"STUDY OF RISK FACTORS AND CLINICAL PROFILE OF PATIENTS WITH ACINETOBACTER BAUMANNII INFECTION ADMITTED IN MEDICAL INTENSIVE CARE UNIT OF TERTIARY CARE HOSPITAL BELAGAVI. A ONE YEAR CROSS-SECTIONAL STUDY"

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LIST OF ABBREVIATIONS USED

AB	AcinetobacterBaumannii
HAI	Hospital-Acquired Infection
ICU	Intensive Care Unit
lkkmMICU	Medical Intensive Care Unit
MDR	Multi Drug-Resistant
PDR	Pan Drug-Resistant
ET	Endotracheal Tube
VAP	VentilatorAssosciated Pneumonia
CR	carbapenem-resistant
MRSA	Methicillin-resistant Staphylococcus Aureus
HCAI	Healthcare-Associated Infection
BSI	Bloodstream Infection
CRBSI	Catheter-Related Bloodstream Infection
UTI	Urinary Tract Infection

ABSTRACT

TITLE:STUDY OF RISK FACTORS AND CLINICAL PROFILE OF PATIENTS WITH ACINETOBACTER BAUMANNII INFECTION ADMITTED IN MEDICAL INTENSIVE CARE UNIT OF TERTIARY CARE HOSPITAL BELAGAVI. A ONE YEAR CROSS-SECTIONAL STUDY

INTRODUCTION:AcinetobacterBaumannii(AB) is now largely regarded as one of the most troublesome pathogens and is responsible for several types of HAI including ventilator-associated pneumonia(VAP), bacteremia, Urinary tract infections, Skin, and soft tissue/surgical site infections.Information is limited regarding the epidemiology, risk factors, resistance pattern, and outcomes of patients with AB in developing countries likeIndia. Therefore, we designed the present study to investigate the risk factors, infection trend, and resistance pattern of AB in ICU patients, which might be beneficial for providing support for future management in ICU clinical practice.

AIMS AND OBJECTIVES: To investigate the risk factors and clinical profile of patients with AB infection admitted in Medical ICU and also to study the risk factors associated with multidrug-resistant AB(MDR-AB).

METHODS: This cross-sectional study was done on patients who acquired fever 48 hours after admission to the medical ICU. Based on the culture report, the research participants were classified into AB group and NON-AB based on organisms grown in the culture media. Microbiological data, history,examination findings, investigations, and all other information needed wereobtained and compared between two groups to assess the risk factors, clinical profile and resistance pattern of AB.

RESULTS:Among 260 patients, 29.2% belong to the AB group. AB infection wascommonly seen among patients with comorbidities, prior carbapenem use, bedridden status, and patients who have undergone multiple invasive procedures but the increase is not statistically significant when compared to NON-AB group. There is also no significant increase in Co-infection and mortality in the ABgroup.

Pandrug-resistance(PDR-AB) was commonly seen amongAB(47.3%) and Klebsiella(16.2%) infected patients.Among AB group, about $3/4^{th}$ of cases(76%) who has undergone multiple procedures, 60.2% patients with prior history of antibiotic usage(≥2) and 70% of patients with VAP had developed PDR AB. Majority of them(92.8%) attained mortality.

CONCLUSION: In our cross-sectional study, We have observed that there is no statistically significant association between AB and NON-AB group with respect to demographic features, risk factors,and outcomes of patients.Hence it is concluded that AB is mainlya colonizing agent rather than an infectious agent.

Among AB cases, PDR- AB was most commonly seen in patients with a history of multiple antibiotic uses, multiple invasive procedures, and in patients with VAP. Poor outcome was seen among these patients with 93% mortality.

KEYWORDS:AcinetobacterBaumannii, Hospital Acquired infection, Ventilator-associated pneumonia, Central line-related bloodstream infection.

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INTRODUCTION

Modern medicine and the technology involvedinmedical care have grown leaps and bounds over the last few decades, there is a huge transformation in the ways of practicing medicine. Due to this, the increase in life expectancy has also increased, many diseases that were considered difficult to treat are easily treatable and even curable now, which has led to patients recovering more and leading a good and productive life.

However, the advent of newer treatments have given rise to the emergence and re-emergence of new organisms, some of the organisms have adapted to their new atmosphere. Many of the organisms have rapidly developed resistance to new antibiotics. One such organism is Acinetobacterbaumannii (AB), it is a Gram-negative, lactose non-fermenting,Cocco-bacilli. The AB survives in environments of the hospital, and it is progressively becoming a troublesome problem among Hospital Acquired Infections (HAI), and it is being observed worldwide.

AB is one of the major pathogens causing various HAI including ventilator-associated pneumonia(VAP), bacteremia, urinary tract infections, skin, and soft tissue/surgical site infections.

AB is recognized throughout the globe as one of the main pathogens causing nosocomial infections, usually seen in patients who are critically ill, it causes severe infections in intensive care units (ICUs). Many studies have shown that Acinetobacter infections represent 7.9% of VAPandbloodstream infections ranging from 5.7 to 15.7% in the ICUs.[(1)(2)]

Due to the number of studies conducted a good amountofinformationand data is available about AB in terms of its epidemiology, range of risk factors, and information about the outcome of AB infected patients. However, the drug resistance pattern of AB shows a significant regional difference.

There is a constant increase in reports of multidrug-resistantAB (MDR-AB), in ICU patients. MDR AB infections are usually very difficult to identify and treat, they also lead to increased mortality and duration of hospital stay[3]

One of the studiesshowedthat the mortality rate of bloodstream associated infections caused by MDR AB for a period of the 30-day hospital was 55.2% in geriatric age group inpatients.[4]

Every year there is a Carbapenem-resistant rate increase. There is also evidence that in some hospital ICU there is an emergence of carbapenem-resistant (CR) AB. It is common in a hospital setting where Cross-transmission of MDR-AB occurs, resulting in infection outbreaks in ICU and neonatal wards usually leading to poor outcomes, including an independent cause of mortality and complications. [3]

In developing countries, there is limited study on risk factors for Multidrug-Resistant(MDR-AB) in ICU patients. The Prognosis of a patient is drastically reduced when there is a development of an ICU associated infection with multidrug-resistance. All over the world, there is an increase in the occurrence of HAIs and device-associated infections, which adversely affects the patient outcome.

The need to study the mechanisms and to prevent these infections is important, mainlyto assess the management of these affected patients. There is limited data in

India aboutAB infection, antibiotic susceptibility pattern, and their outcome associated with mortality or morbidity is needed.

Therefore, the present study was undertaken to know the risk factors and clinical profile in patients infected with MDR-AB in ICU patients, which might be beneficial for future management in ICU patients.

AIMS AND OBJECTIVES

1. To investigate the risk factors and clinical profile of patients with AB infection admitted in MICU.
2. To study the risk factors associated with MDR-AB.

REVIEW OFLITERATURE

NOSOCOMIAL INFECTIONS

DEFINITION:

Out of multiple problems in hospitals, the main problems in the critical care unit are Infections which have a high incidence,they also pose serious problems for the hospitals. Nosocomial infections are generally defined as the Infections acquired during the hospital stay,earlieris known as infection acquiring 48 hours afteradmission to the hospital. (1)

The definition given by the National NosocomialInfectionsSurveillancesystem is “it is a localized or systemic condition that results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) that was not present or incubating at the time of admission to the hospital” (5)

It is also defined by WHOas “infections that occur within 48 hours after hospital admission, 3 days after discharge or 30 days after an operation”.

These are opportunistic infections, and microorganisms that usually cause these kinds of infections are usually low virulent and can cause infection in admitted patients with impaired immune mechanisms. There is an increase in morbidity and mortality in patients infected with drug-resistant organisms. Typically, HAIs are exogenous, can be acquired from people like doctor or staff, orhospitalenvironment including objects, water, food, and circulating air in the hospital.(2)

There are many factors which usually increase the risk of antibiotic resistance are poor selection and utilization of antimicrobial agents, patient to patient

transmission of resistant bacteria and transmission from health care team members to patients, poor adherence or lack of proper guidelines for judicious use of antimicrobial medicines and poor auditing tools for restriction or misuse of antimicrobial medicines in the animal industry and many same agents are used in humans.(7)

Moreover, they significantly induce heavy costs on the health care system, hospitals, and patients, due to an increase in the hospitalization time, and they also increase the morbidity and mortality. There are many risk factors for HAIs including Diabetes mellitus, patients on mechanical ventilation,use of surgical drains, impaired immune status, poor nursing care, irregular and inappropriate wound management in ICUs, usually,account for ≤10% of total beds in mosthospitals, greater than 20% of all HAIs are linked to ICUs.(8)

Many articles mentioned the most common micro-organisms EColi (10,073/44%), next was by Klebsiellapneumonia (4,709/20%), P aeruginosa (4,287/18.7%), MRSA (1,216/5.4%), Acinetobacter (1,061/5%), with C. difficile and Enterococcus representing less than 1%.(7)

The frequently encountered infections (urinary, respiratory, and surgical site) were most commonly present in elderlypatients with the use of the invasive device in the Medical ICUs.(9)

EPIDEMIOLOGY

The European Centre for Disease Prevention and Control, ECDC reported that approximately 4,131,000 patients are infected by about 4,544,100 episodes of HCAI (Nosocomial infections) every year in Europe, with a mean HCAI prevalence of 7.1%.[10]

The HCAI incidence in the USA is estimated to be 4-5% in 2002, corresponding to 93 infections /1000 patient-days and 1.7 million affected patients.[11]

According to a study which was multicentric conductedin Europe, the percentage of patientsinfected in the ICU can be up to51%; the majority of these are healthcare-associated. [12]In high-income countries, about 30% of ICU patients have at least one episode of HCAI with considerable morbidity and mortality.HCAI incidence went from 13.0 to 20.3 episodes per 1000 patient-days cumulative incidence was 17.0 episodes per 1000 patient-days in adult patients with high-risk in high-income countries.[13]

A higher frequency of infections is seen with the use of invasive devices, particularly ventilators, centrallines, andurinary catheters.USA NNIS system reported that about 83% of episodes of HAPwere related with mechanical ventilation, 97% of UTIs were seen in catheterized patients, and 87% of primary BSI were seen in patients having a central line.[14]

In studies conducted in countries like France, Germany, and Italy, the frequently pathogens causing infection in ICU settings were Staphylococcus aureus(21 8%); enterobacteriaceae (20.2%); Pseudomonas spp(17.2%); enterococci (10.0%); Escherichia coli (9.1%); Candida spp (8.8%); coagulase-negative staphylococci (7.0%); and Acinetobacterspp (5.1%).[15][16]

INDIAN SCENARIO

The International Nosocomial Infection Control Consortium(INICC)conducted a study where it was noted that nosocomial infections in Indian hospitals were higher than the CDC statistics(Centre for Disease Control and Prevention).[17]

Many of the factors seem to influence the nosocomial infections in India, mainly poor infrastructure with Overcrowded hospitals, poor standards of basic hygiene, healthcare professionals to patient ratio is low, invasive devices are used inappropriately and unscientific way of using antibiotics, and poor rules implementationleads to nosocomial infections-associated mortality in India. The prevalence of nosocomial infections in India remains high. In one of the studiesbyAkula S et al in Hyderabad, it was found that 143 strains of Acinetobacter were present in a tertiary health center in India, of which, 126 i.e 88.1% were extremely drug-resistant.[13]

Another study carried out in north India in a burn unit of a tertiary care referral center the infection density was reported to be 36.2 infections per 1000 patient-days[19]

AB have emerged as important organisms causing infections in invasive diagnostics or therapeutic procedures adopted in ICUs in the last decade,It is now recognized as a major pathogen involved in nosocomial infections causing outbreaks or endemic occurrence with high mortality rates.[20]

DEFINITIONS OF ALL NOSOCOMIAL INFECTIONS

Primary bloodstream infection (BSI):A Laboratory Confirmed Bloodstream Infection (LCBI) that is not secondary to an infection at another body site

1. Secondary BSI: A BSI that is thought to be seeded from a site-specific infection at another body site
2. Central line-associated BSI (CLABSI): A laboratory-confirmed bloodstream infection where an eligible BSI organism is identified and an eligible central line is present in the patients with LCBI.

Catheter-Associated Urinary Tract Infections

"A catheter-associated urinary tract infection is a UTI that occurs in a patient who had an indwelling urethral urinary catheter in place within 48 hours before the onset of the UTI. If the UTI develops in a patient within 48 hours of discharge from a location, indicate the discharging location on the infection report, not the current location of the patient".[21]

SURGICALSITE INFECTIONS

"Surgical site infections (SSIs) are infections of the incision or organ or space that occur after surgery". [22]

CATHETER-RELATED BLOODSTREAM INFECTIONS(CRBSIS):

DEFINITION:

Catheter-related bloodstream infection (CRBSI) is defined as "the presence of bacteremia originating from an intravenous catheter". [23]

Central-venous-catheter-related bloodstream infections (CRBSIs) are an important cause of nosocomial infection associated with morbidity and mortality. They are also a common source of bacteremia and septicemia in admitted patients. Most of the CRBSIs are associated with central venous catheters and some prospective studies mentioned that "the relative risk for CRBSI is up to 64 times more with CVCs than with peripheral venous catheters".[23]

RISK FACTORS AND EPIDEMIOLOGY AND PREVENTION

CRBSI is the most important adverse effect of central venous catheterization which is commonly associated with high morbidity and increases the expense of treatment. It most commonly causes nosocomial bacteremia.Multiple studies have shownevidence that CRBSI can be reduced. CRBSI is seen in about 3% of central venous catheterization, the incidence range upto16%.[24][22]

It is around 2–30 episodes\1000 catheter days. The origin of the CRBSI can be from peripheral intravenous access orintra-arterial cannulae. A similar incidence was seen with pulmonary artery catheters and catheters of dialysis have a higher rate of around 29%.

Based on the following parameter CRBSIs are diagnosed:

a) The presence of a CVC;

b) Signs of catheter insertion site infection

c) Clinical symptoms and signs of bacteremia;

d) Resolution of the symptoms and signs of bacteremia after removal of the suspect CVC;

e) Positive blood culture; and

f) Growth of the same organism from the catheter.[24]

Pathogenesis of catheter-related bloodstream infections

Several factors have been involved in the pathogenesis of CRBSI. The catheter itself can be related to four different pathogenic pathways like

1. colonization of tip of the catheter and cutaneous tract with skin flora
2. colonization of the catheter lumen caused by contamination
3. haematogenous seeding of the catheter from another infected site and
4. Contamination of the lumen of the catheter with an infective agent.

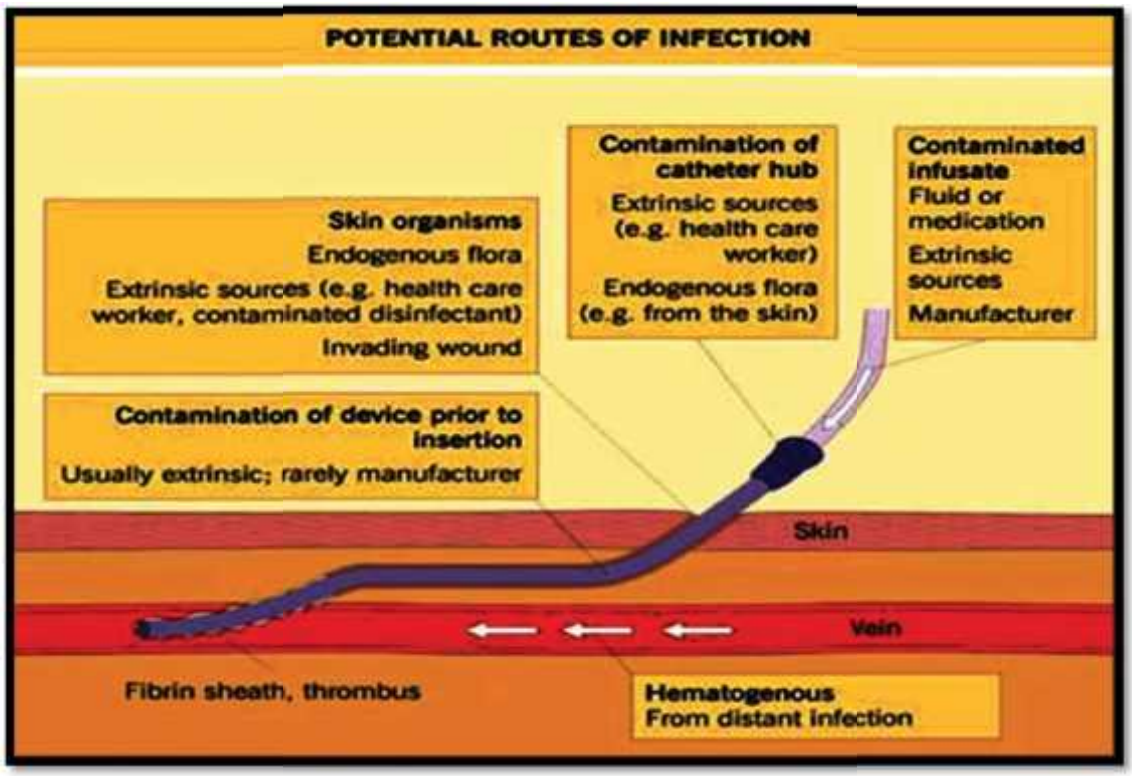


Figure 3.1 depicts the factors involved in the pathogenesis of CRBSI[23]

PREVENTION OF CATHETER-RELATED BLOODSTREAM INFECTION

Selection of cathetertype

- Use a single-lumen catheter
- Using an implantable catheter for long term (>30 days) use
- Using antimicrobial impregnated catheter for high-risk patients
- Using the subclavian route
- Strict aseptic precautions
- Thorough Cleaning of the site of insertion with alcoholic chlorhexidinegluconate solution.
- Guidewire exchange is can be only used for faulty catheters in case of absence if evidence of infection.[26]

VENTILATOR-ASSOCIATED PNEUMONIA

"Ventilator-associated pneumonia (VAP) is one of the types of infection leading to pneumonia. It generally is seen in patients who are put on mechanical ventilation.[27]

VAP is generally acquired by the patient in Hospital setting approximately between the second and third days,i.e 48 t o72 hours after initiating mechanical ventilation. Improving the gas exchange capacity without causing trauma or compromise to the lungs is the main aim of mechanical ventilation. The stress and strain developed in the lung due to mechanical ventilation can harm the lungs,Barotrauma and volume trauma to the lungs is caused due to the high pressure and volume, biotrauma and atelectasis follow later. According to the International Nosocomial Infection Control Consortium (INICC), the overall rate of VAP is 13.6 per 1,000 ventilator days".[25]

There are variations observed in incidence rate with respect to patient group and hospital environment. The incidence of VAP ranges from 13–51\1,000 ventilation days.[29]

The cost of management is increased byVAP as it increases the stay in the ICU and it can be divided into two types based on the time of onset of VAP.

Early-onset VAP

"Early-onset VAP occurs during the initial 96 hours or 4 days of initiationof mechanical ventilation and antibiotic sensitive bacteria usually causesit".

Late-onset VAP

"Late-onset VAP develops after five or more days after initiating the mechanicalventilationandgenerally it is caused by multidrug-resistant (MDR) pathogens." [27]

If the diagnosis of VAP is made early the emergence of resistant organisms can be prevented with appropriate antibiotic therapy

DIAGNOSIS

Criteria for the diagnosis of VAP is based on medical history and clinical examination. Chest radiograph and systemic signs of infection can be done to determine the infection clinically.lung parenchymal involvement and the presence of any pleural effusion or cavitation can be noted in the chest radiograph. The systemic signs are fever, leucocytosis, tachycardia, and some non-specific signs like the release of cytokines.

A temperature greater than 38^{o} C is an indication that a patient is developing VAP. Similarly, a leukocyte count of more than 11,000 cells/cu mm or less than 5,000/cu mm can help in diagnosis.

CLINICAL PULMONARY INFECTION SCORE (**CPIS SCORE)**

Pugin et al. presented the clinical pulmonary infection score (CPIS), which has different variableslike :

1. Temperature,
2. Total WBC count,
3. Volume and purulence of tracheal secretions,
4. Oxygenation, chest roentgenogram,

Semi-quantitative analysis of the ETA, with gram stain[31]

CPIS ranges from a score of 0 to 12. Patients with CPIS greater thanthe score of six were taken to be having pneumonia. [29]

A study conducted by Papzainand et al. further found out andconcluded that CPIS ≥6 had sensitivity ranging from 72– 85 percent and specificity ranging from 85–91 percent [33]

PATHOPHYSIOLOGY

Patient care can be improved and better quality care can be given by understanding the mechanisms responsible for the acquirement of VAP. The Endotracheal tube plays a very important role in the development of a VAP, the mechanism behind it is mucociliary clearance of secretions is impaired the ET tube also irritates the mucosa which in turn leads to increased quantities of respiratory secretions which stagnate.

The major aspirations in the trachea can be prevented by the cuff of the ET tube, but the sealing is usually not perfect and there will be some escape of the secretions from the sides of the cuff which in turn leads to micro-aspirations.

Due to the gravity, the secretions and micro aspirations form a nidus for infection in the dependent portions of the lung.[31]

Foreign bodies any get adhered to the biofilm and then there may be colonization by the pathogenic organism the biofilm that is formed of various protein, polysaccharides, serve as a barrier between the host and the microbes [35]

The risk of infection is thus increased and facilitates the growth of the organisms. Antibiotic resistanceis also increased by this mechanism, also there is a complex interaction between organisms,the antibiotic action on it directly is also decreased by this mechanism due to their inability to act directly on the organism.[36]

Since gram-negative organisms produce most of the biofilms, they are considered as most common etiological agents for VAP.[34]

The course of the disease is determined by the balance between host-microbe interaction.

Clinical significance

VAPs have increased mortality, in which the attributable mortality is around 10%. [35].

The increased mortality occurs as a result of increased ICUstay and severity of the underlying illness. The duration of stay in hospital in VAP was around 2.03 days.[39]

In India, most of the patients individually bear the financial burden. The causative organism of VAP was found to be an independent cause of mortality, with the highest risk from organisms like Acinetobacter species,Pseudomonas, and Xanthomonasmaltophilathey are associated with a mortalityof about 65 %.[40]

The increasedmultidrug-resistant organisms and also mortality and the increased duration of stay in hospitals and the cost of healthcare make the early identification,prevention, and treatment the highest priority in the ICU setting.

DEFINITIONS OF DRUG RESISTANCE:

- MDR (Multidrug-resistance): The isolate is non-susceptible to at least one agent in at least three antimicrobial categories.

- PDR (Pandrug-resistant): Non-susceptible to all antimicrobial agents listed. antimicrobial categories.

- The antimicrobial classes are:

1. Aminoglycosides,
2. Carbapenems,
3. Fluoroquinolones,
4. Antipseudomonalpenicillins + beta-lactamase inhibitors,
5. Extended-spectrum cephalosporins,
6. Folate pathway inhibitors,
7. Penicillins + b-lactamase inhibitors,
8. Polymyxins (Polymixin B and colistin),
9. Tetracyclines

- Carbapenem-susceptible AB (CS-AB) was defined as" MIC ≤ 2 μg/mL for imipenem or meropenem"

- Carbapenem-resistant AB (CR-AB)was defined as "MIC ≥ 8 μg/mL for imipenem or meropenem."

Comorbidities refer to coronary heart disease, diabetes, hypertension, chronic renal insufficiency, cancer, cerebral infarction

Previous use of antibiotic agents was considered, if antibiotic therapy had been adopted for more than 3 consecutive days within 30 days before the collection of the first blood specimen for culture.

Invasive procedures refers to mechanical ventilation, tracheotomy,arteriovenous catheter, nasal feeding,abdominal puncture, indwelling catheter,etc.[41]

STRUCTURE OF AB

AB is a Gram-negative bacillus that is aerobic, pleomorphic, and non-motile. Nonfermenting, non-motile,non-fastidious, catalase-positive and oxidase-negative bacteria. In the Genus there are about 26 named species and nine genomic species, A. Calcoascetics complex are those which are medically important. AB is the most widespread and medically important pathogen.The natural habitat of the Acinetobacter genus is found to be ubiquitous as it is isolated from various environments, it is also found in most of the samples of soil and water. In its pathogenic capacity, it usually is found in mucous membranes, it has an ability of biofilms formation over surfaces of invasive devices used in diagnostic and therapeutic devices used in intensive care makes the chronically ill patients in ICU asthe target of this organism.[42]

It can survive despite weeks of contact to dry hostile environments without losing its virulence, this property makes it a potentially dangerous pathogen, if it gains entry into a setting with critically ill patients, like ICUs, the spread through, health care workers and fomites can have increased morbidity and mortality.[43]

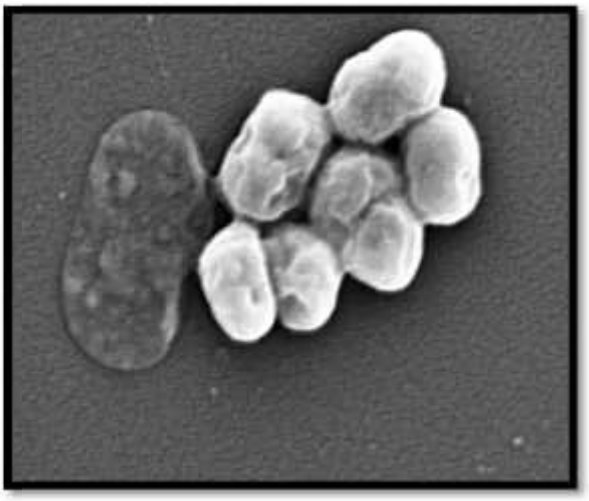


Figure 3.2 Image of A.baumannii visualized under an electron microscope

Acinetobacter was frequently wrongly identified as it lacked distinguishing features. Earlier Acinetobacter was generally identified by the absence of certain characteristics such as the absence of color, nonmotile, non-nitrate-reducing, and nonfermenting. The lack of distinctive characteristics was a driving force in the evolving nomenclature of the day Micrococcus (small), Mima (mimics), Achromobacter (colorless), Acinetobacter (motionless), and non-nitrate-reducing.The first recognizable member of the group to be described as the soil organism isolated by Beijerinck in 1911.[(44)]

The habitat of the organism varies widely, the Acinetobacter species are found in soil surfaces,etc, in the environment, and in the hospital, they are present in a variety of objects such as Ventilators, humidifiers, catheters. Acinetobacter species also colonize the skin in about 25% of adults about 7% carry the organism in their pharynx.

The patients in hospitals may become easily colonized by the organism, many of the patients already harbor the organisms, and thus their isolation may be insignificant when isolated from urine, feces, vaginal secretions, and many different

types of respiratory specimens. As many as 45% of tracheostomy sites may be colonized.(45)

In recent years, in intensive care or high dependency units these antibiotic-resistant strains pathogens are involved in the outbreaks of hospital infection, these organisms have been isolated from a wide range of clinical specimens, including tracheal aspirates, blood cultures, cerebrospinal fluid and pus. (46)

Acinetobacter is short, plump, gram-negative bacilli, typically 1-1.5 µmx 1.52.5µm in the exponential phase of growth, but becoming more coccoid (0.6-0.8µm x 1-1.5 µm) in the stationary phase.in the stationary phase, Apparent diplococci with bipolar staining are seen but while growing exponentially chains of cells may be observed members of the genus are non-motile, although twitching motility has been described by Lautrop (1961). Fimbriae are often present and many strains are capsulate.(46)

The Nosocomial urinary tract infection due to AB occurs mostly in elderly patients, who are confined to ICUs, and in patients who needs urinary catheters permanently. Most of them are male patients.(47)

Respiratory infections account for 3-5% of nosocomial pneumonia. They play a special role in nosocomial pneumonia for the subset of ICU (Intensive Care Unit) patients with Bacteremia,which might be caused by Acinetobacter alone or as a part of polymicrobial bacteremia. AB is the most common species in most adult patients.(48)

Other infections such as meningitis, endocarditis,wound and skin infections, peritonitis, and urinary tract infections may be seen and Sporadic cases of

conjunctivitis, osteomyelitis, and synovitis have also been reported. It has become apparent that one of the most striking features of the genus is the ability to develop antibiotic resistance extremely rapidly in response to challenge with new antibiotics.(46)

In Acinetobacter species production of β lactamases or cephalosporinases is associated with resistance to β lactams.(49)

These are encoded by plasmid or chromosomally. The mechanisms by which Acinetobacter can become resistant to aminoglycosides include, alteration of the ribosomal target site and reduction of uptake; however, the production of aminoglycoside modifying enzymes is thought to account for more resistance in clinical isolates of Acinetobacterspecies.(50)

VIRULENCE FACTORS OFAB:

Various factors enhance the virulence of strains of this organism which include

Utilizing L-rhamnose,Dglucuronic acid, D-glucose, and D-mannose. The organism can make the polysaccharide capsule surface more hydrophilic this mechanism helps it to survive in humid and moist conditions.(42)

Organism isolated in hospital settings are known to produce a lipopolysaccharide which is of smooth type (S-LPS), and this factor might contribute to increased pathogenicity.(20)

Few strains of this organism have a capsule and the capsular polysaccharide (CPS) which may offer protection of bacteria from phagocytosis and complement system. LPS of A.baumannii strains isolated from bacteremic patients might be

important in allowing the strains to survive in the blood and contributing to the pathogenesis of this species.(44)

There may be damage to lipids in tissue due to the production of enzymes by AB. The potentially toxic role of the lipopolysaccharide may act toxic and damage the components of the cell wall. Acinetobacter species produce endotoxins like other gram-negative bacteria is responsible for disease symptoms observed during Acinetobactersepticaemia.(46)

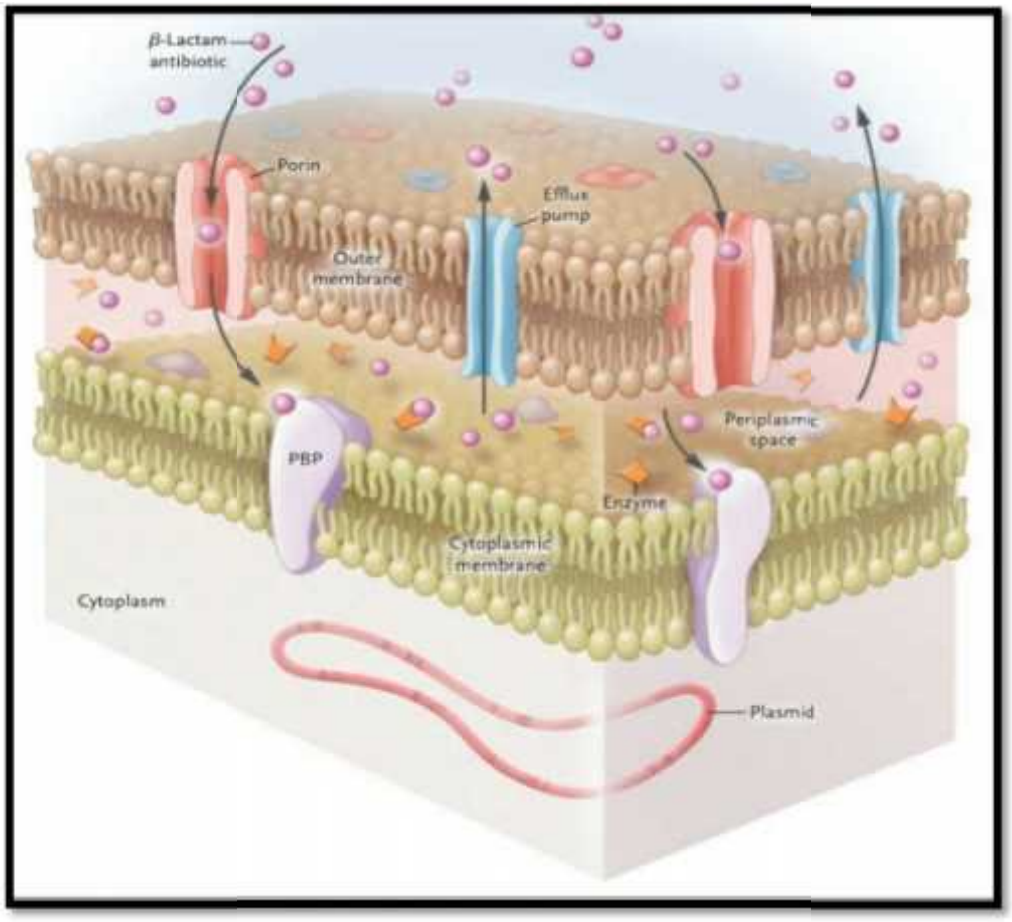


Figure 3.3 Mechanisms of Antimicrobial Resistance in Acinetobacter(43)

Acinetobacter, like other gram-negative bacteria, has an outer membrane and a cytoplasmic membrane, between which (the periplasmic space) β-lactamases (carbapenemases, AmpC β-lactamases, and extended-spectrum β-lactamases) reside.

Penicillin-binding proteins (PBPs), located at the level of the cytoplasmic membrane, constitute the final targets of β-lactam antibiotics. To bind to these targets, antibiotics must traverse the outer membrane through porin channels (outer-membrane proteins) into the periplasmic space. Once in the periplasmic space, β-lactam antibiotics bind to PBPs or are actively expelled from the bacterial structure through efflux pumps. Acinetobacter can harbor integrons and transposons, genetic elements on the bacterial chromosome or on plasmids, that can carry multiple cassettes with resistant genes (e.g., extended-spectrum β-lactamases and metallo-β-lactamases)[43]

Various studies conducted have indicated a rising trend in AB prevalence, but resistance varies widely. The Multi-Drug Resistance Acinetobacter infection is seen in severely ill patients, due to which there was high mortality ranging from 26% to 68%.[22]

A. most of the antibiotics are resistant to AB including the first line of treatment antibiotics for severe infections such as carbapenems.[47]
B. AB develops resistance by various mechanisms, one of the main mechanism for β-lactam resistance corresponds to efflux pumps, porin mutations, and the production of acquired β-lactam hydrolyzing enzymes, ie, Class A (extended-spectrum β-lactamases, ESBLs), class B (Metallo-β-lactamases, MBLs), Class C Ampicillinase (AmpC) as well as class D β-lactamases.

Resistance to Carbapenem is due to MBL and various othercarbapenemases production which can be disseminated rapidly in hospital [55]

CHARACTERISTICS OF MULTIDRUG-RESISTANT AB

Drug resistance AB was seen to be resistant to most of the antimicrobial agents available or susceptible to only older toxic antibiotics, like polymyxins, it leaves the treating medical team with feweroptions for treatment.(56)

Various mechanisms may play role in Carbapenem- and colistin-resistant AB infections, including class B and D carbapenemase production, penicillin-binding protein alteration, decreased permeability, overexpression of efflux pumps also seen rarely.(57)

Production of OXA-type carbapenemases and Metallo-β-lactamases (MBLs) are more commonly associated withCarbapenem resistance in Acinetobacter species. Four wide groups comprise in OXA-type carbapenemases: "blaOXA-23-like, blaOXA-40-like, blaOXA-58like and an intrinsic blaOXA-51-like"(59)

OXA51-like β-lactamases are intrinsic to AB, which are used for identification. the zinc ion is required by MBLs for their activity, and metal chelators, such as EDTA, inhibit them but not by clavulanicacid,sulbactam, ortazobactam. BlaIMP and blaVIM are the most common MBL types.(59)

The chromosomal or plasmidgenes may be responsible for MBL production and horizontal allocationamid threat to Gram-negative bacteria.

The genetic material responsible for coding NDM-1 ispresent on a plasmid, thereforehelping the spread of resistance among Gram-negative organisms, mostly by horizontal gene transfer.(60)

Mortality

High prevalence of drug Resistance to Carbapenem and the Mortality of Nosocomial AB Bacteremia CRAB (71.2%) was mentioned in a study conducted by Shuangshuang Yang in China other studiesfrom the same region also showed resistance rates which ranged from 62.1% to 91%,[(61)]

The mortality from Abumanniranged from 29% to 63.5% ([(62).]

The infections due to AB are associated with a mortality ranging from 28.3 to 84.3% in the ICU.[(64)]

LIST OF DIFFERENT STUDIES

In a study conducted by FuQ,Ye H et al concluded that Bacteremia is associated with a high 30-day hospital mortality rate in geriatric inpatients. Furthermore, stay in ICU, XDR ABbacteremia, a concurrent fungal infection, and age are associated with mortality which increased in inpatients who belonged to the geriatric age group with ABbacteremia.[(4)]

In another study conducted by Li Y,CaoX,GeH,et al concluded that the incidences of ventilation associated pneumonia, CAUTI, and CLABSI were greater in ICUs, and MDR organisms were the primary pathogens of nosocomial infection. The application of directedsurveillance may control the risk factors of nosocomial infection so that effective control measures can be taken to reduce the incidence of nosocomial infection in ICU patients[(65)]

In a study conducted by Ju M, HouD,Chen S, et al observed thatthe impact of bacterial cytotoxicity concluded that there was increased bacterial cytotoxicity might be a risk factor for short-term mortality in ICU patients with AB VAP.[(66)]

In a study conducted by MatinAspass,Guererro,et al concluded that infection by AB in an endemic is the admission at ICU and the duration ofstay in the hospital. Mortality of AB infected patients was independently influenced by chronic underlying basal state and the infection by AB.

Few studies have mentioned about risk factors and pattern of resistance of Acenatobacterbaumanii.(67)

In a study conducted by ÖzlemTunger,et al-Risk factors for nosocomial Acinetobacter bacteremia: a case-control study of intensive care unit patients concluded that acinetobacterbacteremia is associated with a significantly increased mortality rate. Central venous catheter insertion, mechanical ventilation, long length of hospital stay, and concomitant metabolic disease were risk factors for the presence of bacteremia.(68)

In a study done by Shojaei L et al in Iran,almost the complete samples of AB isolates were found to be resistant to piperacillin-tazobactam, ceftriaxone, amikacin, and ciprofloxacin. It was noted that the rate of resistance was 93.1% for meropenem and 41.4% for ampicillin/sulbactam among patients infected with AB species. Depending on antibiotic susceptibility pattern Patients were given either meropenem/ampicillin-sulbactam (48.3%) or meropenem/colistin(51.7%) as the treatment.(69)

In a study conducted by BasimaAAlmoman out of 121 AB-VAP cases, MDR-AB was observed in 119 (98.3%) cases. MDR-AB VAP incidence rate was 1.59 cases per 100 ICU admissions. The mortality of 42% (50/119) of cases in the critical care unit was associated with AB-VAP. Lower hospital mortality was independently associated with prescription of two or more definitive antibiotics (depending on

susceptibility pattern) (OR = 0.075, p = 0.001) and with ipratropium/salbutamol usage during mechanical ventilation (OR = 0.140, p = 0.017). [70]

In another study done by Jean Uwingabiye et al 8.4% of ICU patients developed AB infections. The following risk factors for ICU acquired AB infection were obtained by Multivariate logistic regression analysis: "ICU stay ≥14 days (odds ratio (OR)=6.4), prior use of central venous catheters (OR=18), prior use of mechanical ventilation (OR=9.5), duration of invasive procedures ≥7 days (OR=7.8), previous exposure to imipenem (OR=9.1), previous exposure to amikacin (OR=5.2), previous exposure to antibiotic polytherapy (OR=11.8) and previous exposure to corticotherapy (OR=5)."The post-operative care admission was providinga protective factor. It was observed that the patient'scrude mortality with AB infection was 74.1%. it was assessedbyMultivariate analysis that there is a significant mortality risk in patients with AB infection associated with older age (≥65 years) (OR=4.9) and septic shock (OR=19.2).

RATIONALE FOR THE PRESENT STUDY

ABiscategorized into one of the ESKAPE organisms,these are the group of very important organisms thatpredominantly cause healthcare-associated infection.Another dangerous aspect is that they have the potential for substantial antimicrobial resistance.[71]

In multiple studies, analysis has been done various factors predisposing to Acinetobacter infections, also there is a paucity of studies done in India to determine the risk and prognostic factors for Acinetobacter infection.[72]

As the conditions in Indian health care settings are different compared to other countries. It is of prime importance for Indian medical workers to know about the various factorscontributing to the rising infection rate and factors facilitating the infections and also the profile of the patients who are at greater risk of getting the infection.Asthe AB resistance is also emerging rapidly there is an urgent need to use the antibiotics in a rational way to prevent its resistance emergence. All the above factors mandate that the organism should be thoroughly studied and sensitivity and resistance pattern, affected patient profile and other contributing factors be studied in detail.

Hence The present study attempts to find possible risk and prognostic factors for the nosocomial infection caused due to Acinetobacter infection.

MATERIALS AND METHODS

Study design: This study wasa cross-sectional study.

Study setting: The study was done in a Tertiary care hospital atKLESDr.PrabhakarKorehospital, Belagavi, Karnataka,India.

Study Population The present study was done among the patients that were admitted to the medical intensive Care Unit from 1st January 2019 to 31st December 2019, who were aged above 18 years and those patients that develop a hospital-acquired infection as per the criteria defined.(5)

Study participants

Inclusion criteria:

1. Patients aged above the age of 18 years fulfilling the criteria of nosocomial infections
2. Infections with culture positive for AB taken as ABgroupandother culture-positive patients are taken as NON-ABgroup.

Exclusion Criteria:

1. Patients not giving their consent to be a part of the study.

Sample size: By considering prevalence (~21%) of AB infection in ICU patients from the previous 3 years statistics.

The sample size was calculated by considering a 95% confidence level and 5%error

$$n=p(1-p)(z^2)/e^2$$

by using formulae

Where

z is the z score,

e is the margin of error,

p is the population proportion

By using the above formulae sample size (n) calculated is 254.

Sampling method:

All the patients consenting for the study and meeting the inclusion criteria were included in the study.Theculture reports were collected, any culture positive for AB was considered as AB group, if there were other positive organisms along with AB they were also considered as the AB group, and the rest of the samples positive for other organisms were taken as the NON-AB group till the sample size was fulfilled.

ETHICAL CONSIDERATIONS: The present study was approved by the Institutional Committee of Human Ethicswith IEC number MDC\DOME\25

Informed written consent was taken from each patient or patient attender before collecting data. The nature and purpose of the survey were explained to them in their language. We maintained the study participant's confidentiality.

The patient's information was coded and kept highly confidential and the information was not disclosed anywhere. The data was analyzed and presented in form of results.

DATA COLLECTION TOOLS: All the data that collected using a semi-structured questionnaire and the data collected was stored in a confidential manner, the data was entered in MS Excel sheet and stored in a password protected digital format.

METHODOLOGY:

Our study has taken and evaluated the patients who acquired fever 48 hours after admission to the medical ICU. Detailed information about physical examination findings, blood tests (complete blood counts, ESR, procalcitonin,liver function test,renal function test), cultures (blood, pus,urine, endotracheal aspirate, and other tissue cultures), other tests like Urine analysis and radio diagnostic tests (chest X-Ray, ultrasound abdomen,etc.) were noted to identify the infectious source.

A detailed clinical examination was performed to determine any possible sources of infection. The clinical profile of the patient was filled into the clinical study form after getting informed consent. The research participants were classified as AB group in whom clinical isolates grew Acinetobacter and others were classified as NON-AB group in whom clinical isolates grew organisms other than NON-AB. If the culture grew other organismsalong with AB, still it is classified under the AB group. The principal investigator followed up the patient every day until the outcomes were seen either as the demise of the patient or the patient was discharged.

After obtaining microbiological data and antibiotic susceptibility pattern, other details like duration of hospital stay, co-infection with other organisms, history of comorbidities (hypertension, diabetes, malignancy, heart disease), history of bedridden status,history of invasive procedures(central venous catheterization,

hemodialysis, intubation),history of recent antibiotic use, history of recent surgery,history of prior ICU admission and other related history was noted.

By assessing all the information obtained, risk factors and clinical profiles were compared between the two groups and also the risk factors associated with MDR-AB were obtained.

STATISTICAL METHOD AND ANALYSIS:

Data collected were entered in Microsoft excel 2013 and for statistical analysis, SPSS-19.0 version (Statistical Packages for Social Sciences) was used. Statistical tests like Chi-square and Fisher exact tests and other tests will be applied according to the need. p-value ≤ 0.05 will be considered significant. Co relations for appropriate variables will be calculated. For analysis of any other data, appropriate statistical tests wereused. results will be represented in tables having proportions and percentages and wherever possible they will be represented graphically also.

RESULT

Our study was conducted from January 2019 to December 2019 with a total of 260 patients from medical intensive care units who fulfilled the criteria for hospital-acquired infection has taken for study. Out of which 76 patients were included in the case group who are having culture positive for AB and 184 patients were included in the control group who are having cultures positive for other nosocomial infections.

Table 5.1 Comparison of Age distribution between two groups:

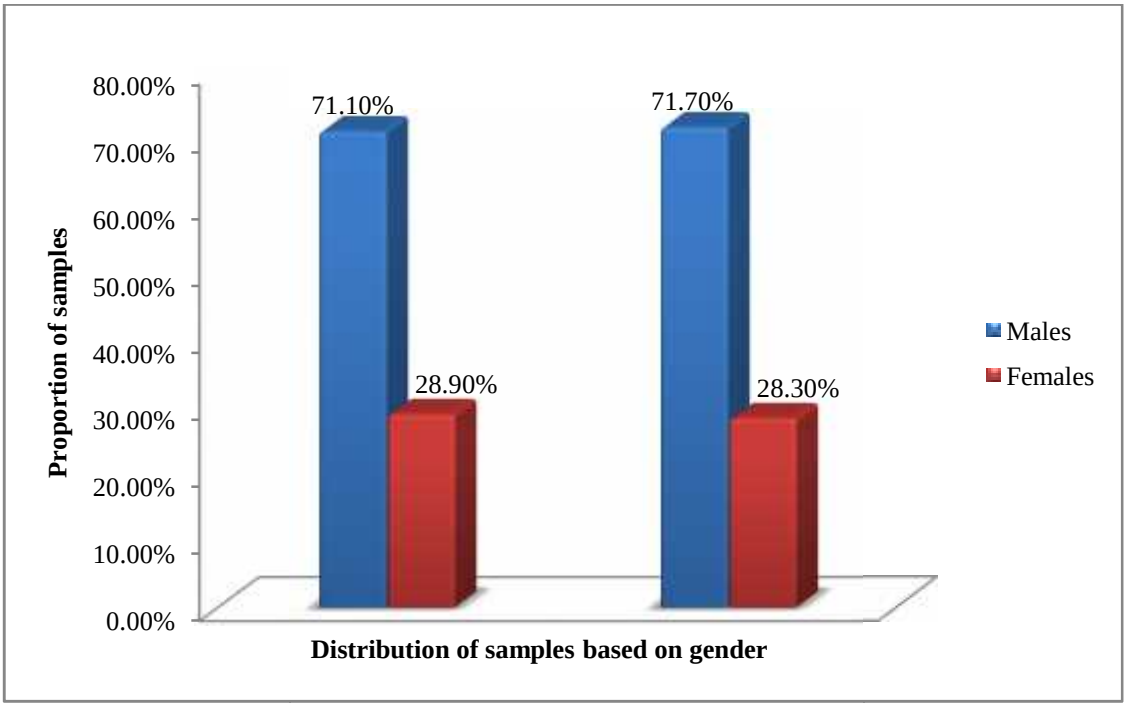
Age	AB group (N = 76)	NON-AB group (N = 184)
	51.46 ± 16.30	48.78 ± 16.87

The mean age among the AB group was found to be 51.46 ± 16.30 years and 48.78 ± 16.87 years among the NON-AB group.

Table 5.2 Comparison of gender distribution between the two groups

	AB group (N = 76)	**NON-AB group (N = 184)**
Male	54 (71.10%)	132 (71.70%)
Female	22 (28.90%)	52 (28.30%)

Graph 5.1 Distribution of males and females among AB and NON-AB group

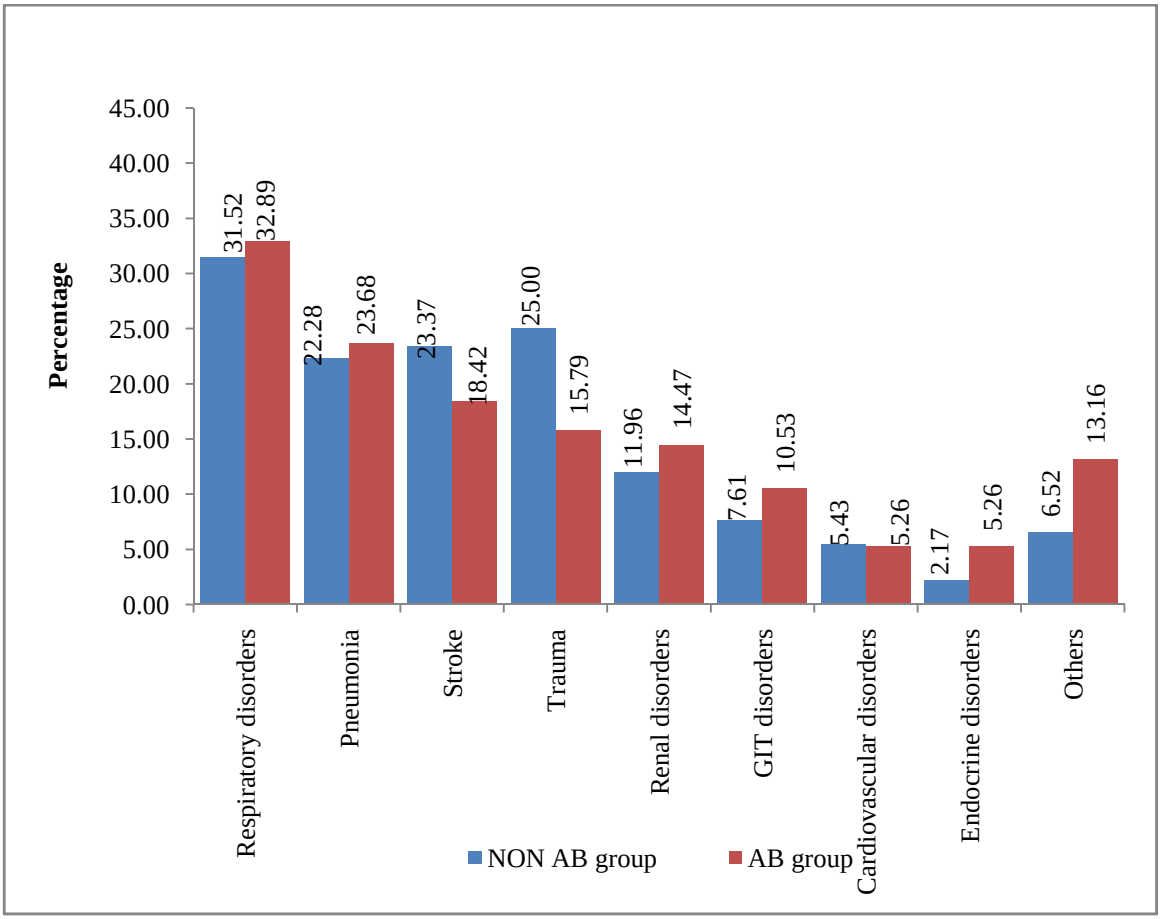


PRIMARY DIAGNOSIS:

Table 5.3: Comparison of AB group and NON-AB group with presence of the various diagnosis

Diagnosis	NON-AB group	%	AB group	%	Total	%	χ^2	p-value
Infections	47	25.54	24	31.58	71	27.31	0.9870	0.3200
Respiratory disorders	58	31.52	25	32.89	83	31.92	0.0470	0.8290
Pneumonia	41	22.28	18	23.68	59	22.69	0.0600	0.8060
GIT disorders	14	7.61	8	10.53	22	8.46	0.5910	0.4420
Renal disorders	22	11.96	11	14.47	33	12.69	0.3080	0.5790
Stroke	43	23.37	14	18.42	57	21.92	0.7690	0.3800
Trauma	46	25.00	12	15.79	58	22.31	2.6330	0.1050
Cardiovascular disorders	10	5.43	4	5.26	14	5.38	0.0030	0.9560
Endocrine disorders	4	2.17	4	5.26	8	3.08	1.7210	0.1900
Others	12	6.52	10	13.16	22	8.46	3.0580	0.0800

Graph 5.2: Comparision of the AB group and NON-AB group with respect to the primary diagnosis.

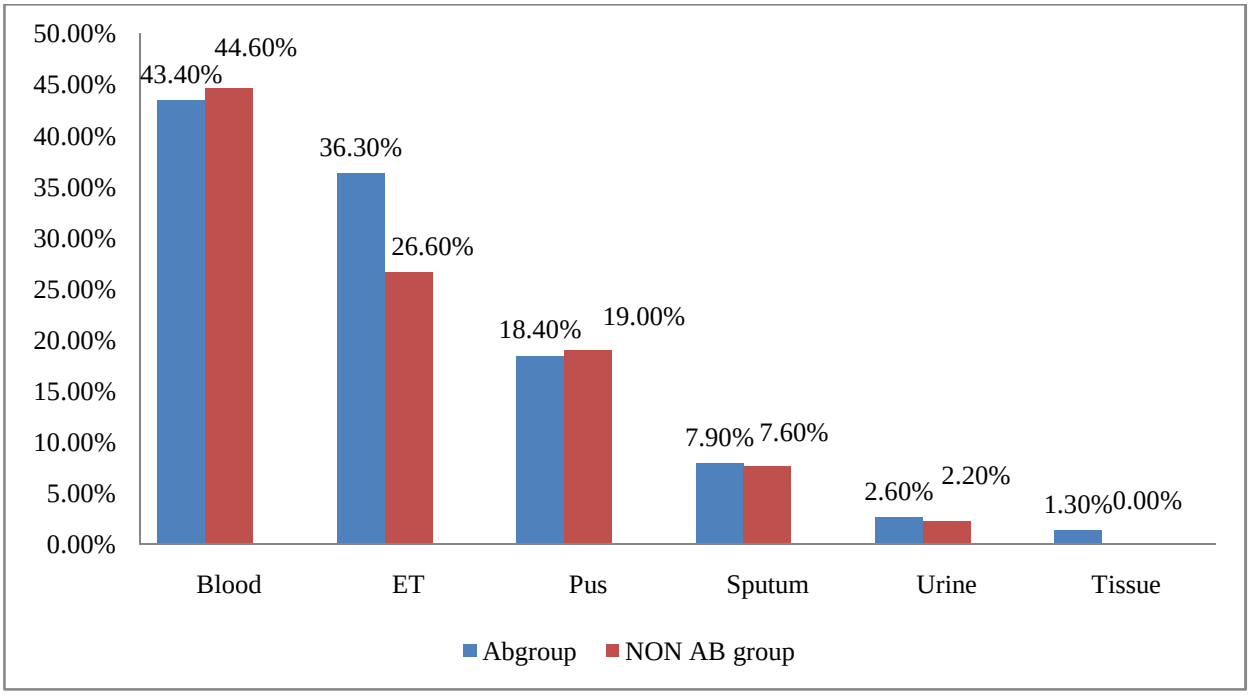


HAIs are more common in patients admitted with respiratory disorders, infectious cause,trauma, stroke, and renal disorders.

Table 5.4: Sites of sample collection in two groups.

	AB group (N= 76)	NON-AB group (N= 184)
Blood	33 (43.4%)	82 (44.6%)
ET	20 (26.3%)	49 (26.6%)
Pus	14 (18.4%)	35 (19.0%)
Sputum	06 (07.9%)	14 (07.6%)
Tissue	01 (01.3%)	0
Urine	02 (02.6%)	04 (02.2%)
$\chi^2 = 2.50$; df = 5; p = 0.77		

Graph 5.3 Distribution of site of sample collection in two groups



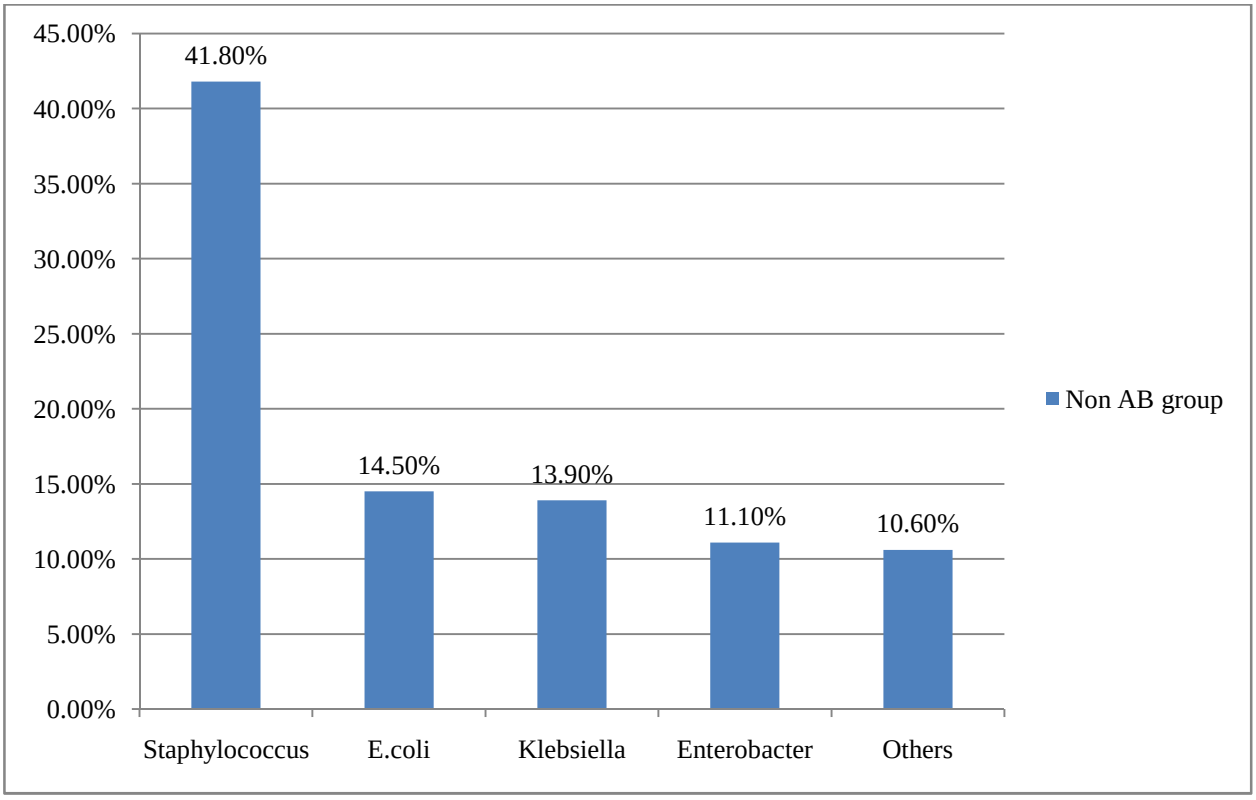
Among the AB group AB was found more commonly in the blood (43.4%), followed by 26.3% in ET, 18.4% in pus, least was found in tissues (1.3%).

Similarly among the NON-AB group, samples collected for other microorganisms showed.

Table 5.5 Distribution of microorganisms in NON-AB group

Organisms	Present	%
Staphylococcus	75	41.8%
E.coli	26	14.5%
Klebsiella	25	13.9%
Others	21	10.6%

Graph 5.4 Distribution of microorganisms in NON-AB group



Most common organisms found in NON-AB group include staphylococcus(most common is coagulase negative staphylococcus Aureus)(41.8%), E.coli(14.5%), klebsiella(13.9%) and enterobacter(11.1%).

Other organisms include pseudomonas, proteus, streptococcus, and other gram-negative organisms.

Table 5.6 Sensitivity pattern in two groups

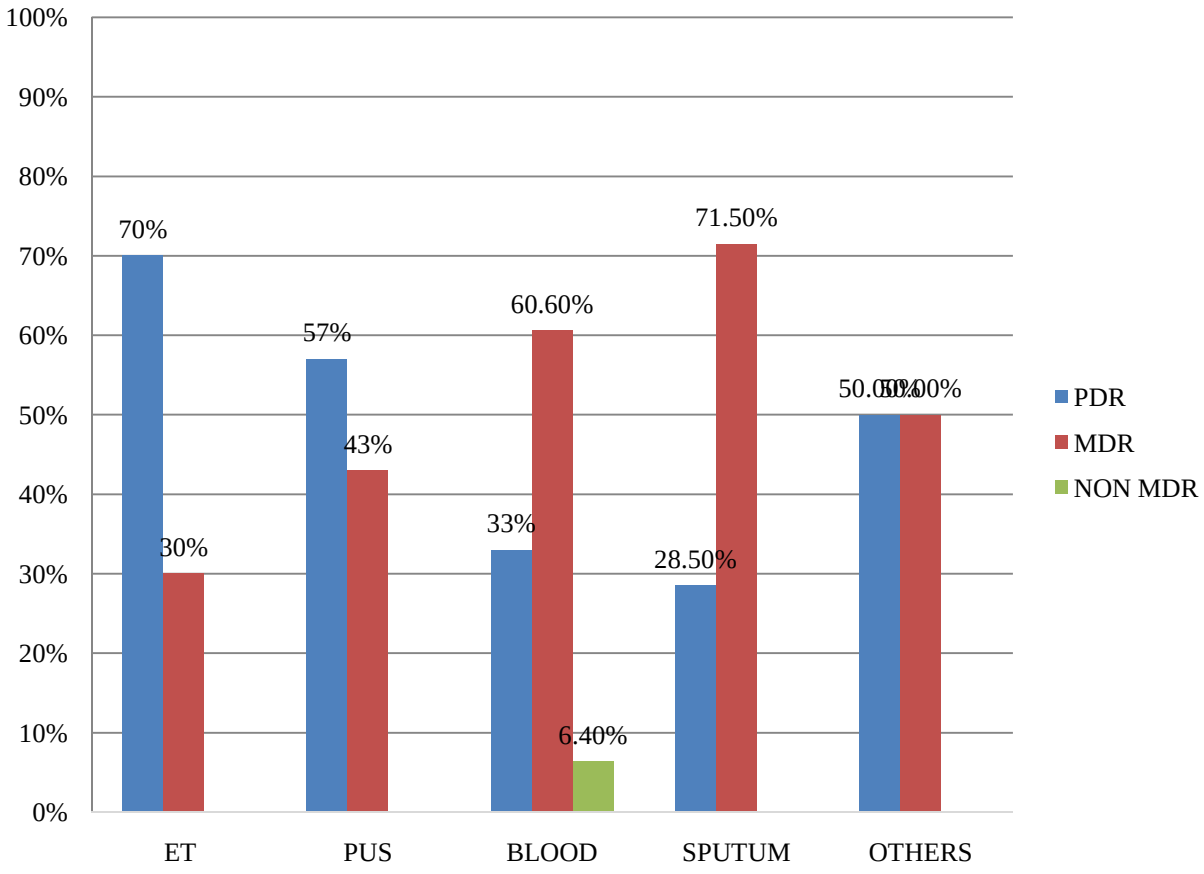
	Sensitive		**Resistant**	
	AB GROUP	**NON-AB group**	**AB group**	**NON-AB group**
Cotrimoxazole	11 (14.5%)	24 (13.0%)	49 (64.5%)	130 (70.7%)
Fluoroquinolones(FQ)				
Other FQ	04 (05.3%)	02 (01.1%)	49 (64.5%)	130 (70.7%)
Lfx	08 (10.5%)	25 (13.6%)	48 (63.2%)	126 (68.5%)
Cephalosporines				
Ceftazidime	02 (02.6%)	01 (00.5%)	49 (64.5%)	130 (70.7%)
Cefotaxime	05 (06.6%)	04 (02.2%)	48 (63.2%)	126 (68.5%)
Cefuroxime	04 (05.3%)	10 (05.4%)	48 (63.2%)	126 (68.5%)
Carbapenem				
Meropenem	09 (11.8%)	12 (06.5%)	48 (63.2%)	126 (68.5%)
Ertapenem	03 (03.9%)	01 (00.5%)	48 (63.2%)	126 (68.5%)
Penicillin derivatives				
Piperacillin	03 (03.9%)	01 (00.5%)	48 (63.2%)	126 (68.5%)

Mezlocillin	05 (06.6%)	07 (03.8%)	48 (63.2%)	126 (68.5%)
Other β-lactams	02 (02.6%)	01 (00.5%)	49 (64.5%)	127 (69.0%)
Aminoglycosides				
Gentamicin	07 (09.2%)	15 (08.1%)	48 (63.2%)	126 (68.5%)
Amikacin	07 (09.2%)	16 (08.7%)	48 (63.2%)	126 (68.5%)
Tobramycin	12 (15.8%)	29 (15.2%)	48 (63.2%)	126 (68.5%)
Other Aminoglycosides	03 (03.9%)	02 (01.1%)	48 (63.2%)	126 (68.5%)
Others				
Tigecycline	03 (03.9%)	01 (00.5%)	48 (63.2%)	126 (68.5%)
Fosfomycin	03 (03.9%)	01 (00.5%)	48 (63.2%)	126 (68.5%)

Pandrug resistance is most commonly seen in AB(47.3%) and Klebsiella(16.2%)

AB group was more sensitive to Aminoglycosides and carbapenems

Graph 5.5 Source And Resistance Pattern Among AB Cases



- Out of 33 blood cultures, positive AB group 11(33%) developed pandrug-resistantAB(PDR-AB), and 20(60.6%) developed multidrug-resistant AB(MDR-AB).

- Out of 20, ET culture-positive AB group 14(70%)patients developed PDR-AB, and 6(30%) developed MDR-AB.

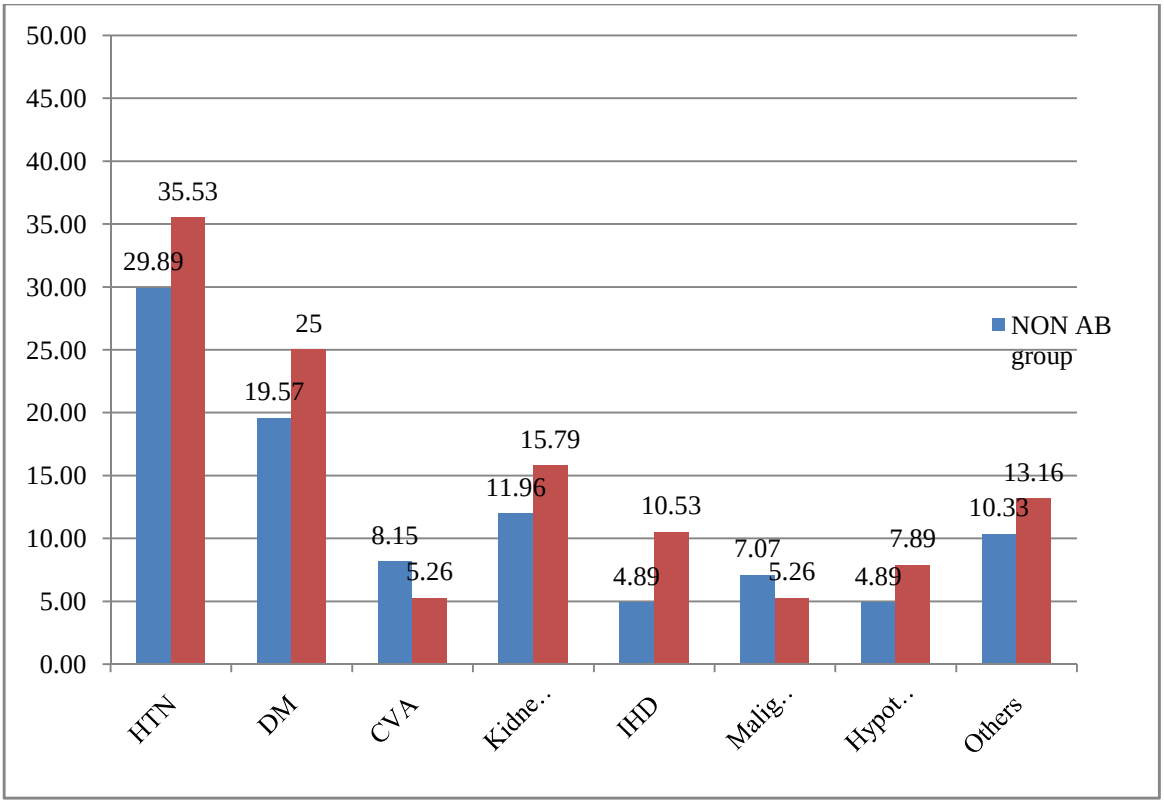
- Among 14 pus culture-positive AB group 8(57%) developed PDR-AB and 6(43%) developed MDR-AB.

- Among 7 pus culture, positive AB group 5(57%) developed PDR AB and 2(43%) developed MDR AB

Table 5.7 Comparison of AB group and NON-AB group with presence of co-morbidities

Co-morbidities	NON-AB group	%	AB group	%	Total	%	χ^2	p-value
HTN	55	29.89	27	35.53	82	31.54	0.7910	0.3740
DM	36	19.57	19	25.00	55	21.15	0.9520	0.3290
CVA	15	8.15	4	5.26	19	7.31	0.6630	0.4160
IHD	9	4.89	8	10.53	17	6.54	2.7950	0.0950
Malignancy	13	7.07	4	5.26	17	6.54	0.2860	0.5930
Hypothyroidism	9	4.89	6	7.89	15	5.77	0.8920	0.3450
Kidney disorder	22	11.96	12	15.79	34	13.08	0.6950	0.4040
Others	19	10.33	10	13.16	29	11.15	0.4350	0.5090

Graph 5.6 Comparison of AB group and NON-AB group with presence of co-morbidities

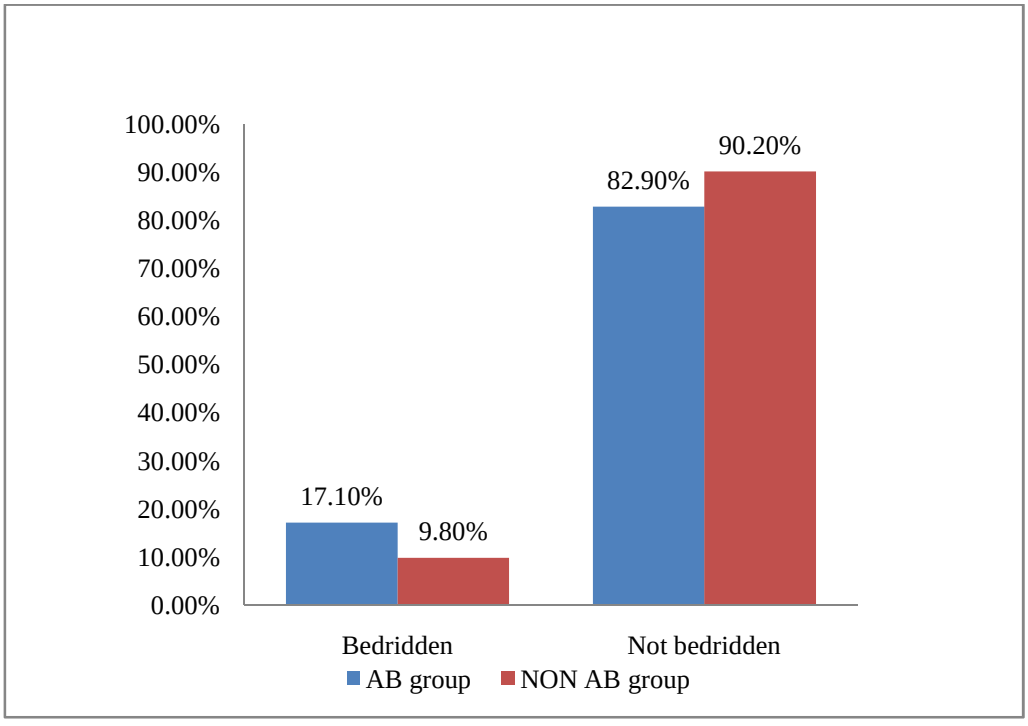


Hospital-Acquired infections are most commonly seen among patients having comorbidities like hypertension,diabetes, and renal disorders.

Table 5.8 Distribution of Bedridden patients in two groups

	AB group (N=76)	NON-AB group (N=184)
Bedridden	13 (17.1%)	18 (09.8%)
Not Bedridden	63 (82.9%)	166 (90.2%)
$\chi^2 = 2.74$; df = 1; p = 0.09		

Graph 5.7 Distribution of Bedridden patients in two groups

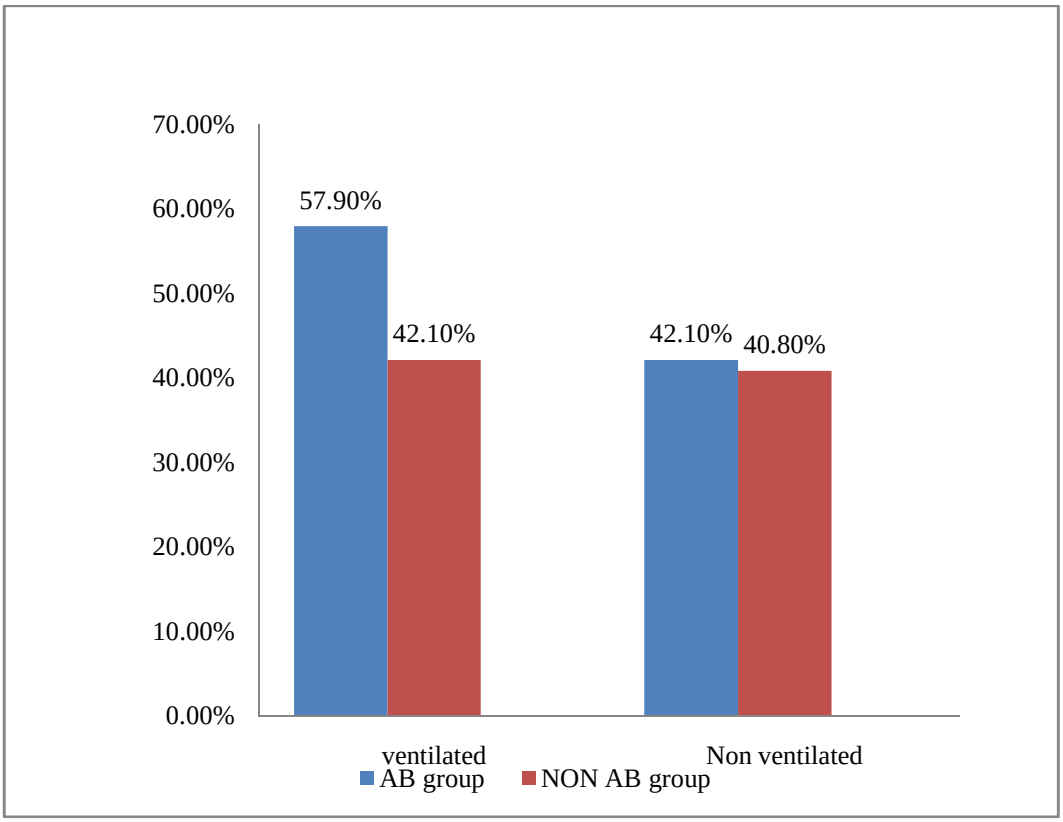


Among bedridden patients, AB is one of the most common hospital-acquired infection(HAI)

Table 5.9 Distribution of patients in two groups with respect to the need for Ventilator Support.

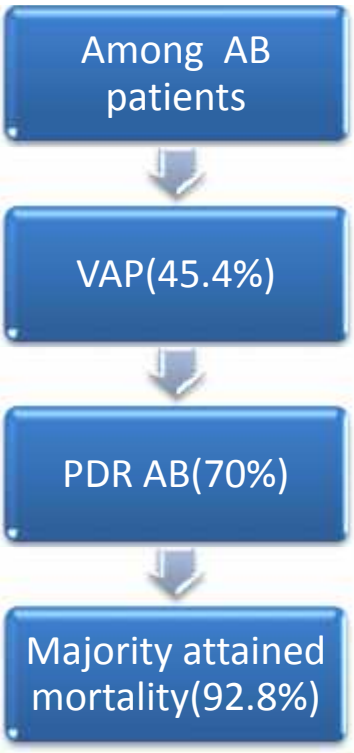
Ventilator Support	AB group (N=76)	NON-AB group (N=184)
Needed	44 (57.9%)	109 (59.2%)
Not Needed	32 (42.1%)	75 (40.8%)
$\chi^2 = 0.040$; df = 1; p = 0.84		

Graph 5.8 Distribution of patients in two groups with respect to the need for Ventilator Support.



HAIs(HAI) are most common in ventilated patients.

Graph 5.9 Resistance pattern and outcome of ventilated patients in the AB group

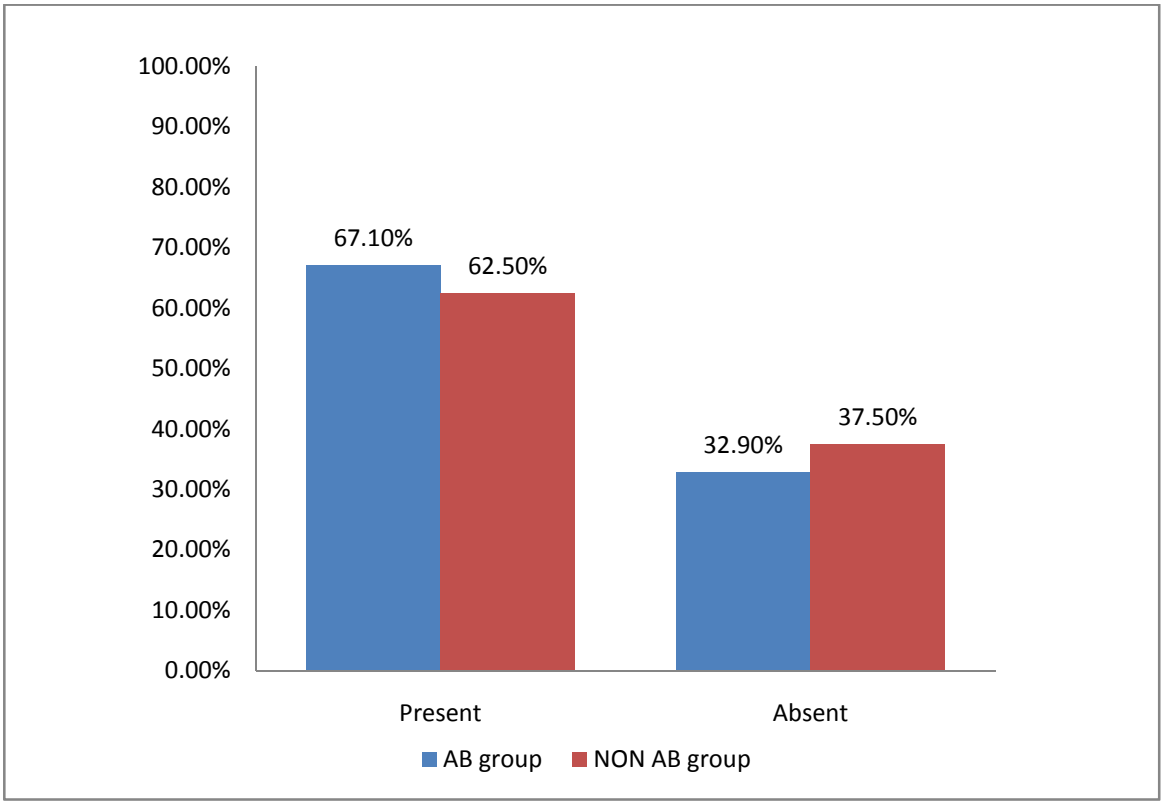


Among total AB cases, it was noted that almost half(45.4%) had VAP, out of which 70% had developed PDR AB, and the majority of them(92.8%) attained mortality.

Table 5.10Distribution of patients with the central line in two groups

Central Line	AB group (N=76)	NON-AB group (N=184)
With Central Line	51 (67.1%)	115 (62.5%)
Without Central Line	25 (32.9%)	69 (37.5%)
$\chi^2 = 0.494$; df = 1; p = 0.48		

Graph 5.10 Distribution of patients with the central line in two groups



The majority of the patients with cental line acquired HAIs

Table 5.11Distribution of patients in two groups based on Procedures done.

Other procedures	AB group (N=76)	NON-AB group (N=184)
Yes	22 (28.9%)	52 (28.3%)
No	54 (71.1%)	132 (71.7%)
$\chi^2 = 0.012$; df = 1; p = 0.911		

Graph 5.11Distribution of patients in two groups based on Procedures done

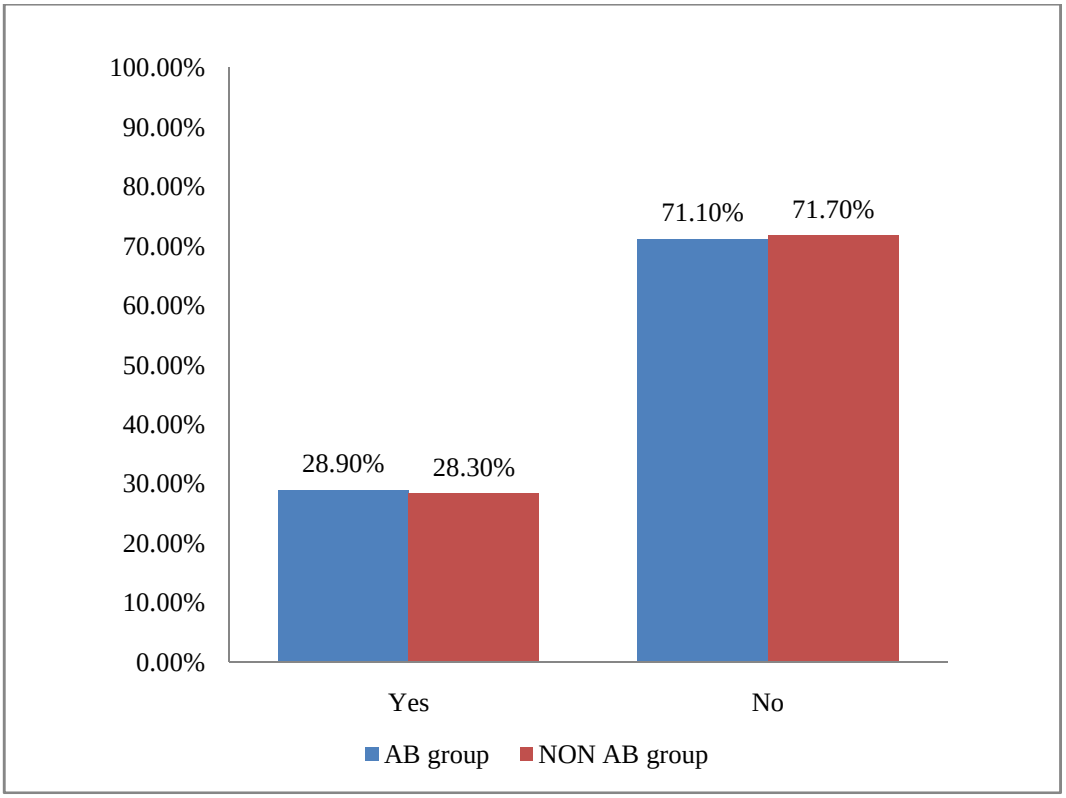
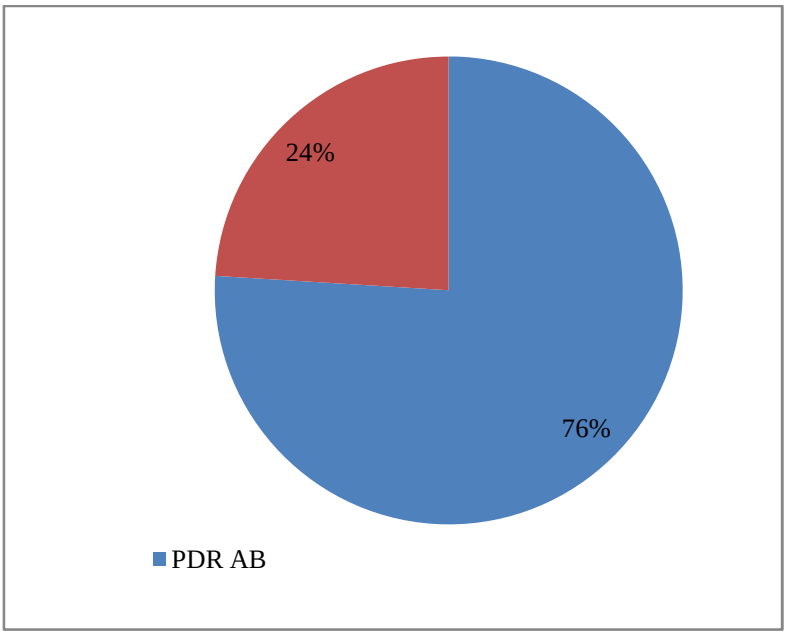


Table 5.12 Comparision of various procedures done in both groups.

Other procedures	AB group (N=76)	NON-AB group (N=184)
Haemodialysis	14 (18.4%)	28 (15.2%)
Gastrointestinal	5 (6.5%)	14 (7.6%)
Respiratory	5 (6.6%)	13 (7.0%)
Tracheostomy	03 (03.9%)	10 (05.4%)

Among the various procedures used. It was found that hemodialysis was the most common procedure seen in 18.4% AB group and 15.2% NON-AB group. This was followed by Respiratory and Gastrointestinal procedures that showed approximately 6% in the AB group and 7% in the NON-AB group respectively. Tracheostomy was performed in a 3.9% AB group and 5.4% in the NON-AB group.

Graph 5.12 Resistance pattern in AB group patients with multiple invasive procedures.



Out of 17 patients who had undergone multiple invasive procedures (≥3) among the AB group, 13(76%) had an infection with PDR AB.

Table 5.13 Distribution of patients in two groups with indwelling SRC/ RT

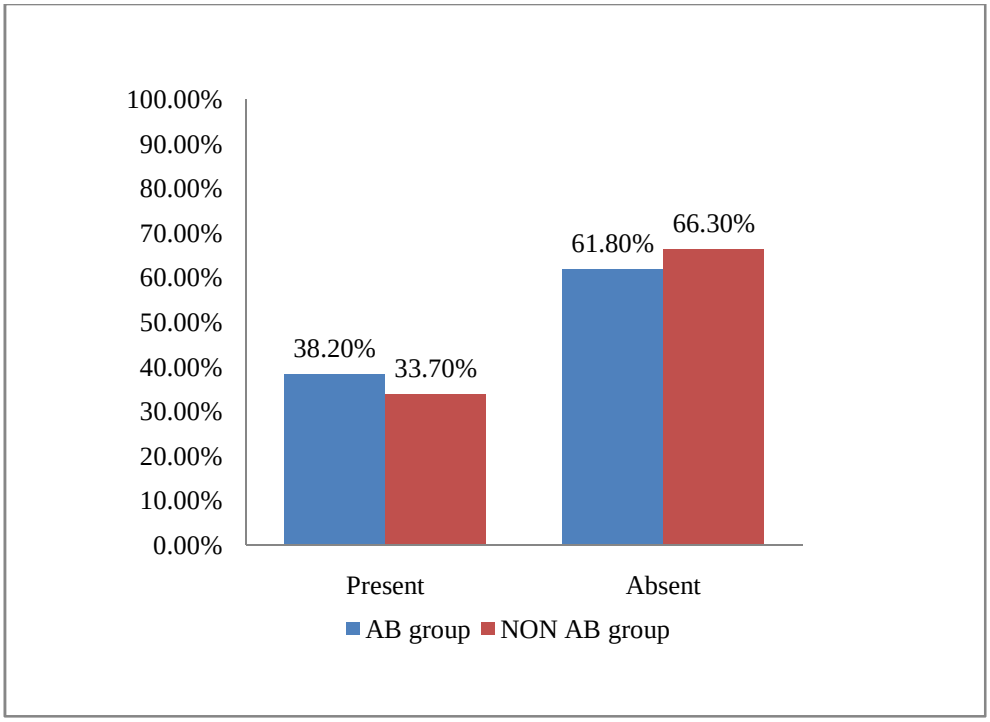
SRC/ RT	AB group (N=76)	NON-AB group (N=184)
Needed	74 (97.4%)	178 (96.7%)
Not Needed	02 (02.6%)	06 (03.3%)
$\chi^2 = 0.071$; df = 1; p = 0.789		

Almost all patients in ICU has SRC/RT

Table 5.14 Distribution of patients in two groups with presence of Co-infections

Co-infections	AB group (N=76)	NON-AB group (N=184)
Present	29 (38.2%)	62 (33.7%)
Absent	47 (61.8%)	122 (66.3%)
$\chi^2 = 0.470$; df = 1; p = 0.492		

Graph 5.13Distribution of patients in two groups with presence of Co-infections

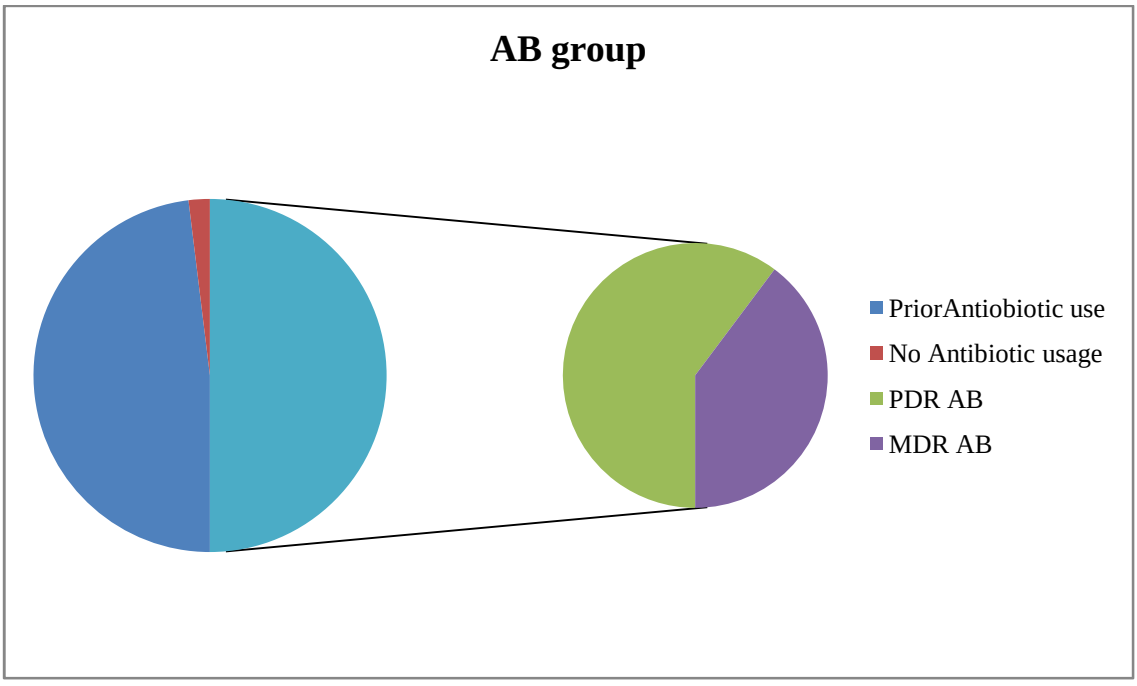


Co-infection more common in AB group patients

Table 5.15Distribution of patients in two groups with respect to Prior Antibiotics Use.

	AB group (N=76)	NON-AB group (N=184)
Used	73 (96.1%)	176 (95.7%)
Not used	03 (03.9%)	08 (04.3%)
$\chi^2 = 0.021$; df = 1; p = 0.884		

Graph 5.14 Resistance pattern among AB group patients with respect to prior Antibiotic use.

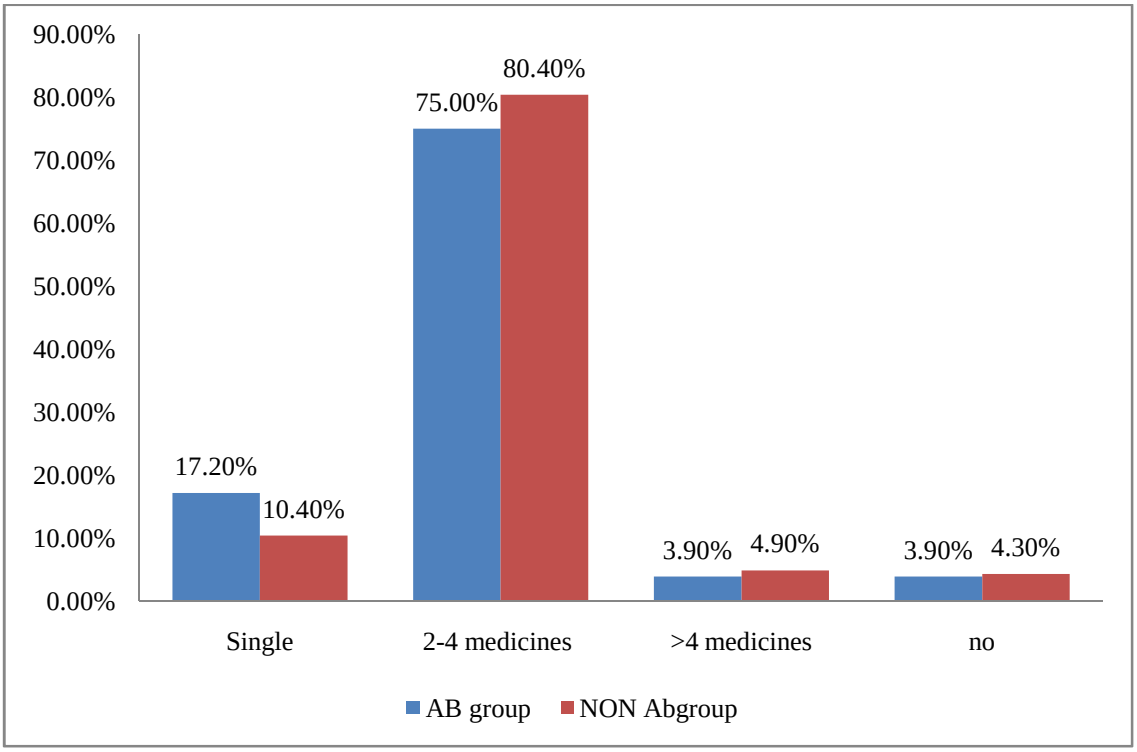


Out of 76 patients, 73 (96.1%) patients had a history of Prior antibiotics use and among them, 43(60.2%) patients developed PDR AB.

Table 5.16 Distribution of patients in two groups with respect to the number of Antibiotics Used.

	AB group (N=76)	NON-AB group (N=184)
Single	13 (17.2%)	19 (10.4%)
2-4 medicines used	57 (75.0%)	148 (80.4%)
>4 medicines used	03 (03.9%)	09 (04.9%)
No	03 (03.9%)	08 (04.3%)
$\chi^2 = 2.33$; df = 3; p = 0.506		

Graph 5.15 Distribution of patients in two groups with respect to the number of Antibiotics Used



The majority of patients with multiple antibiotic usages developed HAIs.

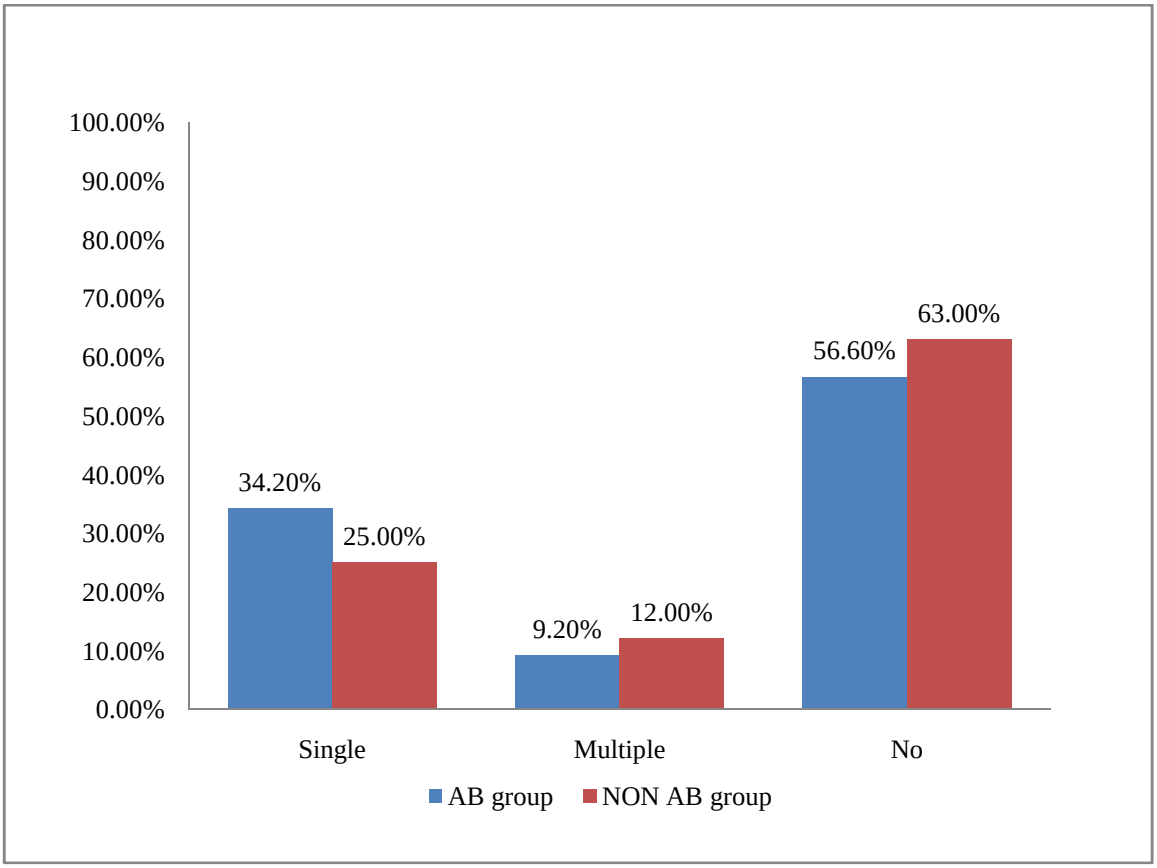
Table 5.17 Distribution of patients in two groups with respect to a recent surgery.

Recent Surgery	AB group (N=76)	NON-AB group (N=184)
Yes	33 (43.4%)	68 (37.0%)
No	43 (56.6%)	116 (63.0%)
$\chi^2 = 1.38$; df = 1; p = 0.239		

Table 5.18 Distribution of patients in two groups with respect to the number of Recent Surgeries done.

Recent Surgery	AB group (N=76)	NON-AB group (N=184)
Single	26 (34.2%)	46 (25.0%)
Multiple	07 (09.2%)	22 (12.0%)
No	43 (56.6%)	116 (63.0%)
$\chi^2 = 2.379$; df = 2; p = 0.304		

Graph 5.16Distribution of patients in two groups with respect to the number of Recent Surgeries done



There is no significant association between the two groups with respect to recent surgeries done.

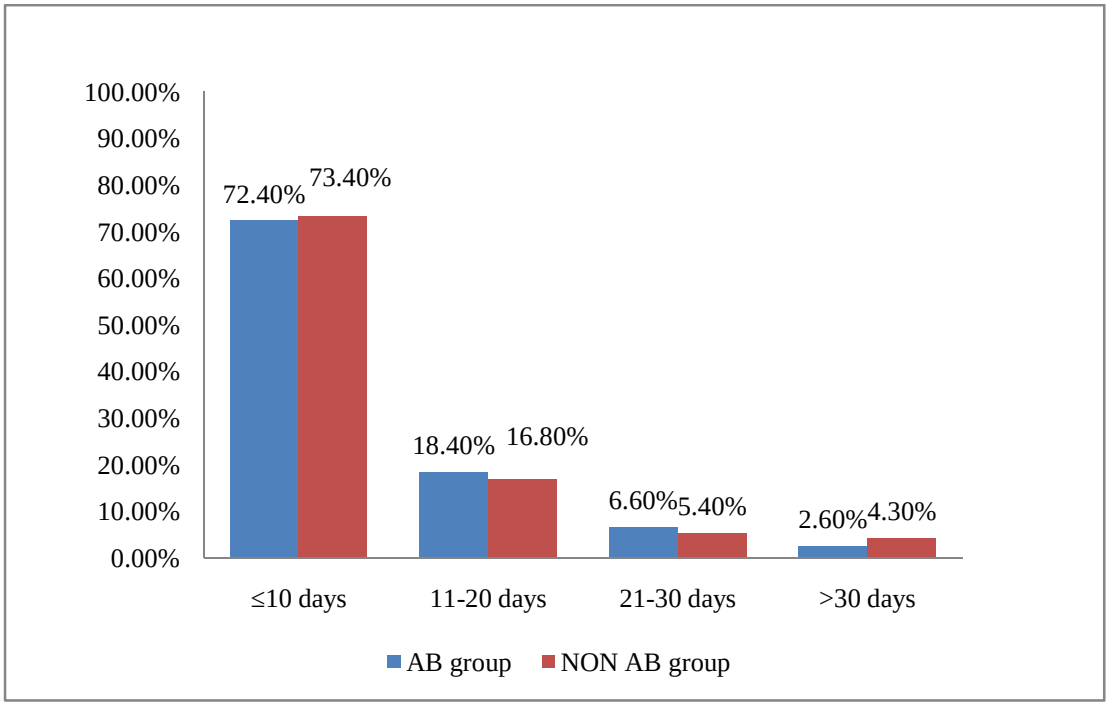
Duration of Hospital Stay during current admission:

Mean ± SD in AB group: 10.00 ± 7.39 days, Mean ± SD in NON-AB group: 10.04 ± 7.80 days, p = 0.969

Table 5.19 Distribution of patients in two groups with respect to the number of days of Hospital Stay.

Duration of Hospital Stay(in days)	AB group (N=76)	NON-AB group (N=184)
≤ 10	55 (72.4%)	135 (73.4%)
11-20	14 (18.4%)	31 (16.8%)
21-30	05 (06.6%)	10 (05.4%)
>30	02 (02.6%)	08 (04.3%)
$\chi^2 = 0.618$; df = 3; p = 0.892		

Graph 5.17 Distribution of patients in two groups with respect to the number of days of Hospital Stay.

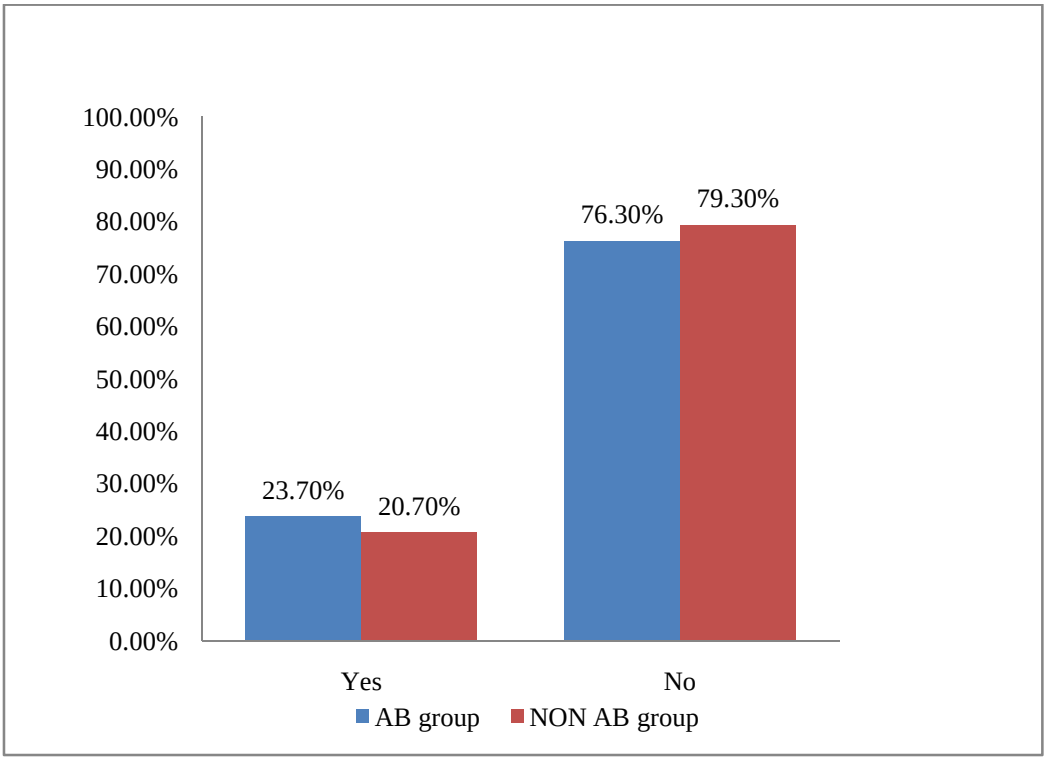


There is no significant difference in hospital stay between two groups.

Table 5.20Distribution of patients in two groups based on Prior ICU Stay

Prior ICU Stay	AB group (N=76)	NON-AB group (N=184)
Yes	18 (23.7%)	38 (20.7%)
No	58 (76.3%)	146 (79.3%)
$\chi^2 = 0.292$; df = 1; p = 0.588		

Graph 5.18 Distribution of patients in two groups based on Prior ICU Stay

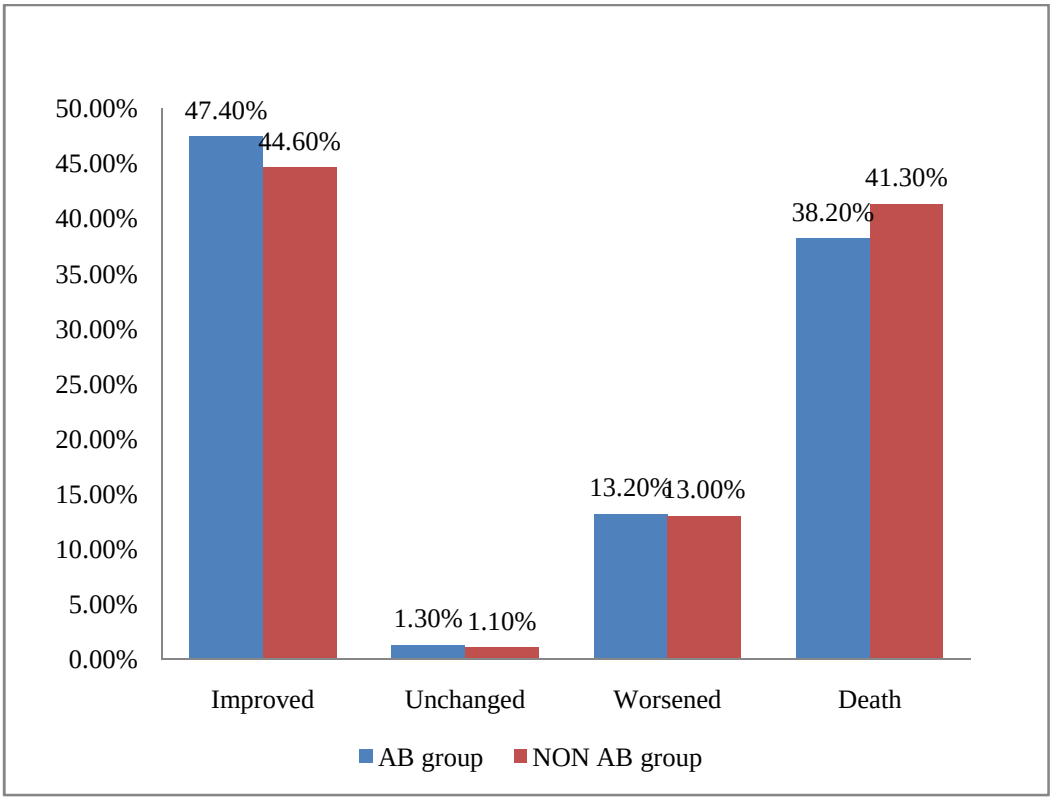


There is no significant association between the two groups with respect to a prior ICU stay.

Table 5.21Comparision of Outcome in two groups.

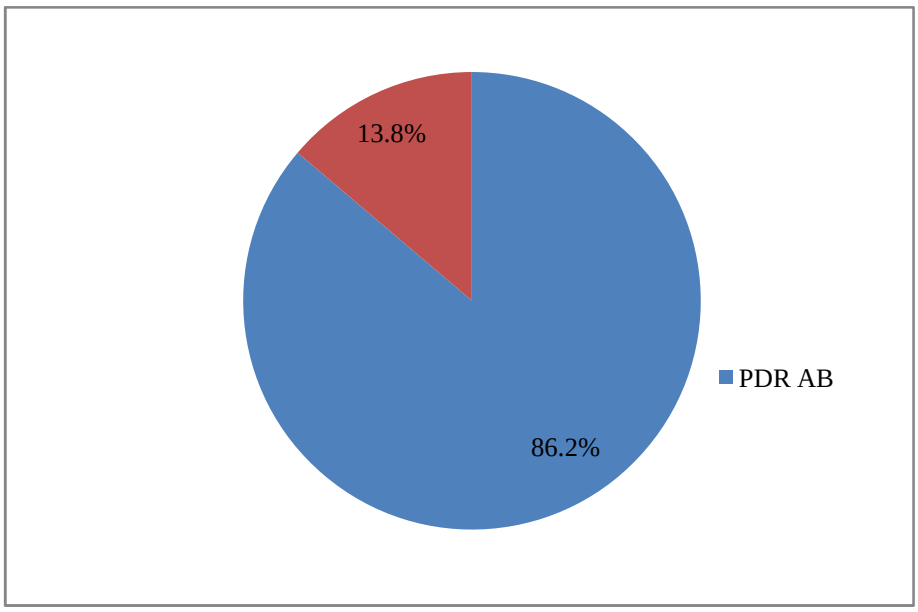
Outcome	AB group (N=76)	NON-AB group (N=184)
Improved	36 (47.4%)	82 (44.6%)
Unchanged	01 (01.3%)	02 (01.1%)
Worsened	10 (13.2%)	24 (13.0%)
Death	29 (38.2%)	76 (41.3%)
$\chi^2 = 0.249$; df = 3; p = 0.969		

Graph 5.19Comparision of Outcome in two groups



There is no significant difference in outcome between the two groups.

Graph 5.20 Resistant pattern of expired patients in two groups



Among dead patients in the AB group,86.2% are having pandrug-resistant AB(PDR-AB).

DISCUSSION

There is an increasing incidence of Acinetobacter related HAIs. Acinetobacter is a ubiquitous organism,it can survive in various environmental conditions with well-developed adaptive mechanisms. In the hospitals, it has been transmitted through many sources like healthcare apparatus, hands of healthcare workers, humidifiers, other sources in the hospital environment. They have gain resistance to many antimicrobial classes with their innate adaptability in a short time, which led to the emergence of a pan-resistant Acinetobacter 'species.

However, with the rise in AB infection worldwide, there are major regional differences in the resistance pattern of AB infection.Therefore, the present study was conducted to assess the risk factors and clinical profile of patients infected with AB in ICU patients with a special focus on multidrug-resistant AB, which might be beneficial in managing ICU patients.

As given in a previous study conducted by Cassini A, Plachouras D, et al Majority of patients admitted in ICU who developed nosocomial infection are critically ill adult male patients.We have also observed that HAIs are most common among elderly patients and common in male patients.[73]

By comparing baseline characters between two groups, it was found that the patients who developed an AB associated HAIs had a higher mean age than theNON-ABgroup. The usual hosts for an AB infection are elderly critically ill patients with a lowered immune system probably due to their primary illness.

A study conducted by Magill SS, Edwards JR, et al.observed that the median interval from hospital admission to the onset of symptoms of a healthcare-associated

infection was 6 days.(74) In our study we have observed the mean duration for acquiring HAIs is 10days.

In studies conducted in countries like France, Germany, and Italy, the frequently pathogens causing infection in ICU settings were Staphylococcus aureus (21 8%); enterobacteriaceae (20.2%); Pseudomonas spp(17.2%); enterococci (10.0%); Escherichia coli (9.1%); Candida spp (8.8%); coagulase-negative staphylococci (7.0%); and Acinetobacterspp (5.1%) [(15)(16)]

In our study most common organisms found in NON-AB group include staphylococcus(most common is coagulase-negative staphylococcus Aureus)(41.8%), E.coli(14.5%), Klebsiella(13.9%) and Enterobacter(11.1%).Other organisms include pseudomonas, proteus, streptococcus, and other gram-negative organisms.

AB was found more commonly in the blood (43.4%), followed by 26.3% in ET, 18.4% in pus, least was found in tissues (1.3%). As given in a study conducted by Elkalioubie A, NseirSABis responsible for several types of infection including healthcare-associated pneumonia, bloodstream infections, surgical-site infections, and urinary tract infections.[(75)]

AB associated Hospital Acquired infection is mainly seen in patients admitted with respiratory infections, other infective disorders, stroke,renal disorders, and trauma. Among respiratory infections, it is most commonly associated with patients of pneumonia and other conditions causing respiratory failure and requiring the need for mechanical ventilation. It is also seen in many patients admitted with other infective disorders like an abscess, sepsis, bedsore,etc. Many patients with sepsis in critically ill conditions might go into multiple organ dysfunction requiring multiple supportive

measures like mechanical ventilation, central line, hemodialysis,etc because of which they are more prone to acquire acinetobacter infection.

HAIs are most commonly seen among those patients with prolonged hospital stay like in patients with trauma, stroke, and other chronic disorders.

In our study region, organophosphate poisoning is most common among poisoning/overdose patients admitted in intensive care units. Most of these patients require prolonged mechanical ventilation because of the intermediate syndrome and, therefore these patients are more prone to develop VAP.As there are many patients in the NON-AB group with poisoning/overdose, may probably the cause ofthe lower median age group in that group as many of these patients are young individuals.

As mentioned in a case-control study conducted by Arduino I, ZangirolamiF,et al in Italy comorbidities, diagnostic and therapeutic procedures, and prior antibiotic therapy are the important risk factors for the acquisition of AB infection.[76]

We have also observed that AB infection is most commonly seen among patients with comorbidities like hypertension, diabetes, ischemic heart disease, kidney disorders,etc. This study also showed that bedridden patients are more commonly infected with AB and most of the patients with AB infection have undergone multiple invasive procedures. Drug-resistant AB is most commonly seen in patients with prior use of Betalactams and carbapenems.

Several studies agree on the fact that, in particular, whatever use of carbapenem, even a single dose, increases the incidence rate of resistant *AB* strains isolates and related infection.[75,77,78] This can be explained by antimicrobial selective pressure, as time-kill studies show a rapid killing by carbapenem of sensitive *AB*, with

the subsequent rise of resistant *AB* strains. By comparison of prior antibiotics use between the two groups, it was found that patients who developed AB related HAI had received the carbapenem group of antibiotics more commonly than those who did not.

In our study,Coinfection is also most commonly seen in the AB group.

AB group had 42 patients (55.2%) with a history of priorCarbapenem use whereasit was seen in 84 patients (45.7%) among the NON-AB group. AB related HAI were more common in patients with 'infectious syndromes' than other syndromes needing ICU admission. As per guidelines of sepsis, in case of severe sepsis irrespective of cause, "the empirical therapy of choice should include a carbapenem if a gram-negative organism is suspected." Therefore, frequent use of the Carbapenem group of drugs in the ABgroup may once again reveal the severity of underlying primary illness in patients who developed an AB related HAI.

As mentioned in many studies, we have not found any significant association with prior ICU stay and a number of recent surgeries done with AB infection.

However the results of our study have not shown a statistically significant association between AB and NON-AB group with respect to demographic features and risk factors like comorbidities, prior ICU stays, invasive procedures, bedridden status, and prior antibiotic.

By comparing two groups, it was observed that the outcome is not dependent on the organism causing HAI and there is no increase in mortality in the ABgroup.It may be seen commonly in critically ill adult patients, but might not be related to mortality. This finding is similar to other studies conducted by Jamulitrat et al in

Thailand which had observed that "the comparative mortality of Acinetobacter related hospital-acquired infection(HAI) is not significantly different from the mortality rate caused by infection with other organisms."[80]

Hence it is concluded that AB is mainly a colonizing agent rather than an infectious agent.

As mentioned in many studies more than half of the patients in whom AB was isolated correspond to colonization and it is hard to differentiate infection from colonization.[80,81]

MULTIDRUG-RESISTANT AB:

The majority of the HAIs are having multidrug resistance.

Feretzakis, Georgios et al. conducted a study in Greece which had reported that antibiotic resistance in ICU patients was maximum with *Acinetobacter* spp. (93.00%), followed by *Klebsiella* spp. (72.30%) and *Pseudomonas* spp. (49.03%).(82)In our study,we have observed that pandrug resistance responsible for mortality was commonly seen amongpatients infected with AB(47.3%) and Klebsiella(16.2%).

As observed in a study conducted by Garnacho-Montero J, Amaya-Villar R AB has developed drug resistance to many antibiotics including first-line antibiotics for severe infections such as carbapenems.(83)Out of 76 AB culture-positive cases, 36(47.3%) are pandrug-resistant AB(PDR-AB) and 39(51.3%) patients are multidrug-resistant AB(MDR-AB) and 1(0.013%) is sensitive to AB.

In a study conducted by Noyal MJC, MenezesGA,et al observed that "AB develops resistance by various mechanisms, one of the main mechanism for β-lactam resistance corresponds to efflux pumps, porin mutations, and the production of acquired β-lactam hydrolyzing enzymes, ie, Class A (extended-spectrum β-lactamases, ESBLs), class B (Metallo-β-lactamases, MBLs), Class C Ampicillinase (AmpC) as well as class D β-lactamases. resistance to Carbapenem is due to MBL and other carbapenemases production which has a potential for rapid dissemination in hospital."[56]

AB culture positive cases are more sensitive to aminoglycosides(38.1%), carbapenems(15.7%) and cotrimoxazole(14.5%).

Out of 33 blood culture-positive cases, 11(33%) developed pandrug-resistantAB (PDR-AB), and 20(60.6%) developed multidrug-resistant AB(MDR-AB). Among PDR-AB cases 9(27.2%)patients died.Out of 20, ET culture-positive cases14(70%)patients developed PDR-AB, and 6(30%) developed MDR-AB.Among 14 pus culture-positive cases 8(57%) developed PDR-AB and 6(43%) developed MDR-AB.

Most of the ventilated patients in the case group developed PDR-AB with poor outcomes.

Among procedures performed like mechanical ventilation,use of central line, and hemodialysis, it was observed that in patients infected with AB, about 3/4th of cases(76%) had developed PDR AB.

Our study revealed that the majority(96%) of the patients had a history of prior antibiotic usage(≥2) among which about 60% had developed PDR AB.Drug-resistant

AB is most commonly seen in patients with prior use of Betalactams and carbapenems. Poor outcome is seen among PDR-AB.Out of 36 PDR AB, 25(69.4%) patients have died.

A study conducted by Sunshine RH, Wright M-O,etal.observed that the MDR Acinetobacter infection is seen in critically ill patients, due to which there is a high mortality rate of 26% to 68%.[54]

As mentioned in a case-control study conducted by Arduino I, ZangirolamiF,et al in Italy, Early recognition of patients at high risk, environmental hygiene control measures, appropriate antibiotic prescriptions, especially regarding carbapenems, and high-quality training of health care workers in all hospital departments are all key aspects for prevention and control of AB infection.[76]

As information is limited regarding treatment for drug-resistant AB. It is recommended to prevent the occurrence of drug-resistant patterns in AB species. It can be prevented by interruption of transmission after reinforcement of existing infection control and prevention standards, such as hand hygiene, standard precautions, barrier precautions, and thorough environmental cleaning and disinfection. Other precautions include the judicious use of multiple invasive procedures and antibiotics to reduce the emergence of resistant strains.

CONCLUSIONS

There is an increasing incidence of AB related HAIs worldwide but information related to riskfactors, clinical profile and resistance pattern of AB infection is limited in developing nations like India.Therefore, the present study is conducted to assess these factors:

AB was most commonly associated with bacteremia and VAP.We have observed that there is no statistically significant association between AB and NON-AB group with respect to demographic features and risk factors like comorbidities, prior ICU stays, invasive procedures, bedridden status, and prior antibiotic use.There was no significant difference between the two groups even in terms of mortality.There was also no statistically significant increase in coinfection in the AB group.Hence it is concluded that AB is mainly a colonizing agent rather than infectious agents.

We have observed that the majority of the HAIs are having multidrug resistance and pandrug resistance which increases mortality. It was commonly seen among patients infected with AB and klebsiella.

Among AB cases, PDR- AB was most commonly seen in patients with a history of multiple antibiotic uses (mainly Betalactams like carbapenem group of drugs),multiple invasive procedures, and in patients with VAP. Poor outcome was seen among these patients and 93% attained mortality.

SUMMARY

This was a cross-sectional hospital-based study conducted to study the risk factors and clinical profile of patients with AB infection admitted in the medical intensive care unit with a special focus on multidrug-resistantAB.

A total of 260 patients were included in the study of which 29.2% belong to the AB group and 70.7% belong to the NON-AB group. In our study population mean age among the AB group was found to be 51.46 ± 16.30 years and 48.78 ± 16.87 years among the NON-AB.

It was observed that Males were almost 2.53 times more common than females.

The mean duration for developing HAIs was observed as 10.04 ± 7.80 days.

Most common organisms found in NON-AB group include staphylococcus(most common is coagulase-negative staphylococcus Aureus)(41.8%), E.coli(14.5%), Klebsiella(13.9%) and Enterobacter(11.1%). Other organisms include pseudomonas, proteus, streptococcus, and other gram-negative organisms.

AB was found more commonly in the blood (43.4%), followed by 26.3% in ET as most of our study participants were diagnosed with respiratory and various other infections.

We have observed that AB infection is most commonly seen among patients with comorbidities like hypertension, diabetes,ischemic heart disease, and kidney disorders. This study also showed that bedridden patients are more commonly infected with AB and most of the patients with AB infection have undergone multiple

invasive procedures but the increase is not statistically significant when compared with the NON-ABgroup.

Even the increased co-infection and prior carbapenem use in the ABgroup were also not statistically significant when compared with the NON-AB group. Frequent use of the Carbapenem group of drugs in ABgroupmay once again reveals the severity of underlying primary illness in patients who developed an AB related HAI.

We have not found any association with prior ICU stay and the number of recent surgeries done with the acquisition of HAIs.

No significant differencein mortality was seen among AB and NON-AB group patients.

All these factors suggest that AB is mainly a colonizing agent rather than an infectious agent.

DRUG RESISTANCE PATTERN:

The majority of the HAIs are having multidrug resistance.We have observed thatpan drug-resistance responsible for mortality was commonly seen amongpatients infected with AB and klebsiella.

Out of 76 AB culture-positive cases, 36(47.3%) are pandrug-resistant AB(PDR-AB) and 39(51.3%) patients are multidrug-resistant AB(MDR-AB) and 1(0.013%) is sensitive to AB.

AB culture positive cases are more sensitive to aminoglycosides(38.1%), carbapenems(15.7%) and cotrimoxazole(14.5%).

Out of 20, ET culture AB positive cases 14(70%)patients developed PDR-AB, and 6(30%) developed MDR-AB.

Among procedures performed like mechanical ventilation,use of central line, and hemodialysis, it was observed that in patients infected with AB, about $3/4^{th}$ of cases(76%) had developed PDR AB.

Our study revealed that the majority(96%) of the patients had a history of prior antibiotic usage(≥2) among which about 60% had developed PDR AB.Drug-resistant AB is most commonly seen in patients with prior use of Betalactams and carbapenems.

Among total AB cases, it was noted that almost half(45.4%) had VAP, out of which 70% had developed PDR AB, and the majority of them(92.8%) attained mortality.

Mortality was seen in almost 70% of the patients infected with PDR-ABwhereas it is about 50% in patients with PDR klebsiella.

As information is limited regarding treatment for drug-resistant AB.It is recommended to prevent the occurrence of drug-resistant patterns in AB species. It can be prevented by interruption of transmission after reinforcement of existing infection control and prevention standards, such as hand hygiene, standard precautions, barrier precautions, and thorough environmental cleaning and disinfection. Other precautions include the judicious use of multiple invasive procedures and antibiotics to reduce the emergence of resistant strains.

LIMITATIONS OF STUDY:

1. Our study was not focused on the cause of mortality among AB patients, whether it was due to primary diagnosis, or superadded AB infection.
1. No differentiation was done between ICU and non-ICU ward patients with respect to infection/colonization by AB.
2. A molecular study for the resistance pattern ofAB infection was not included in this study.

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ANNEXURE I – CONSENT FORM

"STUDY OF RISK FACTORS AND CLINICAL PROFILE OF PATIENTS WITH ACINETOBACTER BAUMANNII INFECTION ADMITTED IN MEDICAL INTENSIVE CARE UNIT OF TERTIARY CARE HOSPITAL BELAGAVI."

A ONE YEAR CROSS-SECTIONAL STUDY

PRINCIPAL INVESTIGATOR:
DR.
Post Graduate student
Department of General Medicine

GUIDE:
DR.
Assosciate professor
Department of General Medicine
J.N. Medical College, KAHER,Belgaum

INTRODUCTION AND PURPOSE:

The present study is being conducted among culture-positive patients admitted in the medical ICU of KLE's Dr.PrabhakarKore Charitable Hospital and Medical Research Centre, Belgaum. They will be divided into AB and NON-AB groups based on the organism grown in the culture and will be assessed for the risk factors, clinical profile, and drug resistance pattern in the AB group. You are requested to participate in the study and your participation is completely voluntary.

PROCEDURE:

If you agree to participate in this study, you will be asked the relevant history and will be subjected to relevant clinical examination and investigations. You will also have to give a blood sample for the necessary investigations.

RISKS AND BENEFITS:

The only risk and possible discomfort you might get is while taking blood from your arm for the investigations. It may cause swelling, pain, redness (rarely happens) at the site from where the blood is drawn. You may be benefitted from these investigations and you will be part of this study which is going to be useful to others in the future.

Alternatives:

Taking part in this study is voluntary. You may choose not to take part in this study. If you decide to take part you can later change your mind and withdraw from the study. Your decision will not change the present or future health care or other services that you receive. The study doctor or sponsor may stop your participation in this study at any time. If you choose not to take part in the study, you will receive the standard treatment for patients with your condition.

PRIVACY AND CONFIDENTIALITY:

All information collected about you during the course of this study will be kept confidential to the extent permitted by law. The code numbers will identify you in this research record. Information from this study may be published but your identity will be confidential in any publication.

INSTITUTION / SPONSOR'S POLICY:

Does not apply to this research

FINANCIAL INCENTIVES FOR PARTICIPATION:

You will not be paid/offered any gifts /incentives for participating in the study.

AUTHORIZATION TO PUBLISH THE RESULTS:

The results of the study would be forwarded to the KLE University, Belgaum as part of the requirement towards the completion of MD degree, review, and publishing.

QUERIES AND CONTACT:

In the case of the queries during study or inthe future you may contact the following persons,

1. Dr., Chairman, J.N.M.C Ethical Committee forHuman Research.	2. Dr., Assosciate professor, Department of General Medicine, JNMC, Belgaum.

3. Dr. Investigator, PG in General Medicine, JNMC, Belgaum.

CONSENT FORM

I voluntarily agree to take part in this study by signing below. I may withdraw at any time. I am not giving up any of my legal rights by signing this form. My signature below indicates that I have read this consent form, or it has been read to me and have had all the questions answered.

Signature / Left Thumb print of the Participant or legally authorized representative

Participant's name :……...

Signature / Left thumb impression:……...of the participant

Name of the legally authorized :……...

representative / guardian

Signature / Left thumb impression :……...

Witness' name :……...

Signature / Left thumb impression :……...

Investigator's name and signature :……...

Date:

Place:

ANNEXURE – II - PROFORMA

Patients details

Name : **IP/OP number** :

Age/ Sex : **Address** :

Contact No. :

General Physical Examination:

Pulse: / min **;** **RR:** cycles /min

BP:/ mm Hg **;** **Temperature:** ^{0}**F**

WEIGHT: kgs **;** **HEIGHT:** cms

BMI: **;** **Waist Circumference:** cms

SYSTEMIC EXAMINATION:

CVS:

RS:

P/A:

CNS:

INVESTIGATIONS:

CBC,ESR, PS

LFT

RFT

BLOOD/ URINE/ ET/ PUS/ OTHER CULTURE

PCT

Radilogical investigations like X ray, CTscan and others.

Other investigations

Following parameters will be correlated with risk factors,clinical profile and resistance pattern of AcinetobacterBaumanii:

Primary diagnosis of patient:

Site of Acinetobacter or other HAI:

Drug susceptibility :

AMINOGLYCOSIDES

CARBAPENEMS

FLUOROQUINOLONES

PENICILLINS +BETA LACTAMASE INHIBITORS

EXTENDED SPECTRUM CEPHALOSPORINS

FOLATE PATHWAY INHIBITORS

POLYMIXINS

TETRACYCLINS

Duration of hospital stay :

Co-infection with other organisms:

h/o comorbidities :

h/o bedridden status :

h/o invasive procedures :

h/o prior antibiotic use :

h/o recent surgery :

h/o malignancy :

h/o prior ICU admission:

Outcome of the patient:

Signature of the Guide: **Date:**

ANNEXURE – III – ETHICAL CLEARANCE LETTER

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
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Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/25 **Date: 24/11/2018**

To,

PG student in Medicine,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"STUDY OF RISK FACTORS AND CLINICAL PROFILE OF PATIENTS WITH ACINETOBACTER BAUMANNII INFECTION ADMITTED IN MEDICAL INTENSIVE CARE UNIT OF TERTIARY CARE HOSPITAL, BELAGAVI. A ONE YEAR OBSERVATIONAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Arathi Darshan)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.