficult to tell the difference between *A. baumannii* and *A. calcoaceticus*. As a result, literature from previous decades is likely to reflect a hybrid of the two species.

Acinetobacter is a genus of Gram-negative coccobacilli that includes oxidase-positive and -negative, nonpigmented strains. The varied Acinetobacter genus (3) has more than 50 species, the vast majority of which are nonpathogenic environmental organisms. *A. baumannii* is the most prevalent species that causes infections, followed by *A. calcoaceticus* and *A. lwoffii* (4). Additional species have been reported as pathogens, including *A. haemolyticus, A. johnsonii, A. junii, A. nosocomialis, A. pittii,*

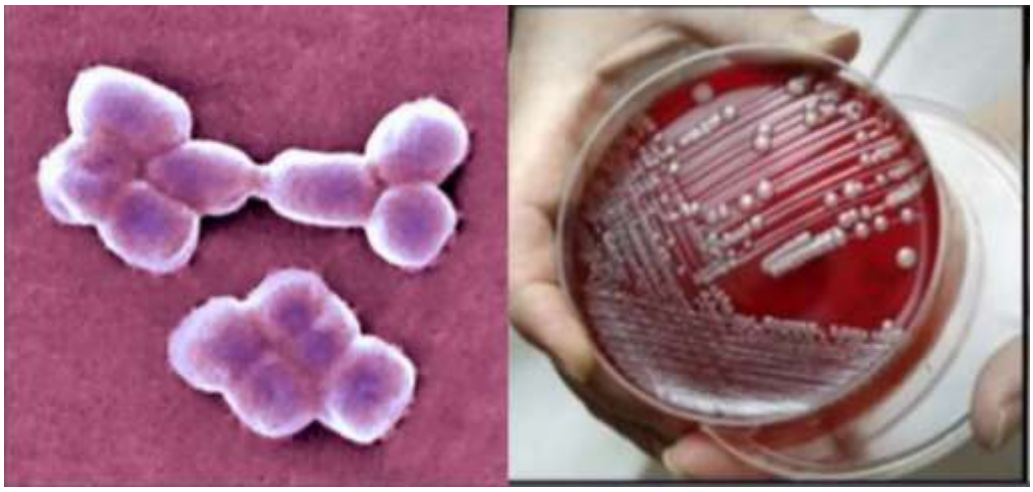
A. schindleri, and *A. ursingii* (5–11). *A. seifertii* is a new pathogen in Asia; it is genetically similar to *A. baumannii* and may be mistaken for it (12–14). *A. baumannii* is the most virulent of all the species, according to multivariate analysis of clinical data and animal model studies (described further below) (15).

Acinetobacter spp. can be found in a variety of wet settings, such as moist soil/mud, marshes, ponds, water treatment facilities, fish farms, wastewater, and even seawater (3). These environmental isolates frequently contain antibiotic resistance mechanisms such as carbapenemases and extended-spectrum-lactamases (ESBLs) (3), and hence may serve as major repositories for resistance elements that eventually change into clinically relevant bacteria. Some medically important species have been discovered on vegetables, meat, dairy products, and human skin, including *A. calcoaceticus*, *A. lwoffii*, *A. nosocomialis*, and *A. pittii* (16). Antibiotic resistance repertoires have been found in such bacteria.

Furthermore, antibiotic-resistant *A. baumannii* strains have been found in commercial products, including meat, vegetables, and several types of cattle, implying diverse environmental routes of transmission into human populations (3, 17–19). However, *non-baumannii* Acinetobacter spp. has predominated in skin colonization monitoring investigations, notably among healthy people, whereas *Acinetobacter baumannii* has only been found as a skin colonizer in a small number of healthy people (3, 20–23). Infections caused by Acinetobacter spp. became more common in the 1960s and 1970s, coinciding with an increase in the usage of complicated critical care units (1, 2). Acinetobacter was once thought to be a commensal opportunist, a low-virulence pathogen with little impact. However, when mechanical ventilation, central venous and urinary catheterization, and antibacterial treatments became more common and intensive in later decades, the frequency and severity of Acinetobacter infections increased (24–27).

Infections caused by Acinetobacter have expanded swiftly across the globe's hospitals. Intensive care units have the highest infection density (ICUs). According to surveillance data from the National Healthcare Safety Network (NHSN) in the United States from 2009 to 2010, Acinetobacter spp. were responsible for 1.8 percent of all health-care-associated illnesses (27). According to hospital network surveillance studies, the prevalence is similar in ICUs across Europe and Latin America (28–32). Acinetobacter, on the other hand, generates a substantially higher proportion of nosocomial infections in China, Thailand, Taiwan, Vietnam, and some South American nations, and may be the most common nosocomial pathogen. In India, it is also becoming a major nosocomial pathogen (33–38). Acinetobacter is one of the three most common causes of bacteremia and nosocomial pneumonia in Asian and Latin American countries (39–43). Acinetobacter infections affect 45,000 people in the United States each year (range: 41,400 to 83,000) and 1 million people worldwide each year (range: 600,000 to 1,400,000). (44).

Appearance in Microscope and Petri Dish



EPIDEMIOLOGY

Acinetobacter can be found in natural surroundings, moist surfaces in hospitals (respiratory therapy equipment), dry surfaces (human skin), and, on rare occasions, normal flora in the oropharynx.

Identification of Acinetobacter

Gram staining, cell and colony morphology, positive catalase test, negative oxidase test, and lack of motility were utilized to identify Acinetobacter in the genus Acinetobacter. (5)

Acinetobacter was classified and identified using glucose oxidation, gelatin liquefaction, beta hemolysis, growth at 37°C and 42°C, arginine hydrolysis, and chloramphenicol sensitivity. (1,7-11)

Clinical Significance

Acinetobacter is commonly isolated in nosocomial infections, and it's especially common in intensive care units, where sporadic cases, epidemics, and endemic outbreaks are all too typical. The bacterium *Acinetobacter baumannii* is a common cause of hospital-acquired pneumonia, particularly late-onset, ventilator-associated pneumonia. Other illnesses it can cause include skin and wound infections, bacteremia, and meningitis, but *A. lwoffii* is primarily responsible for the latter. *A. baumannii* is the most common cause of human disease, having been linked to bacteremia, urinary tract

infections (UTIs), secondary meningitis, infective endocarditis, and hospital-acquired pneumonia among patients admitted to the intensive care unit, as well as wound and burn infections. *A. baumannii* may persist for weeks on human skin or dry surfaces and is resistant to a wide range of disinfectants, making it especially simple to spread in a hospital setting.

Pathogenicity is boosted by biofilms

A. Baumannii forms biofilms with enhanced antibiotic resistance and a chaperone-usher secretion system involved in Pilus assembly affects biofilm formation.

Acinetobacter Baumannii an Emerging Bacterial infection

According to the Centers for Disease Control and Prevention (CDC). *Acinetobacter baumannii* is responsible for 80% of all Acinetobacter infections. Because they lack cilia or flagella, they are immobile. *A. baumannii* is primarily found in hospitals and poses a threat to those with weakened immune systems. *Acinetobacter Baumannii* is a common pathogen that can cause infections in both the community and in health-care settings (HAIs) Because of its antibiotic resistance and proclivity for causing massive, multifacility nosocomial outbreaks, *A. Baumannii* has emerged as a prominent cause of (HAI) health care-associated infections.

CLINICAL SYNDROMES Of *ACINETOBACTER BAUMANNII*

Acinetobacter Baumannii is an opportunistic pathogen that can cause infections in the respiratory, urinary, and gastrointestinal tracts, as well as wounds and septicemia.

Epidemiological Typing Methods

Biotyping, Antibiograms, Serotyping, Phage typing, Bacteriocin typing, Protein profiles, Pulsed Field Gel Electrophoretic typing, Multi-locus Enzyme Electrophoretic typing, Plasmid profiling, Ribotyping, Polymerase Chain Reaction (PCR), Vitex2 Compact Machine.

Treatment, Prevention & Control

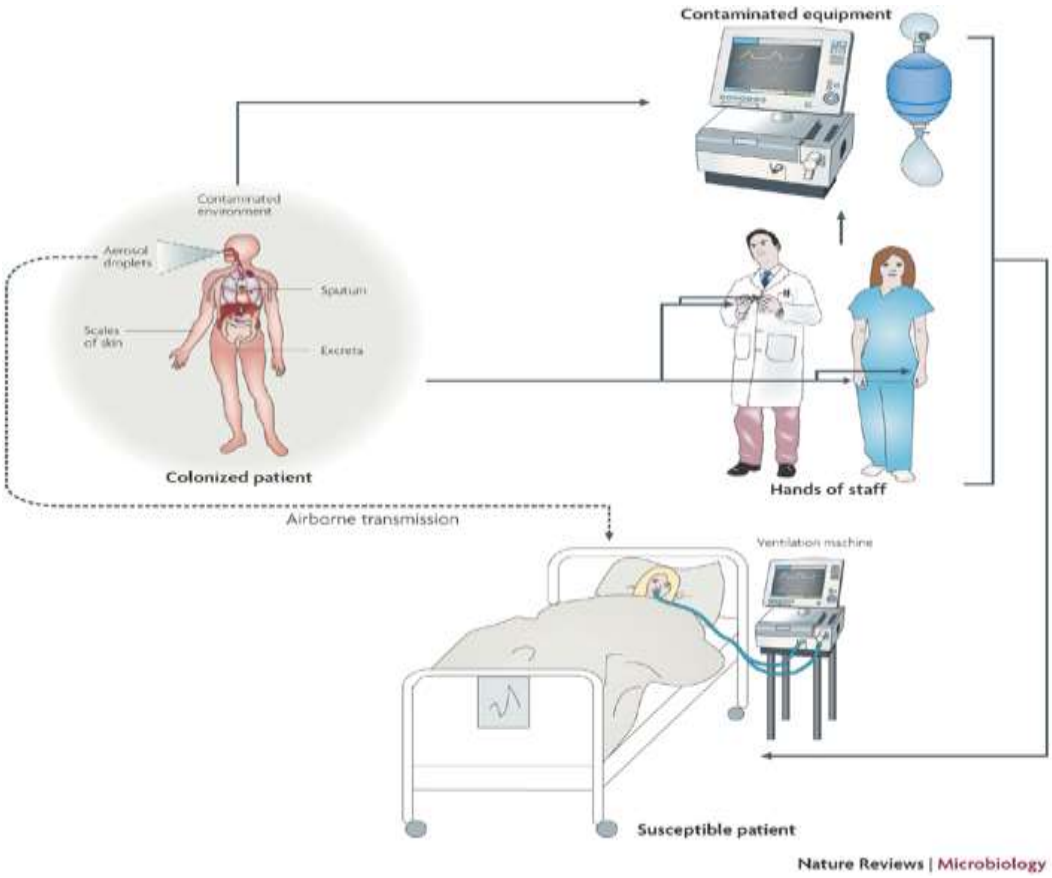
Antibiotic resistance treatments, for example. β-lactam + Aminoglycosides are an empirical treatment for Acute Infections. Antibiotic Susceptibility dictates a specific treatment plan.

Prevalence

Hospital Care Associated Infection (HCAI) prevalence varies widely over the world, ranging from 4% to 10%.

In low-income countries, rates are greater. Microorganisms that cause disease can be found on health care professionals' hands and nasal cavities, floors, and other surfaces, including implants and prostheses.

External surfaces, such as door handles and faucets, are commonly infected.



Detection of Extended Spectrum β-Lactamases Production

The double disc synergy test (DDST) was used to detect the prevalence of extended spectrum β-Lactamases (ESBL) synthesis in Acinetobacter using previously described methods (7,12,13)

Transmission

Acinetobacter spp. are commonly spread to patients by environmental persistence and transitory infection of health care personnel's hands (45, 46). Aerosolized bacteria from infected or colonized patients have been reported to spread nosocomially. In one well-publicized case, a health care worker contracted fulminant pneumonia after inhaling *A. baumannii* aerosolized during ventilated patient endotracheal suctioning (47). Another study found that carbapenem-resistant *A. baumannii* was found in roughly a quarter of air samples taken from patient rooms (CRAB). All of the patients in these rooms were afflicted with CRAB (46, 48). The air ducts were not colonized, indicating that the germs in the air came from the patients (46, 48). However, Rock et al. discovered evidence of *A. baumannii* air pollution in only one of a dozen patient rooms examined, indicating that the prevalence of *A. baumannii* air contamination is variable (49). They hypothesized that the lower rate of air contamination was attributable to frequent air exchanges, as well as the fact that their patients were mechanically ventilated (and thus had closed airway circuits) (49). Nonetheless, the unsettling thought of organisms spreading via settling on patients from polluted air suggests that occasional cleaning of environmental surfaces may not be enough to prevent spread unless measures to disinfect the air in patient's rooms are also made. This concept of airborne dissemination poses a unique problem, and it may necessitate a change in infection management strategy.

Surface disinfection may not be as significant as early control of patient respiratory secretions, patient cohorting, or models focused at limiting environmental spread. Although clinical data is currently missing, novel technologies to facilitate air purification, such as misting, UV radiation, or vapor technologies, may also play a role.

While it is widely assumed that Acinetobacter spp. cause infections predominantly in immunocompromised patients, colonization pressure, selection by broad-spectrum antibiotics, and disruption of anatomical barriers are the most prevalent predispositions to infection (e.g., placement of catheters or endotracheal tubes and traumatic or surgical injury to skin and integument).

Patients with lymphocyte suppression or depletion account for a minor fraction of *A. baumannii* infections (25, 50–52). In patients with burns, trauma, or who are in intensive care units, Acinetobacter infections are connected to mechanical ventilation,

intravenous and urine catheterization, surgery, invasive treatments, and long-term broad-spectrum antibiotics (25, 26, 39, 50, 52, and 53). While Acinetobacter is essentially an opportunistic pathogen, the "opportunities" that typically lead to clinical infection are abnormalities in anatomical host defenses and changes in normal host flora caused by broad-spectrum drug exposure.

Acinetobacter is naturally resistant to desiccation, which helps it survive in the environment and spread in health-care settings. In addition, particularly in hot and humid tropical settings, community-acquired pneumonia and bacteremia can occur (25, 45).

There appears to be a seasonal preference in the cases. According to the National Nosocomial Infections Surveillance (NNIS) System, the rate of Acinetobacter infections in the United States increased by 54 percent between 1987 and 1996 between July and October compared to November through June (45).

Humidifiers and water baths have frequently been implicated as environmental reservoirs, with a high degree of humidity thought to stimulate bacterial development (45).

CHAPTER TWO

LITERATUREREVIEW

Acinetobacter Species:

Acinetobacter species come in a variety of shapes and sizes; below are a few examples of Acinetobacter strains.

Acinetobacter baumannii, *Acinetobacter albensis*, *Acinetobacter apis*, *Acinetobacter celticus*, *Acinetobacter baylyi*, *Acinetobacter bouvetii*, *Acinetobacter brisouii*, *Acinetobacter bohemicus*, *Acinetobacter haemolyticus*, *Acinetobacter proteolyticus*, *Acinetobacter nosocomialis*, *Acinetobacter larvae*, *Acinetobacter nectaris* and *Acinetobacter parvus*.

PATHOGENESIS

Models of Infection

The pathogenesis of *A. baumannii* has been studied using a variety of in vivo infection models. Except at very high inocula (i.e., >109 CFU), healthy mice implanted in the lung or intravenously are often resistant to deadly infection induced by several strains of Acinetobacter, implying doubtful relevance to human pathogenesis (54–58). Artificial models, such as infecting mice intraperitoneally (a clinically irrelevant route of entry) or mixing the inoculum with porcine mucin as a foreign body that inhibits the host's immune system from rapidly clearing the organism, have been used to circumvent the intrinsic resistance of many mouse strains to *A. baumannii* infection (59, 60). Furthermore, mice are frequently made neutropenic prior to infection, despite the fact that neutropenia is not a common risk factor for *A. baumannii* infections, and the vast majority of patients infected with *A. baumannii* have neither a lack of leukocytes nor overt defects in leukocyte function (25, 50–53, 61–68). Given the lack of application to clinical disease, the results of such models must be regarded with caution.

In contrast, A/J and C3HeB/FeJ mice are intrinsically susceptible to lethal intravenous and lung infections by some clinical isolates of *A. baumannii* at inocula comparable to (or lower than) those required for other commonly recognized virulent pathogens like *Pseudomonas aeruginosa* and *Staphylococcus aureus* (54, 69–72).

Due to reduced CXC chemokine responses to the bacteria, A/J mice experienced delayed neutrophil recruitment to the lungs, which could explain their vulnerability to

pulmonary infection (54). It is yet to be discovered why C3HeB/FeJ mice are more vulnerable to *A. baumannii* infection than other mouse strains.

Without being immunocompromised, rats are susceptible to fatal pneumonia produced by *A. baumannii*. Inoculating *A. baumannii* into the lungs of rats caused clinically similar pneumonia, as evidenced by histology, inflammatory response, physiological damage, and death, according to Russo et al (73).

They also established a rat skin and soft tissue infection paradigm in which virulence variations across bacterial strains were discovered, with clinical isolates showing higher virulence than environmental isolates (73, 74). Thompson et al. describe a surgically produced, full-thickness skin incision wound infection model of Acinetobacter in mice (68). These researchers employed *A. baumannii* AB5075, a virulent clinical isolate, but they had to pre-treat mice with cyclophosphamide, as with other BALB/c models, to generate an immunocompromised state that the bacteria could exploit for a sustained infection. *A. baumannii* meningitis, endocarditis, and osteomyelitis models have been summarized by McCon Galleria wax moth larvae have also been utilized as an Acinetobacter infection model. Peleg et al. discovered that *Acinetobacter baumannii* was more harmful in the Galleria model than *non-baumannii* Acinetobacter species, such as *Acinetobacter baylyi* and *Acinetobacter lwoffii*, and that antibiotic therapy enhanced infected larvae survival (75). nell et al (60).

In Galleria, Gebhardt et al. discovered that *A. baumannii,* even a virulent strain (ATCC 17978), was more virulent than *A. baylyi* (76). Biofilm formation variations between strains did not correlate with pathogenicity, according to Wand et al (77). When the strains were made to form biofilms and then disrupted, the sessile bacteria harvested from the biofilms were more virulent in Galleria than the same strain obtained from planktonic growth (77). Surprisingly, the virulence of a strain can be affected by the organism's growth phase at the time of infection.

Acinetobacter Virulence Factors

Multiple investigations have found that *Acinetobacter baumannii* has higher intrinsic human virulence potential than *Acinetobacter calcoaceticus, Acinetobacter lwoffii, Acinetobacter junii, Acinetobacter baylyi* and *Acinetobacter haemolyticus.* In one study, *A. baumannii* developed better at 37°C and was able to withstand macrophage absorption better than the other species (86). As previously stated, *A. baumannii* strains were more harmful to Galleria wax moth larvae than *A. baylyi* and

A. lwoffii strains (75,76). A strain of *A. junii* was shown to be nonlethal in neutropenic mice in another study, although numerous *A. baumannii* strains were fatal (85).

Chusri et al. evaluated clinical outcomes in patients infected with *Acinetobacter nosocomialis, Acinetobacter pittii* and *Acinetobacter baumannii,* then compared clinical isolates in an animal model (15). In comparison to *Acinetobacter baumannii,* infection with a *non-baumannii* Acinetobacter species resulted in a roughly 9-fold reduction in mortality. Furthermore, *non-baumannii* Acinetobacter clinical strains

were significantly less deadly during infection in Galleria wax moth larvae. In a case control study, patients infected with *A. urisingii* had significantly decreased 28-day mortality.

Acinetobacter baumannii has stronger human virulence potential than other Acinetobacter spp., including *Acinetobacter calcoaceticus*, *Acinetobacter lwoffii*, *Acinetobacter junii*, *Acinetobacter baylyi*, and *Acinetobacter haemolyticus*, according to multiple researches. In one investigation, *A. baumannii* developed faster at 37°C and was better at resisting macrophage absorption than the other species (86). As previously stated, *A. baumannii* strains were more harmful to Galleria wax moth larvae than *A. baylyi* and *A. lwoffii* strains (75, 76). A strain of *A. junii* was shown to be nonlethal in neutropenic mice in another study, although numerous *A. baumannii* strains were fatal (85). Chusri et al. evaluated clinical outcomes in patients infected with *Acinetobacter nosocomialis*, *Acinetobacter pittii*, and *Acinetobacter baumannii*, then compared clinical isolates in an animal model (15). In comparison to *Acinetobacter baumannii*, infection with a *non-baumannii* Acinetobacter species resulted in a roughly 9-fold reduction in mortality. Furthermore, upon infection of Galleria wax moth larvae, clinical strains of *non-baumannii* Acinetobacter species were significantly less deadly. Patients infected with *A. ursingii* had a lower 28-day mortality rate than those infected with *A. baumannii* (6 percent versus 37 percent) in a case-control study, despite the fact that multidrug resistance and insufficient initial therapy were equally frequent in patients infected with both species (10).

Our understanding of basic Acinetobacter physiology and virulence factors has been aided by recent discoveries in genetics and molecular biology (87, 88). Many people have created transposon mutant libraries to learn more about *Acinetobacter baumannii* virulence characteristics. In order to discover putative virulence factors, these libraries used transposon insertion sequencing (TnSeq) (76, 89–91). The present mutant collections, when paired with whole-genome sequencing, constitute a great resource for virulence and antibiotic susceptibility tests (57, 74, 89, 92).

Despite the genus Acinetobacter's origin (from a-kineto, Greek for "nonmotile"), bacteria in this genus are very motile; in fact, motility is one of the genus' suspected virulence mechanisms (60, 93). Acinetobacter is also resistant to disinfection and dehydration, as previously stated.

Ethanol improved the development of *A. baumannii* in culture media as well as its salt tolerance, allowing it to grow in the presence of salt concentrations that would otherwise be inhibiting (94). In Galleria, ethanol treatment resulted in significant alterations in the organism's proteome as well as increased pathogenicity (95).

RecA, a bacterial enzyme that mediates DNA repair and resistance to desiccation, protected *A. baumannii* from killing inside macrophages and led to mouse death (96).

A. baumannii displays morphological changes in dry environments, including thicker cell walls (97, 98), which may contribute to its remarkable endurance on environmental surfaces.

In outbreak investigations, *A. baumannii* remained alive in hospital units after months—even years—on a solid surface, highlighting the difficulty of preventing the organism from spreading through the environment once it has colonized nosocomial surfaces (97, 98). Epidemic isolates had a tendency to persist in dry circumstances, according to subsequent experimental models (99).

The creation of biofilms, adhesion mechanisms, iron acquisition features, activities of polysaccharide membrane and outer membrane protein phospholipases, changes in penicillin-binding proteins, and outer membrane vesicles (OMVs) have all been postulated as potential virulence factors (Table 1).

Outer membrane protein A (OmpA), for example, has been linked to host epithelial cell adhesion, biofilm function, and complement resistance (100). Transposon-mediated disruption of OmpA reduced mortality in a small number of mice in a recent lethal model of *A. baumannii pneumonia*, suggesting that the OmpA protein has a virulence function (100).

Overexpression of chromosomal efflux mechanisms has also garnered a lot of attention. Increased multidrug resistance to antimicrobial drugs is conferred by overproduction of these systems (101–103).

A. Baumannii Pathogenesis

These researches are beginning to provide an integrated picture of Acinetobacter species pathogenicity (Fig. 1). The ability of *A. baumannii* to elude complement and phagocytosis appears to be the driving factor behind its pathogenicity, most likely due to its capsular composition and abundance. By using a large infectious inoculum and depletion or decrease of host innate effectors, the balance can be shifted in favor of microbial escape. LPS causes TLR4-mediated sepsis, which starts the second pathogenicity phase, if the organisms are able to resist innate immune clearance.

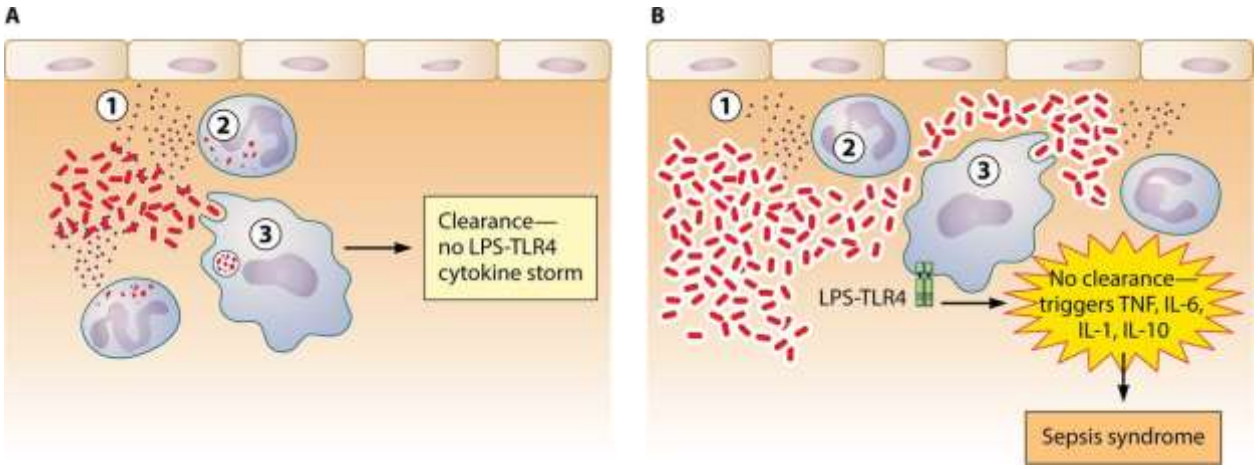


FIG 1 During an Acinetobacter infection, the fate of the host is determined in two stages. (A) The three principal innate effectors, complement (circled 1), neutrophils (circled 2), and macrophages (circled 3), clear the microorganism early, preventing a prolonged LPS-TLR4 activation and subsequent cytokine storm. (B) If the organism survives first innate effector clearance and replicates, LPS activation of TLR4 is prolonged, resulting in cytokine storm and sepsis syndrome. The development of an altered capsule that resists complement and phagocytic uptake is one strategy by which the organism may be able to elude clearance (denoted by thicker shell around the bacteria).

Patient Contact Precautions:

Measures taken to prevent infectious agents from spreading through direct or indirect contact with the patient or the patient's environment. These include ensuring proper patient placement, wearing personal protective equipment such as gloves and gowns, limiting patient transportation and mobility, using disposable or dedicated patient-care equipment, and prioritizing, making room cleanliness and disinfection a top priority. The CDC Guideline for Isolation Precautions: Preventing Transmission of Infectious

Agents in Healthcare Settings (CDC Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings) defines contact precautions (5).

Zone for patients:

The patient and his or her immediate surroundings are included. All inanimate objects touched by or in direct physical contact with the patient, such as bed rails, bedside table, bed linen, infusion tubing, bedpans, urinals, and other medical equipment, are often included. It also includes monitors, knobs, and buttons, as well as other "high frequency" touch surfaces that are regularly touched by health care professionals during patient care. The WHO recommendations on hand cleanliness in health care offer a definition for this (6). Toilets and related products are also susceptible to contamination (7).

1.2. AIM and SCOPE

The aim of this research is to determine, identify and evaluate *Acinetobacter* strains that are isolated from different samples and the detection of their antimicrobial susceptibility testing.
In order to:

1. Isolation and identification of *Acinetobacter species* in Near East University hospital.
2. Determine the spread of Acinetobacter species among male and female patients.
3. Detection of antibiotic susceptibility of Acinetobacter strains.
4. Prevalence of *Acinetobacter species* in Near East University hospital.

CHAPTER THREE
MATERIAL AND METHOD

2.1. Material & Method

2.1. Design of Study

The current study was conducted in the Microbiology Laboratory at the Near East University hospital in the Turkish Republic of Northern Cyprus (TRNC). The study were designed as mixed method retrospective and prospective method. It is mixed study the samples and results has been collected retrospectively between (2019 and 2020). In the prospective method the results have been collected between (2020-2021) prospectively. A total of 100 samples for the study was executed from different clinical specimens of hospitalized patients from various hospital departments these include patients from ICU, Emergency, OPD and different general wards (Cardiology, Neurology, Oncology, Gastroenterology, Anesthesia, Urology, Orthopedics & Traumatology, Chest diseases and Allergy, Internal Medicine, General Surgery and general wards of female and male etc.). Between (October 2019 and May 2021) The study protocol was accepted by the NEU Research Committee. Acinetobacter species organisms obtained from separate clinical specimens (Blood, Urine, Sputum, Aspirational Fluid, Sperm, Cerebral Spinal Fluid, Catheter Tip, Abscess/ Wound material, Bronchial lavage etc.) were used for testing and repeated isolates were removed from the same clinical specimen of the same patient.

The study will be performed among *Acinetobacter spp.* infected individuals, the sample was collected from those who expect from suffering urinary infection, blood and wound infection in both gender (male and female), following, the collecting information's according to the special questioners that related to the current study. Detection and evaluation of Acinetobacter strains by microbiological culture method in addition Antibiotic-susceptibility, Moreover, the patient's demographic features (age, sex, sample type, isolated Acinetobacter strains, are determined Antibiotic Susceptibility test "AST") were recorded and analyzed.

2.2. Specimens Collection

In the Microbiology Laboratory, 100 clinical specimens of Acinetobacter species were collected between October 2019 and May 2021 in Cyprus-Nicosia city. During the study, different samples were received in the microbiology laboratory at the Near East University. These samples were categorized by gender (male and female), sample type was (Blood, Urine, Sputum Aspirational Fluids etc.). The isolates were identified by standard microbiological methods. The following study after collected each sample were cultured on Blood agar (Merck, KgaA, Germany) and Eosin Methylene Blue (EMB) agar (Becton Dickinson, Sparks, MD 211 52 USA) and incubated for 24-48 hours at 37°C to get pure colonies. then all samples of isolated *Acinetobacter species* strains were kept in bacteria storage tubes (OR-BAK, Ankara, Turkey) at -80°C until they were used.

2.3. Sample Processing

100 samples collected from NEU Microbiology Laboratory were cultured on Blood Agar, MacConkey Agar and EMB Agar plates, incubated for 24-48hours at 37°C. After proper incubation, the colony colour and different characteristics were observed usng standard microbiological methods. Different characteristics included colony colour,

size, Gram staining and biochemical testing. Vitex-2 Combact machine was the instrument used for identification and evaluation of Acinetobacter spp. The stored samples of *Acinetobacter* strains isolates were cultured on Blood agar and Eosin Methylene Blue (EMB) agar to prepare for Antibiotic Susceptibility Testing. Blood agar, Eosin Methylene Blue (EMB) agar for confirmation were prepared as per the manufacturer's directions as follows:

2.3.1. Quality Control

Sometimes known gram positive and gram-negative bacteria were stained to compare with test organisms.

2.3.2. Biochemical Tests

Different biochemical tests were done to identify the organisms. Known control were performed with each biochemical test.

2.3.3 Turbidity Standard Solution (0.5 McFarland Standards)

In order to prepare 1% v/v solution of H2SO4 (sulphuric acid), 1 ml of concentrated H2SO4nwas added to 99 ml of water. Exactly 2.35g of dehydrated barium chloride was dissolved in 200 ml of distilled water to make 1.175% w/v solution of barium chloride (BaCl2.2H2O).0.5 McFarland (0.5% turbid) standard was set by mixing 0.5ml of barium chloride solution to 99.5ml of sulphuric acid with continuous stirring. This standard solution was then stored at room temperature in the dark.

3.3.5 Preparation of Inoculum

A sterile loop of inoculum was used to pick 3 to 4 isolated, identical colonies of test microorganism from plates. These colonies were transferred to a sterile tube containing 2-3ml of normal saline. Inoculum density was prepared with comparison to 0.5

McFarland turbidity standard. Suspension was used within 15 minutes after preparation.

2.3.4. Preparation of Blood Agar

1. 1000 ml of purified/distilled water is applied to suspend around 40 grams of the prepared medium.
2. Heat to a boil to totally remove the medium.
3. Sterilize at 15 lbs by autoclaving. (121°C) pressure for 15 minutes.
4. The medium is then withdrawn from the autoclave and cooled to around 40-45 °C.
5. The sterile defibrinated blood with 5 percent v / v is applied aseptically and well mixed.
6. Then the media is mixed well and poured into sterile Petri dishes.
7. Replace each Petri dish's lid and stack the plates in a fridge.

2.3.3. Preparation of Eosin methylene blue agar (EMB)

1. Using 1000 ml of purified/distilled water to suspend 36 grams of EMB agar.
2. Heat to a boil to completely dissolve the medium.
3. Sterilize at 15 lbs by autoclaving. (121°C) intensity for 15 minutes.
4. To oxidize the methylene blue and to suspend the flocculent precipitate, cool to 45-50 ° C and shake the media in.
5. To allow plates to warm to room temperature, pour into sterile Petri plates.
6. Replace each Petri dish's lid and stack the plates in a fridge.

2.5. Antibiotic Susceptibility Testing

In this study, the disc diffusion method has been performed for the antibiotic susceptibility test. The process of disk diffusion used for bacteria (Mueller-Hinton agar) was augmented by 2% glucose and 0,5 µg/mL methylene blue coloring with a pH range of 7,2 to 7,4. The presence of glucose provides the bacteria with sufficient development,

while the presence of methylene blue dye enhances the description of the zone edge (Fothergill, 2012).

Mueller-Hinton agar was processed as follows, combined with 2 percent glucose and 0,5 μg/mL methylene blue dye (MH-GMB) (Espinel-Ingroff & Cantón, 2007).

1. For 1000 mL of Mueller-Hinton agar, apply 100 μL of methylene blue dye.
2. For 1000 mL of Mueller-Hinton agar, apply 20 g of glucose.
3. Sterilize by autoclaving at 15 lbs. pressure (121°C) for 15 minutes.
4. To 45-50 ° C, cool. Mix well and drop into roughly 4 mm diameter, sterile Petri dishes.
5. Stored at refrigerator temperature 2 to 8°C and used within 7 days of preparation.

Figure: 2.2. *Acinetobacter* growth on blood media

Figure 1. Susceptibility of Acinetobacter against β-lactam - β-lactamase Inhibitors.

Figure:2.3. Bacterial susceptibility on Mueller-Hinton Agar

2.6. Storage and Usage Instructions

As the manufacturer's instructions, place the discs at -20 to +8 ° C after receipt. The expiry date is only valid for unopened blister packs which are kept under appropriate conditions. If a cartridge is open, it is best to store it for no more than 7 days. Allow room temperature to come in containers before opening to prevent condensation as this can reduce the antimicrobial agent's potency. If opened, the discs should be placed in the container given or any appropriate opaque airtight desiccated container within the dispenser to protect the discs from moisture. Containers will be placed in the refrigerator inside the dispenser and allowed to reach room temperature before opening to avoid condensation from the formation. Return unused discs to the refrigerator once the discs have been applied. First, use the oldest discs. Discard discs that have expired.

2.7. Bacterial Inoculum

From the primary isolation medium, five colonies showing similar morphology are either taken by direct colony suspension method and suspended by using a flamed loop or by using a sterile cotton swab, bacteria are extracted and suspended in a clean saline solution of 4-5 ml (0,85 percent NaCl). For 15 seconds, combine the cell suspension using a vortex mixer. The turbidity is then noticeable and the density of the suspension is modified with the usage of a spectrophotometer. The turbidity needs to be balanced to 0,08 to 0,10 at an absorbance of 625 nm for the 0,5 McFarland standard. It needs to be used about an hour after the standard suspension has been prepared.

2.7.1. Inoculation into Agar Plates

Inoculation has been done according to the Kirby-Bauer method as follows:

1. Mix the prepared bacterial suspension well with a sterile cotton swab, and by gently pushing and spinning the swab within the container, the excess fluid of the swab is extracted above the fluid level.
2. Three times streak the whole agar surface of an EMB layer, turning the plate 60 ° between streaks to achieve even inoculation.
3. For preventing the excessive wetness of the medium, allow Petri dishes to dry for 3 to 5 minutes, a maximum of 15 minutes, at room temperature.

2.7.2. Application of Antibacterial discs to Inoculated Agar Plates & Incubation

1. The cartridge is opened under the flame and then discs are discharged from the cartridge onto a clean Petri dish with the help of a flamed and cooled forceps.

2. The discs have to be distributed into the agar plates not less than 24 mm from the center to the center and 12 mm away from the edge of the agar plate within 15 minutes.
3. Once in touch with the surface of the agar, do not transfer the disk.
4. In an incubator set at 35 °C (± 2 °C), put the plates in an inverted position for one night in an aerobic atmosphere within 15 minutes of the application of the disks.
5. Incubate all plates for 20 to 24 hours.

2.7.3. Reading Inhibition Zones and Interpretation of Results

1. During overnight incubation, test the plates (20-24 hours). If the plate has been satisfactorily streaked and the inoculum is right, the resultant inhibition zones across the disk are circular, with a semi confluent growth area, uniformly clear.
2. Keep the plate over a dark, non-reflective backdrop illuminated with reflective light only a few centimeters above.
3. Measure the diameter of the zone to the nearest full millimeter at the point where there is a noticeable reduction in growth. (The emergence of pinpoint micro-colonies at the outside of the zone or large colonies within the inhibition zone must be overlooked).
4. If there is insufficient growth after 24 hours of incubation, re-incubate the plates and read them at 48 hours of initial incubation time.
5. Accordingly, the results obtained are either evaluated as susceptible (S), intermediate (I), or resistant (R) for clinical application.

2.8. Statistical Data Analysis

Qualitative and quantitative data values along with the percentage.

Pictorial explanations of the major results of the study were rendered using an appropriate statistical graph.

The data analysis was performed using SPSS version (25.00) statistical package.

The evaluation of the total percentages number analyzed by the Frequency test with the cross-table test, in order to investigate the real amount of each data present in the study.

CHAPTER FOUR
RESULTS

3. RESULTS

3.1. Study Population

The contemporary study was conducted in the microbiology laboratory of the Near East hospital in the Turkish Republic of Northern Cyprus (TRNC). There was a total of 100 samples for the study was implemented Between (October 2019 to May 2021) from blood, urine, wound material and aspirational fluid samples of the hospitalized patients and outdoor patients from various hospital departments. Moreover, the study was performed among the Acinetobacter species infection individuals. In addition, the collecting information's according to the special questioners that related to the current study such as gender (Male 61 %, Female 39 %), then distribution of patients according to age group for example, Teenage 4%, Middle Aged 8% Adult 27%, Elder 61 %), and type of patients was divided in to In-patient 94% and Out-patient 6 %. Moreover, the evaluation of the Acinetobacter strains by microbiological culture method. In addition, Antibiotic-susceptibility test was performed and the features of the determination. Antibiotic Susceptibility test "AST") were recorded and analyzed.

Table 4.1: The distribution of patients within gender groups.

Gender	No of patients	Percentage (%)
Male	61	61
Female	39	39
Total	100	100,0

Table 4.1.

Out of the 100 isolates of Acinetobacter species 61(61%) were derived from male patients and 39 (39%) were derived from female patients. The gender distribution is shown in Table 4.1& Graph 4.1.

Graph 4.1: Percentage of patient's distribution according to Gender

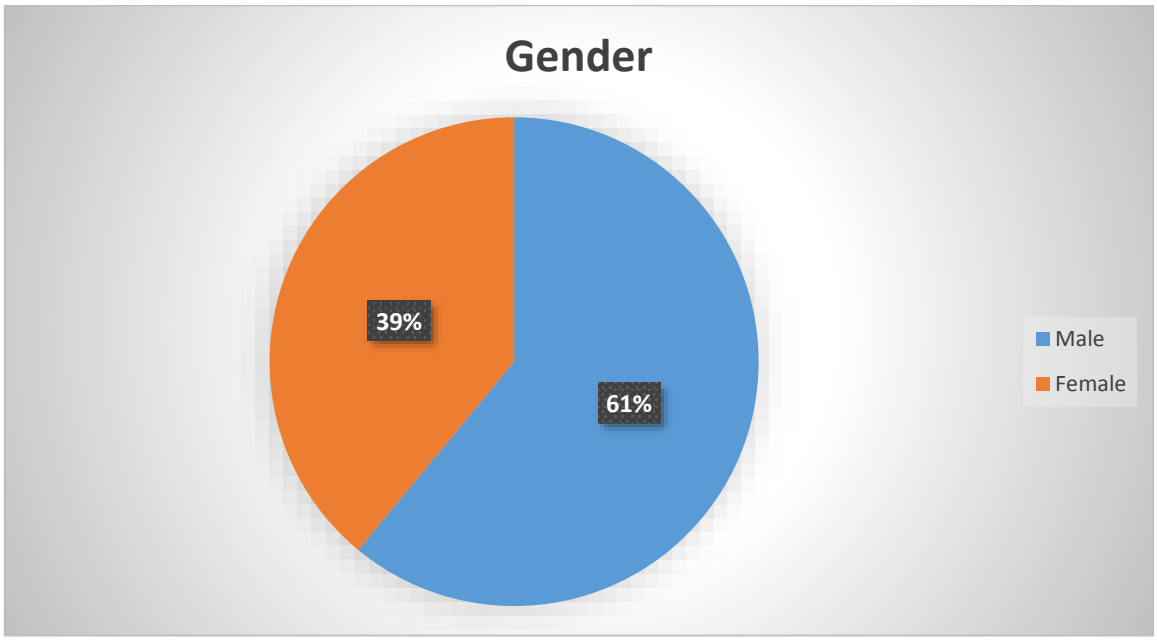


Table 4.2: The distribution of patients within age groups.

Age Groups		No of patients	Percentage (%)
	18-24	4	4
	25-50	8	8
	51-70	27	27
	71-99	61	61
	Total	100	100

Table: 4.2.
Patients were divided into 4 age groups and the number of patients were calculated in each group. Thus, it was seen that the highest number of Acinetobacter 61% were found between the age group 71-99 years followed by 51-70 years of age group while the Acinetobacter strains range was 27%.

Graph 4.2.

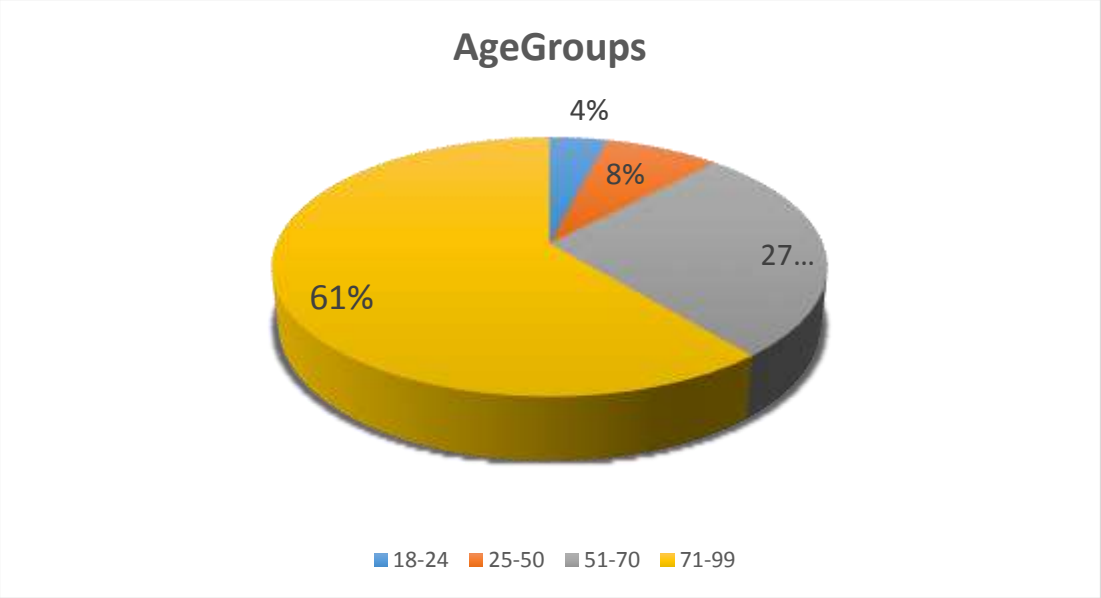


Table 4.3: The in-patient and out-patient distribution of the specimens.

Patient Type	No. of Patient	Percent
In- Patient	94	94%
Out-Patient	6	6%
Total	100	100%

Table 4.3.

The distribution of patients according to ward/indoor patients were 94% while the outdoor patients were less than 6%. Thus, the maximum number of patients were admitted in different hospital wards.

Table 4.4: Overall Antimicrobial Susceptibility Testing Pattern (%age).

Antibiotics	R (%)	S (%)	Total (%)
Amikacin	75 (78,1)	21 (21,9)	96 (100)
Cefepime	80 (91,95)	7 (8,05)	87 (100)
Ceftazidime	36 (41,37)	51 (58,63)	87 (100)
Ceftriaxone	60 (89,55)	7 (10,45)	67 (100)
Ciprofloxacin	79 (90,80)	8 (9.20)	87 (100)
Colistin	38 (43,18)	50 (56,82)	88 (100)
Ertapenem	72 (91,13)	7 (8,87)	79 (100)
Gentamycin	81 (92,0)	7 (8)	88 (100)
Imipenem	43 (44,79)	53 (55,21)	96 (100)
Levofloxacin	47 (92,15)	4 (7,85)	51 (100)
Meropenem	87 (90,62)	9 (9,38)	96 (100)
Netilmicin	19	0	19
Piperacillin/Tazobactam	38 (97,43)	1 (2,57)	39 (100)
Trimethoprim/Sulfamethoxazole	30 (78,94)	8 (21,06)	38 (100)

Table 4.4:

15 antibiotics were tested against different strains of Acinetobacter using Vitek2 combact system, the highest sensitivity were found for the following antibiotics:

Colistin 50 (56,82), Imipenem 53 (55,21) & Ceftazidime 51 (58,63) Acinetobacter spp, showed high resistance to almost all antibiotics tested even to colistin the last resort for treatment of Acinetobacter spp.

Table 4.5. Distribution Of Acinetobacter Species

Species		No of Patients	Percentage (%)
	Acinetobacter	2	2
	Acinetobacter baumannii	10	10
	Acinetobacterbaumannii/calcoaceticus complex	58	58
	Acinetobacter lwoffii	1	1
	Acinetobacter species	29	29
	Total	100	100

Table 4.5.

The most frequent number of Acinetobacter species were found to be *Acinetobacter baumannii/calcoaceticus complex* group 58% followed by Acinetobacter species 29% and *Acinetobacter baumannii* 10% while *Acinetobacter lowffii* was found to be the least 1%.

Table 4.6 Distribution of Hospital Departments/Wards within patients:

Departments		No of patients	Percentage (%)
	Anesthesiology ICU	46	46
	Brain Surgery	7	7
	Cardiology	14	14
	Cardiovascular Surgery	2	2
	Chest Diseases and Allergy	9	10
	Emergency	1	1
	General Surgery	1	1
	Geriatrics	3	3
	Infection	1	1
	Intensive Care Unit	3	3
	Internal Medicine	2	2
	Laboratory	1	1
	Neurology	1	1
	Oncology	6	6
	Urology	2	2
	Total	100	100

Table 4.6.

The highest number of isolates were found in Anesthesiology ICU unit 46(46%), followed by the Cardiology department 14(14%) and Chest Diseases and Allergy which were 9%.

Table 4.7. Distribution of Specimens Types within patients

Sample Type		No of patients	Percentage (%)
	Abscess/Wound material	5	5
	Aspiration Fluid	51	51
	Blood	4	4
	Bronchial lavage	2	2
	Catheter Tip	4	4
	Cerebral Spinal Fluid	1	1
	Sperm	1	1
	Sputum	17	17
	Urine	15	15
	Total	100	100

Table 4.7.

The isolates were recovered from Aspiration fluid 51% followed by sputum samples17% and urine 15% respectively.

Table.4.8. Distribution of Acinetobacter species according to Inpatients and outpatients

Species		Inpatient	Outpatient	Total (%)
	Acinetobacter	2	0	2(2.1%)
	Acinetobacter baumannii	10	0	10(10.6%)
	Acinetobacterbaumannii/calcoaceticus complex	55	3	58(58%)
	Acinetobacter lwoffii	0	1	1(1%)
	Acinetobacter species	29	0	29(29%)
	Total	96	4	100.0%

Table 4.8.

When organisms were compared according to the type of patient application, significantly higher proportion of *Acinetobacterbaumannii/calcoaceticus complex* 55% were found in admitted patients as compared to outpatients followed by Acinetobacter species 29% within the admitted patients.

CHAPTER FIVE
DISCUSSION

4.10. DISCUSSION

Our findings revealed that 46 (46%) of patients were admitted to the Anesthesiology ICU unit, indicating that this unit admitted more patients than any other department in the hospital followed by the Cardiology department 14(14%) and Chest Diseases and Allergy which were 9%. which is comparable to the findings of Sieniawski et al., (2013) who found the number and percentage rate of Acinetobacter baumannii infections in 2011

at particular wards, according to prevalence, was as follows: ICU – 67 (48% of all infections), Department of Internal Medicine – 22 (16%), Neurology Department – 18 (13%), surgical wards – 28 (20%), out of which the Department of General and Oncological Surgery – 12 (8%), other wards – 5 (3%) (106).

In addition to an increase in the bacterial pathogen, is an excess of patients being admitted to the Anesthesiology ICU department multiple times and staying for long periods of time that has been documented. In our study higher number of Acinetobacter isolates were recovered from Aspiration fluid 51% followed by sputum samples17% and urine 15% respectively. However in another study conducted by Gupta *et al.*, (2015) maximum Acinetobacter isolates were from blood samples and from ICUs (105).

Antibiotic resistance has caused the highest incidence of infection in the patients aged (70 years and older) age group. Males (61%) are also more prone to Acinetobacter infection, according to this study.

Acinetobacter is a nosocomial infection that can be found in hospitals. Infectious disease specialists are concerned about its potential to infect healthy hosts and its

proclivity for developing antimicrobial medication resistance. Acinetobacter has been found to produce serious and sometimes deadly infections when isolated from normal skin and mucous membranes. (17). In our study the most frequent number of Acinetobacter species were found to be *Acinetobacter baumannii/calcoaceticus complex* group 58% followed by Acinetobacter species 29% and *Acinetobacter baumannii* 10% while *Acinetobacter lowffii* was found to be the least 1% which is consistent with the results of another study carried out by Gupta *et al.*, (2015) (105). In the present study, maximum isolated species were *Acb (Acinetobacter calcoaceticus-A. baumannii) complex* (80 (72%) of total Acinetobacter isolates), non-*Acb complex (Acinetobacter lwoffii* 16 (14%), *Acinetobacter haemolyticus* 13 (12%), *Acinetobacter junii* 1 (1%), *Acinetobacter radioresistant* 1 (1%).

Despite this, Acinetobacter is becoming more common in several hospital departments' hemocultures (11) Bacteremia caused by Acinetobacter is most common among critically ill patients, especially those admitted to intensive care units (ICUs), because these patients typically have a longer hospital stay, require multiple invasive operations, and are commonly treated with wide range antimicrobials (18)

In my study patients were divided into 4 age groups and the number of patients were calculated in each group. Thus, it was seen that the highest number of Acinetobacter 61% were found between the age group 71-99 years followed by 51-70 years of age group while the following range of Acinetobacter strains was 27%.
We also discovered that the infection was most common in people over the age of 50, followed by those aged 0 to 10. Isolates of Acinetobacter were found in the age group of >45 years in a research by Mindolli et al. (2010), perhaps due to a compromised immune system and accompanying chronic disease within such age groups.

My research's data reveals that 15 antibiotics were tested against different strains of Acinetobacter using Vitek2 Combact system, the highest sensitivity was found for the following antibiotics:

Colistin 50 (56,82), Imipenem 53 (55,21) & Ceftazidime 51 (58,63) Acinetobacter spp, showed high resistance to almost all antibiotics tested even to colistin the last resort for treatment of Acinetobacter spp.

While in another study from other published articles that Piperacillin showed the highest level of resistance (55%) in this investigation, followed

by ceftriaxone (46%), and ceftazidime (4%). (46 percent). Rahbar et al. (2010) observed that ceftriaxone (90.9%), piperacillin (90.9%), ceftazidime (84.1%), ciprofloxacin (90.9%), and imipenem (90.9%) were all highly resistant against *A. baumannii*, and that imipenem was the most effective antibiotic. In comparison to wards where *Acb complex* was most abundant, ICU isolates showed the most resistance. Ciprofloxacin was the most sensitive medication in ICUs (69 percent), followed by imipenem (64 percent). Shakibaie et al 2012 discovered that numerous Acinetobacter species isolates were resistant to practically all antibiotics frequently used in their hospital's ICUs.) in our study. Acinetobacter appears to have a high proclivity for antibiotic resistance, possibly as a result of its lengthy evolutionary exposure to antibiotic-producing microbes in the soil environment. (24). The increased usage of antimicrobial drugs per patient and per surface area in ICUs has resulted in the rise of antibiotic-resistant bacteria. (18). The number of Acinetobacter species collected was highest from July to September, which is consistent with earlier observations. (25-27) The cause of this seasonality was linked to fluctuations in air temperature (high isolation rates especially in regions where temperature is hot and humid). Nonetheless, performing such prevalence and sensitivity testing on a regular basis is critical, as a result, it will aid clinicians will be able to better manage Acinetobacter infections.

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The current study was the design of Study in order to evaluate Acinetobacter strains by microbiological culture method, in addition, Moreover, the determination of Antibiotic Susceptibility Test "AST") were recorded and analyzed.

Acinetobacter, despite a century of research, remains an elusive opponent and a huge challenge for doctors. With increased rates of resistance and a dry pipeline targeting this organism, early administration of effective medication is vital, but it is extremely difficult to achieve. β-lactam antibiotics are the primary treatment when this pathogen is sensitive. Although it is unknown if combination regimens are effective, for XDR strains, particularly those with carbapenem MICs of 4 to 16 g/ml, combination carbapenem-polymyxin therapy is a reasonable option. Inhaled colistin is a reasonable alternative for isolated pulmonary illness caused by XDR strains in the absence of bacteremia. It delivers high amounts of medication while minimizing systemic exposure. Given our limited therapeutic choices, combating Acinetobacter infections will require a multidisciplinary approach that includes infection control, antimicrobial stewardship, and the collaboration of numerous health care providers. Additional research into new treatments has the potential to improve future outcomes. Meanwhile, we must figure out how to improve the efficacy of our present antimicrobials, possibly through combinational regimens and longer infusion, in order to address the Acinetobacter infection epidemic.

In conclusion, analysis of the antimicrobial susceptibility shows a different level of both types of resistance and susceptibility to the Amikacin, Gentamicin, Ampicillin/ Sulbactam, Ceftriaxone, Meropenem, Ciprofloxacin, Trimethoprim/ sulfamethoxazole, After the assessment of Acinetobacter strains and their virulence factors antimicrobial resistance. Routine checking and co-relation of the factors is recommended. These results would definitely help to clarify the pathogenicity and careful treatment of patients, thus minimizing the usage of antibiotics improperly.

Acinetobacter baumannii infections account for a significant portion of all nosocomial infections.

The majority of Acinetobacter baumannii infections were discovered in patients in Anesthesiology ICUs, Cardiology units and surgical wards, confirming the impact of recognized infection risk factors.

Colistin sensitivity is higher in Acinetobacter baumannii.

Acinetobacter baumannii's sensitivity to currently used antibiotics is rapidly declining.

The occurrence of Acinetobacter species among nonfermenters is high in hospital settings. Rationale use of antibiotics is important and necessary to prevent microbial resistance catastrophe. Definitive identification and characterization of ESBLs can only be confirmed by molecular techniques. However, these techniques are not available in all laboratories. Therefore, simple phenotypic methods can be used to recognize these enzymes. Resistant antibiotic after sensitivity report should be discontinued and in place a sensitive drug should be given. A continued awareness of the need to maintain good housekeeping and control of the environment, including equipment decontamination, strict attention to hand washing should undertake to control the spread of Acinetobacter in hospitals.

5.2. RECOMMENDATION

These results would definitely help to clarify the pathogenicity and careful treatment of patients with Acinetobacter species, thus reducing the usage of antibiotics improperly.

Moreover:

1. The randomly prescribing of antibiotics should be avoided.
2. For all patients who has Acinetobacter species, a culture examination should be done.
3. Randomly taking antibiotics by individuals should be avoided.
4. Sterilizing the medical equipment, using the gowns and gloves, (PPE).
5. Room Sanitation and Disinfection.
6. Alcohol- based hand sanitizer tend to kill bacteria less effectively than washing thoroughly with regular soap and water.
7. Complete elimination of Acinetobacter from the environment may require multiple bleach cleanings or no touch decontamination system such as hydrogen peroxide vapor.

REFERENCE

1.Glew RH, Moellering RC Jr, and Kunz LJ. 1977. Infections with Acinetobacter calcoaceticus (Herellea vaginicola): clinical and laboratory studies. *Medicine (Baltimore)*56:79–97.

1. Mindolli PB, Salmani MP, Vishwanath G, Hanumanthapa AR. Identifi cation and speciation of Acinetobacter and their antimimicrobial susceptibility testing. Al Ameen J Med Sci 2010;3:3459.

2.Daly AK, Postic B, and Kass EH. 1962. Infections due to organisms of the genus Herellea. B5W and B anitratum. *Arch Intern Med*110:580–591.

3.Al Atrouni A, Joly-Guillou ML, Hamze M, and Kempf M. 2016. Reservoirs of non-baumannii Acinetobacter species. *Front Microbiol*7:49.

1. Mindolli PB, Salmani MP, Vishwanath G, Hanumanthapa AR. Identifi cation and speciation of Acinetobacter and their antimimicrobial susceptibility testing. Al Ameen J Med Sci 2010;3:3459.

2. Winn WC, Allen SD, Janda WM, Koneman EW, Procop GW, Schreckenberger PC, et al. Taxonomy, biochemical characteristics and clinical signifi cance of medically important nonfermenters. In: Darcy P, Peterson N, editors. Koneman's Colour Atlas and Textbook of Diagnostic Microbiology. 6th ed. Philadelphia: LippincoJ̇ Williams and Wilkins; 2006. p. 353-5.

3. Oberoi A, Aggarwal A, Lal M. A decade of underestimated nosocomial pathogen-Acinetobacter in a tertiary care hospital in Punjab. JK Sci 2009;11:24-6.

4. Prashanth K, Badrinath S. In vitro susceptibility paJ̇ ern of Acinetobacter species to commonly used cephalosporins, quinolones, and aminoglycosides. Indian J Med Microbiol 2004;22:97-103.

5. Lone R, Shah A, Kadri SM, Lone S, Shah F. Nosocomial multidrug resistant Acinetobacter infections-clinical fi ndings, risk factors and demographic characteristics. Bangladesh J Med Microbiol 2009;03:34-8.

5. Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. Am J Infect Control. 2007;35(10 Suppl 2):S65-164.

6. WHO guidelines on hand hygiene in health care. Geneva: World Health Organization;2009(http://apps.who.int/iris/bitstream/10665/44102 /1/9789241597906_eng.pdf, accessed 26 October 2017).

7. Hand hygiene technical reference mannual. Geneva: World Health Organization; 2009

(http://www.who.int/infectionprevention/tools/handhygiene/evaluation_feedback/en/, accessed 26 October 2017).

6. Clinical and Laboratory Standards Institute. Performance Standards for Antimicrobial Susceptibility Testing; Seventeenth Informational Supplement. CLSI document M100-S17. Wayne, PA, USA: CLSI; 2007.

7. Sinha M, Srinivasa H, Macaden R. Antibiotic resistance profi le & extended spectrum beta-lactamase (ESBL) production in Acinetobacter species. Indian J Med Res 2007;126:63-7.

5. Robert Koch Institute (Germany). Infection control measures for infections or colonisation by multidrug-resistant gram-negative bacteria. 2012 (http://www.rki.de/DE/Content/Infekt/Krankenha ushygiene/Kommission/Downloads/Gramneg_Er reger.pdf?__blob=publicationFile, accessed 26 October 2017).

6. Ministry of Health, Welfare and Sport (Netherlands). Guidelines for multidrugresistant microorganisms (MDRO). 2013.

7. Public Health England. Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae. 2013 (https://www.gov.uk/government/publications/c arbapenemase-producing-enterobacteriaceaeearly-detection-management-and-controltoolkit-for-acute-trusts, accessed 26 October 2017).

8. Koneman EW, Allen SD, Janda WM, Schreckenberger PC, Winn WC. The nonfermentative gram negative bacilli. In: Allen A, Deitch S, editors. Colour Atlas and Textbook of Diagnostic Microbiology. 5th ed. Philadelphia: LippincoJ̇ -Raven Publishers; 1997. p. 253-309.

9. Baron EJ, Peterson LR, Finegold SM. Nonfermentative gram negative bacilli and coccobacilli. In: Shanahan JF, PoJ̇ s LM, Murphy C, editors. Bailey and ScoJ̇ 's Diagnostic Microbiology. 9th ed. St. Louis, Missouri: Mosby-Year Book; 1994. p. 386-4.

10. Lahiri KK, Mani NS, Purai SS. Acinetobacter spp as nosocomial pathogen: Clinical signifi cance and antimicrobial sensitivity. Med J Armed Forces India 2004;60:7-10.

11. Hejnar P, Kolár M, Hájek V. Characteristics of Acinetobacter strains (phenotype classification, antibiotic susceptibility and production of beta-lactamases) isolated from haemocultures from patients at the Teaching Hospital in Olomouc. Acta Univ Palacki Olomuc Fac Med 1999;142:73-7.

12. Gupta V. An update on newer beta-lactamases. Indian J Med Res 2007;126:417-27.

13. Fallon RJ, Young H. Neisseria, Moraxella, Acinetobacter. In: Collee JG, Fraser AG, Marimon BP, Simmons A, editors. Mackie & McCartney Practical Medical Microbiology. 14th ed. India: Elsevier; 2007. p. 294.

4.Dijkshoorn L and van der Toorn J. 1992. Acinetobacter species: which do we mean?*Clin Infect Dis*15:748–749.
5.Chang WN, Lu CH, Huang CR, and Chuang YC. 2000. Community-acquired Acinetobacter meningitis in adults. *Infection*28:395–397.

6.Visca P, Seifert H, and Towner KJ. 2011. Acinetobacter infection–an emerging threat to human health. *IUBMB Life*63:1048–1054.
7.Dortet L, Legrand P, Soussy CJ, and Cattoir V. 2006. Bacterial identification, clinical significance, and antimicrobial susceptibilities of Acinetobacter ursingii and Acinetobacter schindleri, two frequently misidentified opportunistic pathogens. *J Clin Microbiol*44:4471–4478.
8.Loubinoux J, Mihaila-Amrouche L, Le Fleche A, Pigne E, Huchon G, Grimont PA, and Bouvet A. 2003. Bacteremia caused by Acinetobacter ursingii. *J Clin Microbiol*41:1337–1338.
9.Endo S, Sasano M, Yano H, Inomata S, Ishibashi N, Aoyagi T, Hatta M, Gu Y, Yamada M, Tokuda K, Kitagawa M, Kunishima H, Hirakata Y, and Kaku M. 2012. IMP-1-producing carbapenem-resistant Acinetobacter ursingii from Japan. *J Antimicrob Chemother*67:2533–2534.

10.Chiu CH, Lee YT, Wang YC, Yin T, Kuo SC, Yang YS, Chen TL, Lin JC, Wang FD, and Fung CP. 2015. A retrospective study of the incidence, clinical characteristics, identification, and antimicrobial susceptibility of bacteremic isolates of Acinetobacter ursingii. *BMC Infect Dis*15:400.

11.Salzer HJ, Rolling T, Schmiedel S, Klupp EM, Lange C, and Seifert H. 2016. Severe community-acquired bloodstream infection with Acinetobacter ursingii in person who injects drugs. *Emerg Infect Dis*22:134–137.
12.Nemec A, Krizova L, Maixnerova M, Sedo O, Brisse S, and Higgins PG. 2015. Acinetobacter seifertii sp. nov., a member of the Acinetobacter calcoaceticus-Acinetobacter baumannii complex isolated from human clinical specimens. *Int J Syst Evol Microbiol*65:934–942.

13. Fallon RJ, Young H. Neisseria, Moraxella, Acinetobacter. In: Collee JG, Fraser AG, Marimon BP, Simmons A, editors. Mackie & McCartney Practical Medical Microbiology.

14th ed. India: Elsevier; 2007. p. 294. 14. Saha R, Jain S, Kaur IR. Metallo beta-lactamase producing Pseudomonas species — A major cause of concern among hospital associated urinary tract infection. J Indian Med Assoc 2010;108:344-8.

15. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug resistant, extensively drug resistant and pandrug resistant bacteria: An international expert proposal for interim standard defi nitions for acquired resistance. Clin Microbiol Infect 2012;18:268-81.

16. Adams-Haduch JM, Paterson DL, Sidjabat HE, Pasculle AW, Potoski BA, Muto CA, et al. Genetic basis of multidrug resistance in Acinetobacter baumannii clinical isolates at a tertiary medical center in Pennsylvania. Antimicrob Agents Chemother 2008;52:3837-43.

17. Pal RB, Kale VV. Acinetobacter calcoaceticus — An opportunistic pathogen. J Postgrad Med 1981;27:218-21.

18. Cisneros JM, Rodríguez-Baño J. Nosocomial bacteremia due to Acinetobacter baumannii: Epidemiology, clinical features and treatment. Clin Microbiol Infect 2002;8:687-93.

19. Seifert H, Strate A, Pulverer G. Nosocomial bacteremia due to Acinetobacter baumannii. Clinical features, epidemiology, and predictors of mortality. Medicine (Baltimore) 1995;74:340-9.

20. Rahbar M, Mehrgan H, Aliakbari NH. Prevalence of antibioticresistant Acinetobacter baumannii in a 1000-bed tertiary care hospital in Tehran, Iran. Indian J Pathol Microbiol 2010;53:290-3.

21. Shakibaie MR, Adeli S, Salehi MH. Antibiotic resistance paĴ erns and extended-spectrum β-lactamase production among Acinetobacter spp. isolated from an intensive care Unit of a hospital in Kerman, Iran. Antimicrob Resist Infect Control 2012;1:1.

22. Kansal R, Pandey A, Asthana AK. Beta-lactamase producing Acinetobacter species in hospitalized patients. Indian J Pathol Microbiol 2009;52:456-7.

23. Kumar AV, Pillai VS, Dinesh KR, Karim S. The phenotypic detection of carbapenemase in meropenem resistant Acinetobacter calcoaceticusbaumannii complex in a tertiary care hospital in south India. J Clin Diagn Res 2011;5:223-6.

24. Manchanda V, Sanchaita S, Singh N. Multidrug resistant Acinetobacter. J Glob Infect Dis 2010;2:291-304.

25. McDonald LC, Banerjee SN, Jarvis WR. Seasonal variation of Acinetobacter infections: 1987-1996. Nosocomial Infections Surveillance System. Clin Infect Dis 1999;29:1133-7.

26. Joshi SG, Litake GM, Satpute MG, Telang NV, Ghole VS, Niphadkar KB. Clinical and demographic features of infection caused by Acinetobacter species. Indian J Med Sci 2006;60:351-60.

27. Fournier PE, Richet H. The epidemiology and control of Acinetobacter baumannii in health care facilities. Clin Infect Dis 2006;42:692-9

13.Kishii K, Kikuchi K, Tomida J, Kawamura Y, Yoshida A, Okuzumi K, and Moriya K. 2016. The first cases of human bacteremia caused by Acinetobacter seifertii in Japan. *J Infect Chemother*22:342–345.
14.Yang Y, Wang J, Fu Y, Ruan Z, and Yu Y. 2016. Acinetobacter seifertii isolated from China: genomic sequence and molecular epidemiology analyses. *Medicine (Baltimore)*95:e2937.
15.Chusri S, Chongsuvivatwong V, Rivera JI, Silpapojakul K, Singkhamanan K, McNeil E, and Doi Y. 2014. Clinical outcomes of hospital-acquired infection with Acinetobacter nosocomialis and Acinetobacter pittii. *Antimicrob Agents Chemother*58:4172–4179.
16.Rafei R, Hamze M, Pailhories H, Eveillard M, Marsollier L, Joly-Guillou ML, Dabboussi F, and Kempf M. 2015. Extrahuman epidemiology of Acinetobacter baumannii in Lebanon. *Appl Environ Microbiol*81:2359–2367.
17. .Zhang WJ, Lu Z, Schwarz S, Zhang RM, Wang XM, Si W, Yu S, Chen L, and Liu S. 2013. Complete sequence of the bla(NDM-1)-carrying plasmid pNDM-AB from Acinetobacter baumannii of food animal origin. *J Antimicrob Chemother*68:1681–1682.

18.Lupo A, Vogt D, Seiffert SN, Endimiani A, and Perreten V. 2014. Antibiotic resistance and phylogenetic characterization of Acinetobacter baumannii strains isolated from commercial raw meat in Switzerland. *J Food Prot*77:1976–1981.

19.Berlau J, Aucken HM, Houang E, and Pitt TL. 1999. Isolation of Acinetobacter spp. including A. baumannii from vegetables: implications for hospital-acquired infections. *J Hosp Infect*42:201–204.
20. Rahbar M, Mehrgan H, Aliakbari NH. Prevalence of antibioticresistant Acinetobacter baumannii in a 1000-bed tertiary care hospital in Tehran, Iran. Indian J Pathol Microbiol 2010;53:290-3.
20.Seifert H, Dijkshoorn L, Gerner-Smidt P, Pelzer N, Tjernberg I, and Vaneechoutte M. 1997. Distribution of Acinetobacter species on human skin: comparison of phenotypic and genotypic identification methods. *J Clin Microbiol*35:2819–2825.
21.Patil JR and Chopade BA. 2001. Distribution and in vitro antimicrobial susceptibility of Acinetobacter species on the skin of healthy humans. *Natl Med J India*14:204–208.
21. Shakibaie MR, Adeli S, Salehi MH. Antibiotic resistance paĴ erns and extended-spectrum β-lactamase production among Acinetobacter spp. isolated from an intensive care Unit of a hospital in Kerman, Iran. Antimicrob Resist Infect Control 2012;1:1.
22.Berlau J, Aucken H, Malnick H, and Pitt T. 1999. Distribution of Acinetobacter species on skin of healthy humans. *Eur J Clin Microbiol Infect Dis*18:179–183.
23.Griffith ME, Ceremuga JM, Ellis MW, Guymon CH, Hospenthal DR, and Murray CK. 2006. Acinetobacter skin colonization of US Army soldiers. *Infect Control Hosp Epidemiol*27:659–661.
24.Spellberg B and Bonomo RA. 2014. The deadly impact of extreme drug resistance in Acinetobacter baumannii. *Crit Care Med*42:1289–1291.

24. Manchanda V, Sanchaita S, Singh N. Multidrug resistant Acinetobacter. J Glob Infect Dis 2010;2:291-304.
25.Maragakis LL and Perl TM. 2008. Acinetobacter baumannii: epidemiology, antimicrobial resistance, and treatment options. *Clin Infect Dis*46:1254–1263.
25. McDonald LC, Banerjee SN, Jarvis WR. Seasonal variation of Acinetobacter infections: 1987-1996. Nosocomial Infections Surveillance System. Clin Infect Dis 1999;29:1133-7.
26.Joly-Guillou ML. 2005. Clinical impact and pathogenicity of Acinetobacter. *Clin Microbiol Infect*11:868–873.
27.Sievert DM, Ricks P, Edwards JR, Schneider A, Patel J, Srinivasan A, Kallen A, Limbago B, and Fridkin S,National Healthcare Safety Network (NHSN) Team and Participating NHSN Facilities. 2013. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2009-2010. *Infect Control Hosp Epidemiol*34:1–14.

28.Rodriguez-Bano J, Cisneros JM, Fernandez-Cuenca F, Ribera A, Vila J, Pascual A, Martinez-Martinez L, Bou G, and Pachon J,Grupo de Estudio de Infeccion Hospitalaria (GEIH). 2004. Clinical features and epidemiology of Acinetobacter baumannii colonization and infection in Spanish hospitals. *Infect Control Hosp Epidemiol*25:819–824.
29.Agodi A, Auxilia F, Barchitta M, Brusaferro S, D'Alessandro D, Montagna MT, Orsi GB, Pasquarella C, Torregrossa V, Suetens C, and Mura I,GISIO. 2010. Building a benchmark through active surveillance of intensive care unit-acquired infections: the Italian network SPIN-UTI. *J Hosp Infect*74:258–265.
30.Martins AF, Kuchenbecker RS, Pilger KO, Pagano M, and Barth AL,CMCIES-PMPA/SMS Task Force. 2012. High endemic levels of multidrug-resistant Acinetobacter baumannii among hospitals in southern Brazil. *Am J Infect Control*40:108–112.

31.Labarca JA, Salles MJ, Seas C, and Guzman-Blanco M. 2016. Carbapenem resistance in Pseudomonas aeruginosa and Acinetobacter baumannii in the nosocomial setting in Latin America. *Crit Rev Microbiol*42:276–292.
32.Villar M, Cano ME, Gato E, Garnacho-Montero J, Miguel Cisneros J, Ruiz de Alegria C, Fernandez-Cuenca F, Martinez-Martinez L, Vila J, Pascual A, Tomas M, Bou G, and Rodriguez-Bano J,GEIH/GEMARA/REIPI-Ab20101 Group. 2014. Epidemiologic and clinical impact of Acinetobacter baumannii colonization and infection: a reappraisal. *Medicine (Baltimore)*93:202–210.

33.Gupta V, Datta P, and Chander J. 2006. Prevalence of metallo-beta lactamase (MBL) producing Pseudomonas spp. and Acinetobacter spp. in a tertiary care hospital in India. *J Infect*52:311–314.
34.Mathai AS, Oberoi A, Madhavan S, and Kaur P. 2012. Acinetobacter infections in a tertiary level intensive care unit in northern India: epidemiology, clinical profiles and outcomes. *J Infect Public Health*5:145–152.

35.Bali NK, Fomda BA, Bashir H, Zahoor D, Lone S, and Koul PA. 2013. Emergence of carbapenem-resistant Acinetobacter in a temperate north Indian State. *Br J Biomed Sci*70:156–160.
36.Shah S, Singhal T, and Naik R. 2015. A 4-year prospective study to determine the incidence and microbial etiology of surgical site infections at a private tertiary care hospital in Mumbai, India. *Am J Infect Control*43:59–62.
37.Golia S, Sangeetha KT, and Vasudha CL. 2013. Microbial profile of early and late onset ventilator associated pneumonia in the intensive care unit of a tertiary care hospital in Bangalore, India. *J Clin Diagn Res*7:2462–2466.
38.Ginawi I, Saleem M, Sigh M, Vaish AK, Ahmad I, Srivastava VK, and Abdullah AF. 2014. Hospital acquired infections among patients admitted in the medical and surgical wards of a non-teaching secondary care hospital in northern India. *J Clin Diagn Res*8:81–83.
39.Chung DR, Song JH, Kim SH, Thamlikitkul V, Huang SG, Wang H, So TM, Yasin RM, Hsueh PR, Carlos CC, Hsu LY, Buntaran L, Lalitha MK, Kim MJ, Choi JY, Kim SI, Ko KS, Kang CI, and Peck KR. 2011. High prevalence of multidrug-resistant nonfermenters in hospital-acquired pneumonia in Asia. *Am J Respir Crit Care Med*184:1409–1417.
40.Kuo SC, Chang SC, Wang HY, Lai JF, Chen PC, Shiau YR, Huang IW, and Lauderdale TL,TSAR Hospitals. 2012. Emergence of extensively drug-resistant Acinetobacter baumannii complex over 10 years: nationwide data from the Taiwan Surveillance of Antimicrobial Resistance (TSAR) program. *BMC Infect Dis*12:200.
41.Dejsirilert S, Tiengrim S, Sawanpanyalert P, Aswapokee N, and Malathum K. 2009. Antimicrobial resistance of Acinetobacter baumannii: six years of National Antimicrobial Resistance Surveillance Thailand (NARST) surveillance. *J Med Assoc Thai*92(Suppl 4):S34–S45.
42.Madani N, Rosenthal VD, Dendane T, Abidi K, Zeggwagh AA, and Abouqal R. 2009. Health-care associated infections rates, length of stay, and bacterial resistance in an intensive care unit of Morocco: findings of the International Nosocomial Infection Control Consortium (INICC). *Int Arch Med*2:29.

43.Luna CM, Rodriguez-Noriega E, Bavestrello L, and Guzman-Blanco M. 2014. Gram-negative infections in adult intensive care units of Latin America and the Caribbean. *Crit Care Res Pract*2014:480463.

44.Spellberg B and Rex JH. 2013. The value of single-pathogen antibacterial agents. *Nat Rev Drug Discov*12:963.
45.McDonald LC, Banerjee SN, and Jarvis WR. 1999. Seasonal variation of Acinetobacter infections: 1987-1996. Nosocomial Infections Surveillance System. *Clin Infect Dis*29:1133–1137.
46.Spellberg B and Bonomo RA. 2013. "Airborne assault": a new dimension in Acinetobacter baumannii transmission. *Crit Care Med*41:2042–2044.
47.Whitman TJ, Qasba SS, Timpone JG, Babel BS, Kasper MR, English JF, Sanders JW, Hujer KM, Hujer AM, Endimiani A, Eshoo MW, and Bonomo RA. 2008.

Occupational transmission of Acinetobacter baumannii from a United States serviceman wounded in Iraq to a health care worker. *Clin Infect Dis*47:439–443.
48. Munoz-Price LS, Fajardo-Aquino Y, Arheart KL, Cleary T, Depascale D, Pizano L, Namias N, Rivera JI, O'Hara JA, and Doi Y. 2013. Aerosolization of Acinetobacter baumannii in a trauma ICU. *Crit Care Med*41:1915–1918.
49. Rock C, Harris AD, Johnson JK, Bischoff WE, and Thom KA. 2015. Infrequent air contamination with Acinetobacter baumannii of air surrounding known colonized or infected patients. *Infect Control Hosp Epidemiol*36:830–832.
50. Freire MP, de Oliveira Garcia D, Garcia CP, Campagnari Bueno MF, Camargo CH, Magri AS, Francisco GR, Reghini R, Vieira MF, Ibrahim KY, Rossi F, Hajar L, Levin AS, Hoff PM, Pierrotti LC, and Abdala E. 2016. Bloodstream infection caused by extensively drug-resistant Acinetobacter baumannii in cancer patients: high mortality associated with delayed treatment rather than with the degree of neutropenia. *Clin Microbiol Infect*22:352–358.

51. Guan X, He L, Hu B, Hu J, Huang X, Lai G, Li Y, Liu Y, Ni Y, Qiu H, Shao Z, Shi Y, Wang M, Wang R, Wu D, Xie C, Xu Y, Yang F, Yu K, Yu Y, Zhang J, and Zhuo C,Chinese XDR Consensus Working Group. 2016. Laboratory diagnosis, clinical management and infection control of the infections caused by extensively drug resistant Gram-negative bacilli: a Chinese consensus statement. *Clin Microbiol Infect*22(Suppl 1):S15–S25.
52. Chopra T, Marchaim D, Johnson PC, Awali RA, Doshi H, Chalana I, Davis N, Zhao JJ, Pogue JM, Parmar S, and Kaye KS. 2014. Risk factors and outcomes for patients with bloodstream infection due to Acinetobacter baumannii-calcoaceticus complex. *Antimicrob Agents Chemother*58:4630–4635.

53. Chopra T, Marchaim D, Awali RA, Krishna A, Johnson P, Tansek R, Chaudary K, Lephart P, Slim J, Hothi J, Ahmed H, Pogue J, Zhao JJ, and Kaye KS. 2013. Epidemiology of bloodstream infection due to Acinetobacter baumannii and the impact of drug resistance to both carbapenems and ampicillin-sulbactam on clinical outcomes. *Antimicrob Agents Chemother*57:6270–6275.
54. Qiu H, KuoLee R, Harris G, and Chen W. 2009. High susceptibility to respiratory Acinetobacter baumannii infection in A/J mice is associated with a delay in early pulmonary recruitment of neutrophils. *Microbes Infect*11:946–955.
55. Luo G, Lin L, Ibrahim AS, Baquir B, Pantapalangkoor P, Bonomo RA, Doi Y, Adams MD, Russo TA, and Spellberg B. 2012. Active and passive immunization protects against lethal, extreme drug resistant-Acinetobacter baumannii infection.

56. Luo G, Spellberg B, Gebremariam T, Bolaris M, Lee H, Fu Y, French SW, and Ibrahim AS. 2012. Diabetic murine models for Acinetobacter baumannii infection. *J Antimicrob Chemother*67:1439–1445.
57. Jacobs AC, Hood I, Boyd KL, Olson PD, Morrison JM, Carson S, Sayood K, Iwen PC, Skaar EP, and Dunman PM. 2010. Inactivation of phospholipase D diminishes Acinetobacter baumannii pathogenesis. *Infect Immun*78:1952–1962.

58. Joly-Guillou ML, Wolff M, Pocidalo JJ, Walker F, and Carbon C. 1997. Use of a new mouse model of Acinetobacter baumannii pneumonia to evaluate the postantibiotic effect of imipenem. *Antimicrob Agents Chemother*41:345–351.

59. Lopez-Rojas R, Dominguez-Herrera J, McConnell MJ, Docobo-Perez F, Smani Y, Fernandez-Reyes M, Rivas L, and Pachon J. 2011. Impaired virulence and in vivo fitness of colistin-resistant Acinetobacter baumannii. *J Infect Dis*203:545–548.
60. McConnell MJ, Actis L, and Pachon J. 2013. Acinetobacter baumannii: human infections, factors contributing to pathogenesis and animal models. *FEMS Microbiol Rev*37:130–155.
61. Kim WY, Moon JY, Huh JW, Choi SH, Lim CM, Koh Y, Chong YP, and Hong SB. 2016. Comparable efficacy of tigecycline versus colistin therapy for multidrug-resistant and extensively drug-resistant Acinetobacter baumannii pneumonia in critically ill patients. *PLoS One*11:e0150642.
62. Ozvatan T, Akalin H, Sinirtas M, Ocakoglu G, Yilmaz E, Heper Y, Kelebek N, Iscimen R, and Kahveci F. 2016. Nosocomial Acinetobacter pneumonia: treatment and prognostic factors in 356 cases. *Respirology*21:363–369.
63. Henig O, Weber G, Hoshen MB, Paul M, German L, Neuberger A, Gluzman I, Berlin A, Shapira C, and Balicer RD. 2015. Risk factors for and impact of carbapenem-resistant Acinetobacter baumannii colonization and infection: matched case-control study. *Eur J Clin Microbiol Infect Dis*34:2063–2068.
64. Nutman A, Glick R, Temkin E, Hoshen M, Edgar R, Braun T, and Carmeli Y. 2014. A case-control study to identify predictors of 14-day mortality following carbapenem- resistant Acinetobacter baumannii bacteraemia. *Clin Microbiol Infect*20:O1028–O1034.

65. Ng TM, Teng CB, Lye DC, and Apisarnthanarak A. 2014. A multicenter case-case control study for risk factors and outcomes of extensively drug-resistant Acinetobacter baumannii bacteremia. *Infect Control Hosp Epidemiol*35:49–55.
66. Zheng YL, Wan YF, Zhou LY, Ye ML, Liu S, Xu CQ, He YQ, and Chen JH. 2013. Risk factors and mortality of patients with nosocomial carbapenem-resistant Acinetobacter baumannii pneumonia. *Am J Infect Control*41:e59–e63.
67. Arvaniti K, Lathyris D, Ruimy R, Haidich AB, Koulourida V, Nikolaidis P, Matamis D, and Miyakis S. 2012. The importance of colonization pressure in multiresistant Acinetobacter baumannii acquisition in a Greek intensive care unit. *Crit Care*16:R102.

68. Thompson MG, Black CC, Pavlicek RL, Honnold CL, Wise MC, Alamneh YA, Moon JK, Kessler JL, Si Y, Williams R, Yildirim S, Kirkup BC Jr, Green RK, Hall ER, Palys TJ, and Zurawski DV. 2014. Validation of a novel murine wound model of Acinetobacter baumannii infection. *Antimicrob Agents Chemother*58:1332–1342.

69. Lin L, Tan B, Pantapalangkoor P, Ho T, Baquir B, Tomaras A, Montgomery JI, Reilly U, Barbacci EG, Hujer K, Bonomo RA, Fernandez L, Hancock RE, Adams MD,

French SW, Buslon VS, and Spellberg B. 2012. Inhibition of LpxC protects mice from resistant Acinetobacter baumannii by modulating inflammation and enhancing phagocytosis. *mBio*3:e00312-12.
70. Bruhn KW, Pantapalangkoor P, Nielsen T, Tan B, Junus J, Hujer KM, Wright MS, Bonomo RA, Adams MD, Chen W, and Spellberg B. 2015. Host fate is rapidly determined by innate effector-microbial interactions during Acinetobacter baumannii bacteremia. *J Infect Dis*211:1296–1305.
71. Nielsen TB, Bruhn KW, Pantapalangkoor P, Junus JL, and Spellberg B. 2015. Cryopreservation of virulent Acinetobacter baumannii to reduce variability of in vivo studies. *BMC Microbiol*15:252.
72. Lin L, Pantapalangkoor P, Tan B, Bruhn KW, Ho T, Nielsen T, Skaar EP, Zhang Y, Bai R, Wang A, Doherty TM, and Spellberg B. 2014. Transferrin iron starvation therapy for lethal bacterial and fungal infections. *J Infect Dis*210:254–264.
73. Russo TA, Beanan JM, Olson R, MacDonald U, Luke NR, Gill SR, and Campagnari AA. 2008. Rat pneumonia and soft-tissue infection models for the study of Acinetobacter baumannii biology. *Infect Immun*76:3577–3586.

74. Russo TA, Luke NR, Beanan JM, Olson R, Sauberan SL, MacDonald U, Schultz LW, Umland TC, and Campagnari AA. 2010. The K1 capsular polysaccharide of Acinetobacter baumannii strain 307-0294 is a major virulence factor. *Infect Immun*78:3993–4000.
75. Peleg AY, Jara S, Monga D, Eliopoulos GM, Moellering RC Jr, and Mylonakis E. 2009. Galleria mellonella as a model system to study Acinetobacter baumannii pathogenesis and therapeutics. *Antimicrob Agents Chemother*53:2605–2609.
76. Gebhardt MJ, Gallagher LA, Jacobson RK, Usacheva EA, Peterson LR, Zurawski DV, and Shuman HA. 2015. Joint transcriptional control of virulence and resistance to antibiotic and environmental stress in Acinetobacter baumannii. *mBio*6:e01660-15.

77. Wand ME, Bock LJ, Turton JF, Nugent PG, and Sutton JM. 2012. Acinetobacter baumannii virulence is enhanced in Galleria mellonella following biofilm adaptation. *J Med Microbiol*61:470–477.
78. Vallejo JA, Beceiro A, Rumbo-Feal S, Rodriguez-Palero MJ, Russo TA, and Bou G. 9July2015. Optimisation of the Caenorhabditis elegans model for studying the pathogenesis of opportunistic Acinetobacter baumannii. *Int J Antimicrob Agents* doi:
79. Eijkelkamp BA, Stroeher UH, Hassan KA, Elbourne LD, Paulsen IT, and Brown MH. 2013. H-NS plays a role in expression of Acinetobacter baumannii virulence features. *Infect Immun*81:2574–2583.
80. Beceiro A, Moreno A, Fernandez N, Vallejo JA, Aranda J, Adler B, Harper M, Boyce JD, and Bou G. 2014. Biological cost of different mechanisms of colistin resistance and their impact on virulence in Acinetobacter baumannii. *Antimicrob Agents Chemother*58:518–526.

81. Bhuiyan MS, Ellett F, Murray GL, Kostoulias X, Cerqueira GM, Schulze KE, Mahamad Maifiah MH, Li J, Creek DJ, Lieschke GJ, and Peleg AY. 2016.

Acinetobacter baumannii phenylacetic acid metabolism influences infection outcome through a direct effect on neutrophil chemotaxis. *Proc Natl Acad Sci U S A*113:9599–9604.
82. Zimbler DL, Arivett BA, Beckett AC, Menke SM, and Actis LA. 2013. Functional features of TonB energy transduction systems of Acinetobacter baumannii. *Infect Immun*81:3382–3394.
83. Giannouli M, Antunes LC, Marchetti V, Triassi M, Visca P, and Zarrilli R. 2013. Virulence-related traits of epidemic Acinetobacter baumannii strains belonging to the international clonal lineages I-III and to the emerging genotypes ST25 and ST78. *BMC Infect Dis*13:282.
84. Lazaro-Diez M, Navascues-Lejarza T, Remuzgo-Martinez S, Navas J, Icardo JM, Acosta F, Martinez-Martinez L, and Ramos-Vivas J. 2016. Acinetobacter baumannii and A. pittii clinical isolates lack adherence and cytotoxicity to lung epithelial cells in vitro. *Microbes Infect*18:559–564.
85. de Breij A, Eveillard M, Dijkshoorn L, van den Broek PJ, Nibbering PH, and Joly-Guillou ML. 2012. Differences in Acinetobacter baumannii strains and host innate immune response determine morbidity and mortality in experimental pneumonia. *PLoS One*7:e30673.
86. Tayabali AF, Nguyen KC, Shwed PS, Crosthwait J, Coleman G, and Seligy VL. 2012. Comparison of the virulence potential of Acinetobacter strains from clinical and environmental sources. *PLoS One*7:e37024.
87. Jacobs AC, Thompson MG, Gebhardt M, Corey BW, Yildirim S, Shuman HA, and Zurawski DV. 2014. Genetic manipulation of Acinetobacter baumannii. *Curr Protoc Microbiol*35:6G.2.1–6G.2-11.
88. Biswas I. 2015. Genetic tools for manipulating Acinetobacter baumannii genome: an overview. *J Med Microbiol*64:657–669.

89. Wang N, Ozer EA, Mandel MJ, and Hauser AR. 2014. Genome-wide identification of Acinetobacter baumannii genes necessary for persistence in the lung. *mBio*5:e01163-14.

90. Subashchandrabose S, Smith S, DeOrnellas V, Crepin S, Kole M, Zahdeh C, and Mobley HL. 2016. Acinetobacter baumannii genes required for bacterial survival during bloodstream infection. *mSphere*1:e00013-15.

91.Gallagher LA, Ramage E, Weiss EJ, Radey M, Hayden HS, Held KG, Huse HK, Zurawski DV, Brittnacher MJ, and Manoil C. 2015. Resources for genetic and genomic analysis of emerging pathogen Acinetobacter baumannii. *J Bacteriol*197:2027–2035.
92. Knight D, Dimitrova DD, Rudin SD, Bonomo RA, and Rather PN. 2016. Mutations decreasing intrinsic beta-lactam resistance are linked to cell division in the nosocomial pathogen Acinetobacter baumannii. *Antimicrob Agents Chemother*60:3751–3758.
93. Clemmer KM, Bonomo RA, and Rather PN. 2011. Genetic analysis of surface motility in Acinetobacter baumannii. *Microbiology*157:2534–2544.

94. Smith MG, Des Etages SG, and Snyder M. 2004. Microbial synergy via an ethanol-triggered pathway. *Mol Cell Biol*24:3874–3884.

95. Nwugo CC, Arivett BA, Zimbler DL, Gaddy JA, Richards AM, and Actis LA. 2012. Effect of ethanol on differential protein production and expression of potential virulence functions in the opportunistic pathogen Acinetobacter baumannii. *PLoS One*7:e51936.

96. Aranda J, Bardina C, Beceiro A, Rumbo S, Cabral MP, Barbe J, and Bou G. 2011. Acinetobacter baumannii RecA protein in repair of DNA damage, antimicrobial resistance, general stress response, and virulence. *J Bacteriol*193:3740–3747.

97. Fournier PE and Richet H. 2006. The epidemiology and control of Acinetobacter baumannii in health care facilities. *Clin Infect Dis*42:692–699.

98. Houang ET, Sormunen RT, Lai L, Chan CY, and Leong AS. 1998. Effect of desiccation on the ultrastructural appearances of Acinetobacter baumannii and Acinetobacter lwoffii. *J Clin Pathol*51:786–788.

99. Wendt C, Dietze B, Dietz E, and Ruden H. 1997. Survival of Acinetobacter baumannii on dry surfaces. *J Clin Microbiol*35:1394–1397.

100. Schweppe DK, Harding C, Chavez JD, Wu X, Ramage E, Singh PK, Manoil C, and Bruce JE. 2015. Host-microbe protein interactions during bacterial infection. *Chem Biol*22:1521–1530.

101. Yoon EJ, Balloy V, Fiette L, Chignard M, Courvalin P, and Grillot-Courvalin C. 2016. Contribution of the Ade resistance-nodulation-cell division-type efflux pumps to fitness and pathogenesis of Acinetobacter baumannii. *mBio*7:e00697-16.

102. Bonomo RA and Szabo D. 2006. Mechanisms of multidrug resistance in Acinetobacter species and Pseudomonas aeruginosa. *Clin Infect Dis*43(Suppl 2):S49–S56.

103. Richmond GE, Evans LP, Anderson MJ, Wand ME, Bonney LC, Ivens A, Chua KL, Webber MA, Sutton JM, Peterson ML, and Piddock LJ. 2016. The Acinetobacter baumannii two-component system AdeRS regulates genes required for multidrug efflux, biofilm formation, and virulence in a strain-specific manner. *mBio*7:e00430-16.

104. Luke NR, Sauberan SL, Russo TA, Beanan JM, Olson R, Loehfelm TW, Cox AD, St Michael F, Vinogradov EV, and Campagnari AA. 2010. Identification and characterization of a glycosyltransferase involved in Acinetobacter baumannii lipopolysaccharide core biosynthesis. *Infect Immun*78:2017–2023.

105.Gupta, N., Gandham, N., Jadhav, S., & Mishra, R. N. (2015). Isolation and identification of Acinetobacter species with special reference to antibiotic

resistance. *Journal of Natural Science, Biology and Medicine*, *6*(1), 159–162. https://doi.org/10.4103/0976-9668.149116

106. Sieniawski, K., Kaczka, K., Rucinska, M., Gagis, L., & Pomorski, L. (2013). Acinetobacter baumannii nosocomial infections. *Polski Przeglad Chirurgiczny/ Polish Journal of Surgery*, *85*(9), 483–490. https://doi.org/10.2478/pjs-2013-0075

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Education And Qualifications.				
University\ College	**Department**	**Degree**	**Country**	**year**
KingEdward Medical University, Lahore, Pakistan	**Medical Laboratory Technology**	**Bachelor (B.Sc. Hons)**	**Pakistan**	**2009-2013**
Near East University / Faculty of Medicine	**Medical and Clinical microbiology**	**Master (M.Sc.)**	**Cyprus**	**2019-2021**

Masters Thesis	
Title:	**Bacteriological and Clinical Characteristics of Acinetobacter species isolated from Clinical Samples In Near East Univeristy Hospital.**

Supervisor:	Prof. Dr. Nedim Çakır

Job Experience

Duty	Place	Duration
Medical Laboratory Technologist	Somali Turkish Hospital, Ex-Digfeer Somalia	2015-2016
Working in Laboratory	PIMS Hospital Pakistan	2014-2015
Medical Laboratory Technology	Oman Hospital	2017-2018

Courses and Certificate

Name	Name of the Institution where take place	Year
Microbiology Laboratory Practical Training	Near East University, North Cyprus	2020
Rare Disease Day Symposium in Health Certificate (Attendance)	Faculty of Medicine, PIMS Hospital Pakistan	2014

Computer Knowledge

Program	Use proficiency
SPSS	Good
Python Programming Language	Good

Common Computer Programs and Skills	Excellent

Other languages

Languages	Speaking	Writing	Reading
Arabic	Excellent	Excellent	Excellent
English	Excellent	Excellent	Excellent
Turkish	Good	Good	Good

Annexure-B

Antimicrobial Susceptibility:

Organism Identified:

_____

	Antimicrobial Sensitivity Profile		
Antibiotics	**S**	**I**	**R**
Amikacin (AK)			
Imipenem (IPM)			
Ceftazidime (CAZ)			
Ceftriaxone (CRO)			
Tobramycin (TOB)			
Levofloxacin (LEV)			
Ciprofloxacin (CIP)			
Piperacillin+Tazobactam (TZP)			
Cefepime (FEP)			
Cefoperazone+Sulbactam (SCF)			
Piperacillin (PRL)			

Colistin (CL)	

Annexure-A

Near East University Hospital (NEU), North Cyprus Turkey

"Bacteriological and Clinical Characteristics of *Acinetobacter Species* Isolated from Clinical Samples in Near East University Hospital"

PROFORMA

Serial #: _____ **Lab#: _____**

PCN #: _____

Age/Gender: _____ **Ward: _____**

Address: _____ **Marital status: _____**

Specimen Type: _____

Date of Sample Collection: _____

Time of Specimen Collection: _____

DOA: _____ **DOD: _____**

Duration of stay in Hospital at time of sampling: _____

Results: _____ **Organism Identified: _____**