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Observational Study of bacteria causes Nosocomial Infection in an intensive care unit in Al-Brega General Hospital

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دراسة رصدية للبكتيريا المسببة للعدوى المكتسبة داخل المستشفى في وحدة العناية المركزة بمستشفى البريقة العام

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Abstract

This observational study aimed to identify the bacterial causes of nosocomial infections among patients admitted to the Intensive Care Unit (ICU) of Al-Brega General Hospital. A total of 500 patients admitted between August 2024 and January 2025 were monitored for the development of hospital-acquired infections. Clinical data were collected, and bacterial cultures were obtained from various clinical sites to determine the pathogens responsible for these infections.

The findings revealed that nosocomial infections occurred in 27% of ICU patients, with Staphylococcus aureus being the most prevalent pathogen (24.8%), followed by Escherichia coli (15.8%). Rifampin demonstrated the highest antibacterial efficacy, whereas 95.8% of the isolates showed resistance to commonly used antibiotics, underscoring a major therapeutic challenge in infection management.

These results emphasize the urgent need for robust infection control practices and the implementation of antibiotic stewardship programs within ICU settings to reduce infection rates. Furthermore, continuous surveillance of bacterial pathogens and antimicrobial resistance patterns is crucial to enhance patient outcomes and to inform evidence-based treatment strategies in critical care environments.

Keywords: Intensive Care Unit, Nosocomial Infections, Antibacterial.

الملخص

هدفت هذه الدراسة الرصدية إلى تحديد الأسباب البكتيرية للعدوى المكتسبة داخل المستشفى بين المرضى المقيمين في وحدة العناية المركزة بمستشفى البريقة العام. شملت الدراسة 500 مريض تم إدخالهم بين شهري أغسطس 2024 ويناير 2025،

حيث تمت مراقبتهم لاحتمال تطور عدوى مكتسبة أثناء الإقامة. جُمعت البيانات السريرية وأُجريت زراعات بكتيرية من مواقع مختلفة لتحديد مسببات العدوى.
أظهرت النتائج أن نسبة العدوى المكتسبة داخل المستشفى بلغت 27% من مرضى العناية المركزة، وكانت بكتيريا المكورات العنقودية الذهبية (Staphylococcus aureus) هي الأكثر شيوعًا بنسبة 24.8%، تلتها الإشريكية القولونية (Escherichia coli)بنسبة 15.8%. كما أظهرت النتائج أن الريفامبين (Rifampin) كان الأكثر فاعلية ضد العزلات البكتيرية، في حين أبدت 95.8% من العزلات مقاومة عالية للمضادات الحيوية الشائعة الاستخدام، مما يمثل تحديًا كبيرًا في إدارة العدوى.
تؤكد هذه النتائج على الحاجة الملحّة لتطبيق إجراءات فعالة لمكافحة العدوى، وتنفيذ برامج الاستخدام الرشيد للمضادات الحيوية داخل وحدات العناية المركزة للحد من معدلات الإصابة. كما توصي الدراسة بأهمية المراقبة المستمرة لمسببات العدوى وأنماط مقاومتها للمضادات الحيوية لتحسين نتائج المرضى ووضع استراتيجيات علاجية قائمة على الأدلة في بيئات الرعاية الحرجة.

الكلمات المفتاحية : وحدة العناية المركزة – العدوى المكتسبة داخل المستشفى – المضادات البكتيرية.

1. Introduction

The term nosocomial infection, also referred to as a hospital-acquired infection, describes infections that develop in patients after 48 to 72 hours of hospitalization, provided that these infections were not incubating at the time of admission. In the United States, more than 1.6 million patients are affected annually, resulting in an estimated cost of about $4.5 billion per year . (1) According to the Centers for Disease Control and Prevention (CDC), such infections contribute to 0.7–10.1% of all deaths and account for 0.1–4.4% of total hospital mortality.

In India, it is estimated that 10–30% of hospitalized patients in hospitals and nursing homes acquire nosocomial infections, compared with approximately 5% in Western countries, as reported by the Hospital Infection Society (HIS). This concerning situation has been linked to insufficient investment in infection control, lack of awareness, and inefficient waste management systems . In a multicenter study conducted across intensive care units in seven Indian cities, the reported infection rates were 7.92 per 1000 catheter-days for central venous catheter–related bloodstream infections (CVC-BSI), 10.46 per 1000 ventilator-days for ventilator-associated pneumonia (VAP), and 1.41 per 1000 catheter-days for catheter-associated urinary tract infections (CAUTI). (2)

The word “nosocomial” broadly refers to any disease acquired by a patient under medical care. More precisely, nosocomial infections (NI)—or hospital-associated infections (HAI)—are those that arise during hospitalization or other clinical care and were absent upon admission, though they may become clinically apparent either during the hospital stay or after discharge . (3)

Additionally, healthcare workers, hospital visitors, and newborns exposed during childbirth may also develop nosocomial infections. Historically, these infections have existed since the establishment of hospitals, and they continue to pose a major health challenge even in the modern antibiotic era, leading to high morbidity and mortality, prolonged hospital stays, increased antibiotic usage, and greater healthcare costs. Epidemiological data indicate that nosocomial infections occur in 5–10% of hospitalizations in Europe and North America, whereas the incidence may exceed 40% in parts of Asia, Latin America, and sub-Saharan Africa .

While many microorganisms can cause such infections, only a limited number of bacterial species are commonly responsible. This review article provides an overview of nosocomial infections by infection site, highlights frequent bacterial pathogens and antibiotic-resistant

strains, and discusses their sources, transmission routes, risk factors, and prevention strategies. (4)

1.1 Epidemiology of nosocomial infections .

Epidemic infections are observed during outbreaks, which are defined as an unusual rise above the expected baseline for a specific infection or pathogen. With the evolution of healthcare delivery, characterized by shorter hospitalizations and expanded outpatient services, it has been proposed that the term nosocomial infection should extend to include infections acquired in any healthcare environment, not solely within hospitals. Furthermore, infections affecting healthcare personnel or visitors may also fall under this category. In facilities where comprehensive diagnostic tools are unavailable, simplified working definitions may assist in identifying and managing such infections. (5)

The literature identifies three primary factors contributing to nosocomial infections (NI). The first is the use and misuse of antimicrobial agents, as prolonged or inappropriate antibiotic therapy fosters the emergence of resistant microbial strains. The second factor relates to lapses by hospital staff or infection control committees in maintaining strict aseptic conditions. The third concerns the patients themselves, who may be predisposed to infection due to low immunity or inadequate hygiene. In addition to these principal causes, several other precipitating factors may further increase the risk of acquiring nosocomial infections. (6)

Regarding ventilator-associated pneumonia (VAP), approximately 60% of cases are caused by aerobic gram-negative bacilli, most notably Pseudomonas aeruginosa, Acinetobacter species, Proteus species, Escherichia coli, and Klebsiella species. Meanwhile, Staphylococcus aureus accounts for roughly 20–30% of VAP cases, with its incidence showing an upward trend in recent years. (6)

1.2 Bacteriology of Commonly Isolated Nosocomial Pathogens

1.2.1 Staphylococcus aureus

The genus Staphylococcus comprises multiple species, among which Staphylococcus aureus (S. aureus) is recognized as the most significant nosocomial pathogen. It is a nonmotile, non–spore-forming, catalase-positive, gram-positive coccus, and a facultative anaerobe that typically appears in clustered arrangements . S. aureus functions both as a commensal organism and a pathogen; approximately 20% of individuals carry it persistently in their nasal passages, while about 30% are intermittent carriers.

Clinically, S. aureus remains a major etiological agent of hospital-acquired infections, serving as the leading cause of lower respiratory tract and surgical site infections, and the second most common cause of nosocomial bacteremia, pneumonia, and cardiovascular infections . The organism's broad range of virulence factors, encompassing both structural components and secreted products, contributes substantially to its pathogenic potential and infection dynamics. (7)

1.2.1.1 Methicillin resistant Staphylococcus aureus (MRSA)

Resistance to penicillin and to the later-developed narrow-spectrum β-lactamase–resistant penicillins (such as methicillin and oxacillin) emerged shortly after their introduction into clinical use—penicillin in the 1940s and methicillin in the 1960s. Initially, penicillin resistance was observed only among a limited number of hospitalized patients, but as antibiotic usage

expanded, resistant strains rapidly disseminated to other hospitals and eventually into the wider community.

This resistance, largely driven by penicillinase-producing Staphylococcus strains, was temporarily addressed through the development of penicillinase-resistant penicillins, cephalosporins, and other antibiotic classes effective against Staphylococcus species. However, resistance soon re-emerged with the appearance of methicillin-resistant Staphylococcus species (MRSA), which became a major clinical and public health concern. (7)

1.2.2 Escherichia coli

Escherichia coli (E. coli) is a Gram-negative, facultatively anaerobic, and oxidase-negative bacterium. It is among the most frequent pathogens associated with Gram-negative sepsis and endotoxin-mediated shock. In clinical settings, E. coli commonly causes urinary tract infections, wound infections, and pneumonia—particularly in immunocompromised or hospitalized patients—as well as neonatal meningitis and E. coli–associated diarrheal illnesses such as gastroenteritis.

The organism exhibits a wide array of virulence determinants, several of which are shared with other members of the Enterobacteriaceae family, including endotoxin (lipopolysaccharide) and capsular polysaccharides, which enhance its pathogenic potential. (8)

1.2.3 Pseudomonas aeruginosa

Pseudomonas aeruginosa is a Gram-negative bacterium characterized by a mucoid polysaccharide capsule and typically appears in pairs under microscopy. Its identification is primarily based on distinct colony morphology and basic biochemical testing . This organism can transiently colonize the respiratory and gastrointestinal tracts of hospitalized or immunocompromised patients .

The pathogenesis of P. aeruginosa begins when the host's normal defense mechanisms are compromised—for instance, through disruption of physical barriers caused by intravenous or urinary catheters, or during neutropenia associated with cancer chemotherapy. Once defenses are impaired, the bacterium adheres to and colonizes mucosal surfaces or damaged skin, subsequently invading local tissues and potentially leading to systemic infection. (9)

3.3.4 Enterococcus spp .

Enterococci are Gram-positive cocci, typically occurring in pairs or short chains. They constitute part of the normal microbiota of the human gastrointestinal and genitourinary tracts, yet have emerged as major nosocomial pathogens in recent decades . Among the species, Enterococcus faecalis and Enterococcus faecium account for the vast majority of human infections, while other species are infrequently encountered.

Globally, E. faecalis and E. faecium rank as the third or fourth most common hospital-acquired pathogens, contributing significantly to morbidity among inpatients. The urinary tract represents the most frequent site of enterococcal infection, although these organisms are also responsible for surgical wound infections, bacteremia, endocarditis, neonatal sepsis, and, on rare occasions, meningitis. Of the two principal species, E. faecalis causes approximately 80–90% of infections, whereas E. faecium accounts for 10–15%. (10)

1.2.4.1 Vancomycin resistant Enterococci

The first documented case of vancomycin-resistant enterococci (VRE) was reported in 1996 . Since then, four primary resistance phenotypes have been identified—VanA, VanB, VanC, and VanD—with VanA being the most prevalent and clinically significant . The development of vancomycin resistance requires the expression of multiple genes, meaning that resistance does not occur spontaneously, but rather through the horizontal acquisition of resistance genes from other bacterial species.

Furthermore, vancomycin resistance in enterococci is frequently associated with concurrent ampicillin resistance, a phenomenon often attributed to genetic linkage between the resistance determinants . (11)

1.2.5 Klebsiella infections

Klebsiella species represent significant hospital-acquired pathogens, responsible for roughly 5–7.5% of all nosocomial infections. Even with the application of appropriate antimicrobial treatment, the rates of morbidity and mortality associated with severe systemic illnesses—particularly bacteremia and pneumonia—remain considerably elevated. Reported mortality figures range between 20–50% for Klebsiella bacteremia, and may surpass 50% in cases of Klebsiella pneumonia. (12)

2. MATERIA AND METHODS

The study sample comprised all patients admitted to the Intensive Care Unit (ICU) of Al-Brega General Hospital during the period from August 2024 to January 2025. The sample included surgical patients, defined as individuals who had undergone any surgical intervention involving incision and suturing, including video-laparoscopic procedures performed in the operating room.

Colonization by resistant microorganisms was determined through laboratory culture and microbial identification. A nosocomial infection (NI) was defined as any infection diagnosed in the ICU after 48 hours of admission or occurring within 48 hours following discharge from the unit. Additionally, urinary tract infections developing within seven days post-discharge and associated with prolonged urinary catheterization were also classified as nosocomial infections. Cases of colonization by resistant organisms during ICU stay were recorded accordingly.

2.1 Types of Culture Media Used for Growing Bacteria

2.1.1 CLED agar (cystine lactose electrolyte deficient medium)

The culture medium utilized for the isolation and differentiation of urinary pathogens is formulated to be electrolyte-deficient, thereby inhibiting the swarming motility of Proteus species. The inclusion of L-cystine supports the development of cystine-dependent dwarf colonies. The medium incorporates bromothymol blue as a pH indicator, which exhibits a color shift to yellow upon acid production during lactose fermentation, and turns deep blue under alkaline conditions. Consequently, lactose-fermenting bacteria form yellow colonies, whereas organisms capable of decarboxylating L-cystine produce alkaline reactions, resulting in the appearance of deep blue colonies.

2.1.2 Blood Agar Plate (BAP) is an enriched medium widely used in medical bacteriology for the cultivation of various bacterial species. It is prepared by adding sterile blood to nutrient agar that has been melted and cooled to approximately 50 °C, ensuring proper mixing without causing hemolysis of the blood cells**.**

2.1.3 Chocolate Agar (CHOC) , also known as Chocolate Blood Agar (CBA), is an enriched medium and a modified form of blood agar. It is prepared by heating red blood cells to approximately 80 °C, which causes cell lysis and the release of intracellular nutrients such as hemoglobin and NAD (factor V). This process gives the medium its characteristic brown "chocolate-like" appearance and supports the growth of fastidious organisms, including Haemophilus influenzae and Neisseria species.

2.1.4 Mannitol Salt Agar This medium plays a vital role in medical microbiology laboratories as it allows for the rapid differentiation of pathogenic microorganisms. It serves as a differential medium designed to identify mannitol-fermenting bacteria, as it contains

mannitol as the primary carbohydrate source and phenol red as a pH indicator. When mannitol fermentation occurs, acid production lowers the pH, turning the medium yellow. Accordingly, Staphylococcus aureus forms yellow colonies surrounded by yellow zones, while other Staphylococcus species that do not ferment mannitol produce small pink to red colonies without any color change in the medium. (3).

2.1.5 MacConkey agar is a selective and differential culture medium primarily used for the isolation and cultivation of Enterobacteriaceae and other Gram-negative bacteria from clinical specimens.

2.1.6 Eosin Methylene Blue (EMB) Agar is a selective and differential medium containing the dyes eosin and methylene blue, along with the carbohydrates lactose and sucrose. The dyes serve a dual purpose: they inhibit the growth of most Gram-positive bacteria and act as pH indicators to differentiate between lactose fermenters and non-fermenters.

This medium is particularly valuable for the isolation and identification of Escherichia coli, which characteristically forms colonies with a distinctive green metallic sheen on EMB agar due to strong acid production during lactose fermentation..

2.2 Examine the specimen microscopically .

2.2.1 Gram stain: The Gram stain is a differential staining technique used to classify bacteria as Gram-positive or Gram-negative based on differences in their cell wall composition. It is a fundamental procedure in medical microbiology for identifying pathogens in clinical specimens and bacterial cultures, providing essential information about their Gram reaction and cellular morphology.

Reagents Used in the Gram Staining Technique :

The **Gram staining procedure** requires the following reagents:

1. **Crystal Violet Stain** – Primary stain used to color all bacterial cells initially.
2. **Lugol's Iodine Solution** – Serves as a mordant to form a crystal violet–iodine complex, enhancing dye retention in Gram-positive cells.
3. **Acetone-Alcohol (Decolorizer)** – A differential reagent that removes the primary stain from Gram-negative cells while retaining it in Gram-positive cells.
4. **Neutral Red (0.1% w/v; 1 g/L)** – Counterstain applied to visualize Gram-negative bacteria, which appear pink to red, while Gram-positive organisms remain purple.

2.2.1.1 Method

- **Fixation:**

Prepare and air-dry the smear on a clean glass slide. Fix the smear by gently passing it through the flame or, for specimens intended for the detection of *Neisseria gonorrhoeae* or *Neisseria meningitidis*, fix with **methanol for 2 minutes** to avoid damaging pus cells.

- **Primary Staining:**

Flood the fixed smear with **crystal violet stain** and allow it to act for **30–60 seconds**.

- **Rinsing:**

Rinse the slide gently with **clean running water** to remove excess stain. *Note:* If tap water is not clean, use **filtered or boiled rainwater**.

- **Mordant Application:**

Cover the smear with **Lugol's iodine solution** for **30–60 seconds** to form a crystal violet–iodine complex.

- **Rinsing:**

Wash off the iodine with clean water and remove excess fluid by gently tipping the slide.

- **Decolorization:**

Decolorize briefly with **acetone-alcohol** (a few seconds only), then **immediately rinse** with clean water to stop the action.
Caution: Acetone-alcohol is **highly flammable**; handle it away from open flames.

- **Counterstaining:**

Apply **neutral red (0.1% w/v; 1 g/L)** for **2 minutes** to counterstain Gram-negative bacteria.

- **Final Rinse:**

Wash off the counterstain with clean water and allow excess water to drain.

- **Drying:**

Wipe the back of the slide and place it on a **draining rack** to **air dry** completely.

- **Microscopic Examination:**

Examine the stained smear first under the **40× objective** to assess staining quality and material distribution, then under the **oil immersion objective (100×)** to identify bacterial morphology and Gram reaction.

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2.3Biochemical reactions:

2.3.1 Catalase test: The catalase test is a biochemical assay used to distinguish catalase-producing bacteria, such as staphylococci, from non–catalase-producing bacteria, such as streptococci. The test detects the presence of the enzyme catalase, which catalyzes the decomposition of hydrogen peroxide (H_2O_2) into water and oxygen, evidenced by the rapid formation of bubbles upon contact with the reagent.

2.3.2 Coagulase test: The coagulase test is a diagnostic assay used to identify Staphylococcus aureus based on its ability to produce the enzyme coagulase. This enzyme reacts with fibrinogen in plasma, leading to clot formation, which serves as a distinguishing feature separating S. aureus (coagulase-positive) from other staphylococcal species (coagulase-negative)

2.3.3 DNAase test: The DNase test is used to aid in the identification of Staphylococcus aureus, which produces the enzyme deoxyribonuclease (DNase). This enzyme breaks down deoxyribonucleic acid (DNA) into smaller fragments, allowing differentiation of S. aureus from other staphylococcal species that do not produce DNase.

2.3.4 T.S.I The T.S.I test is used to differentiate enteric bacteria based on their ability to ferment carbohydrates (glucose, lactose, and sucrose) and to produce hydrogen sulfide (H_2S).

2.3.5 Citrate utilization test: This test is one of several techniques used occasion-ally to assist in the identification of enterobacteria. The test is based on the ability of an organism to use citrate as its only source of carbon. identify K. pneumonia .

2.3.6 Indole Test: The indole test is based on the ability of certain bacteria to split tryptophan to alanine and indole. The liberated indole will combine with paradimethylaminobenzaldehyde in Kovac's reagent to give a deep red color .

2.3.7 Phoenix 100 system: Used for identification or confirmation of isolated bacteria .

2.4 Susceptibility testing techniques: Laboratory antimicrobial susceptibility testing can be performed using :

2.4.1 Müller Hinton agar is a microbiological growth medium that is commonly used for antibiotic susceptibility testing

2.4.2 Disc diffusion susceptibility tests: Disc diffusion techniques are used by most laboratories to test routinely for antimicrobial susceptibility. A disc of blotting paper is impregnated with a known volume and appropriate concentration of an antimicrobial, and this is placed on a plate of susceptibility test in agar uniformly inoculated with the test organism .

2.4.3 Method

Preparation of the Inoculum:

Using a sterile wire loop, select 3–5 well-isolated colonies of similar morphology from a pure culture of the test organism. Emulsify the colonies in 3–4 mL of sterile physiological saline or nutrient broth to prepare a uniform bacterial suspension.

Standardization of Turbidity:

Under adequate lighting, adjust the turbidity of the bacterial suspension to match that of a standard turbidity reference (e.g., 0.5 McFarland standard). Note: Mix the turbidity standard immediately before use. For easier comparison, observe the tubes against a white background with black text.

Inoculation of Mueller–Hinton Agar Plate:

Using a sterile cotton swab, dip into the standardized suspension and remove excess fluid by pressing and rotating the swab against the inner wall of the tube above the liquid level. Evenly streak the swab across the surface of a Mueller–Hinton agar plate in three directions, rotating the plate approximately 60° each time to ensure uniform distribution.

Drying the Plate:

With the lid closed, allow the inoculated plate to stand at room temperature for 3–5 minutes (but not more than 15 minutes) to permit the surface moisture to be absorbed before applying antibiotic discs.

Application of Antimicrobial Discs:

Using sterile forceps, a needle holder, or a multidisc dispenser, place the appropriate antimicrobial discs onto the agar surface. The discs should be evenly spaced and firmly in contact with the agar. A placement template may be used to ensure proper spacing.

Incubation:

Within 30 minutes of disc application, invert the plate and incubate it aerobically at 35 °C for 16–18 hours. Note: Temperatures *above 35 °C may invalidate results for oxacillin.

Examination and Measurement:

After overnight incubation, examine both control and test plates to confirm that bacterial growth is confluent or nearly confluent. Using a ruler or caliper on the underside of the plate, measure the diameter of each inhibition zone (in millimeters). The endpoint of inhibition is taken as the point where visible bacterial growth begins

3.RESULTS

The study was conducted over a period of 6 month (from August 2024 to January 2025) on 500 patients The results obtained showed that the rate of nosocomial (BSI) in infection rate (27%).

3.1 Distribution of bacterial isolates

Distribution of bacterial isolates shown in (fig. 9). the results showed that Gram positive bacterial isolated from BSI. In this study were more than Gram negative bacteria, the percentage of Gram positive bacteria isolated (59.4%). However lower percentge of Gram-negative bacterial isolated was (40.6%). Among all isolates collected S. aurues represented the highest percentage (24.8%) followed by E coli (15.8%) S hominis (12.9%) S.epidermides (12.9%), K.pneumonia (11.9%), A. baumnnii (6.9%), S. marcescens (4.0%), whereas S. capitis and S. haemoyticus (3.0%), S. pneumonia(2.0%), but S. klossi, K. oxetoca and Enterobacter spp all were (1.0%) (fig.6)

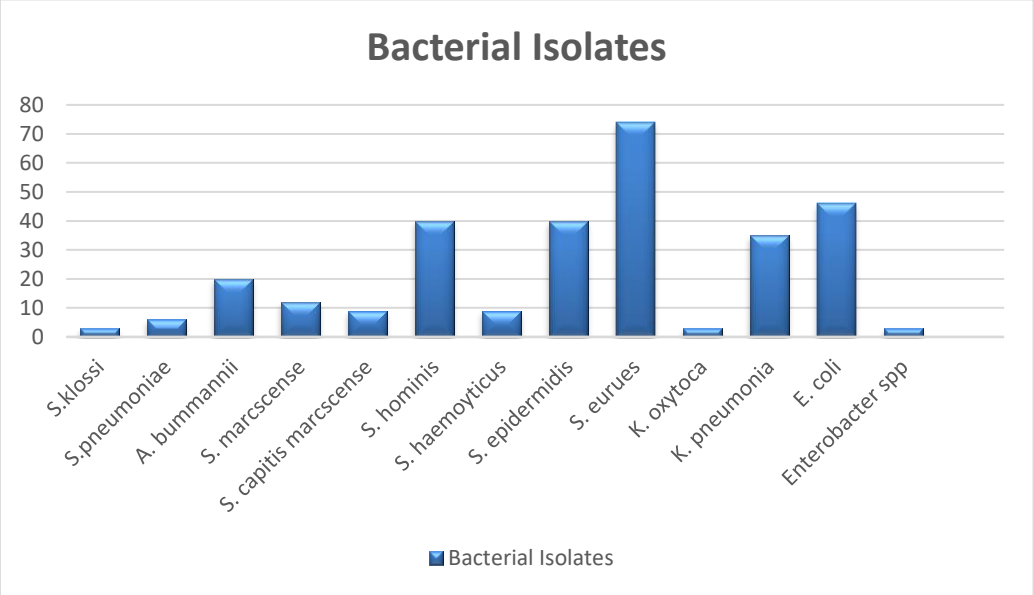

Figure 6: Distribution of bacterial isolates.

3.2 Distribution of bacterial isolates according to age

The occurrence of bacterial BSI pathogens according to age is presented in (fig. 7). the results showed that the highest overall infection rate was in age group range from 50 to 74 (46%) followed by the age from 15 to 49 (41%) while the lowest distribution was in the age from75to 99 (13%). S. aurues represent the highest percentage (11.9%) among group 15-45y and (8.9%) among age group 50 to 74. However the age group 75-99 showed the lowest occurrence, in this age group the highest percentage represented also by S. aureus (4.0%). Notably age is not important factor in this study. (fig. 7)

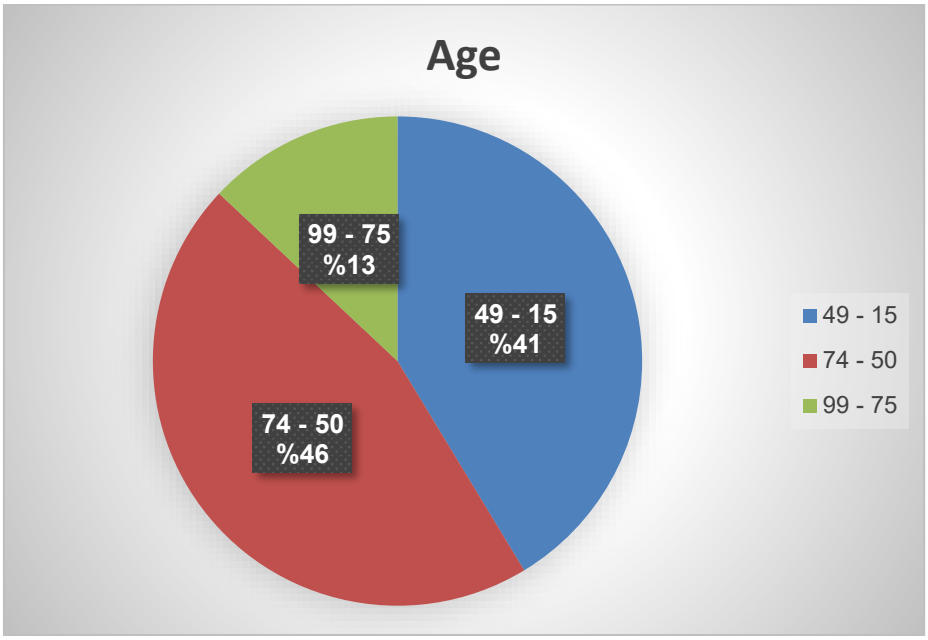

Figure 7: Distribution of bacterial isolates according to age.

3.3 Prevalence of Gram positive isolates according to susceptibility antimicrobials agents Table .1

These results show that Rifampin was the most effective antibacterial (95.8%) against Gram positive isolates followed by Teicoplanin (91.6%) Ciprofloxacin (90.2%), Vancomycin (87.4%), Trimethoprim Sulfamethoxazole (86.0%), Linezolid (84.6%), Gentamicin syne (69.2%), Daptomycin (65.%), Tetracyclin (59.4%), Clindamycin (47.6%), Erythromycin (45.5%), Augmentine (35.0%), Imepenim (25.2%), Oxacillin (20.3%), Gentamycin (18.9%), Cefoxitin (17.5%), (6.3%) and Ampcillin (0.7%).

Table 1: prevalence of gram-positive isolates according to susceptibility to antimicrobials agent

Antibiotic	Susceptible	Intermediate	Resistant
Gentamycin	26.6%	4.2%	69.2%
Imepinim	74.8%		18.9%
Cefoxitin	82.5%		17.5%
Cefotaxime	94.4%	2.1%	3.5%
Ampicillin	99.3%		0.7%
Penicillin	93.7%		6.3%
Oxacillin	79.7%		20.3%
Augmentin	65.0%		35.0%
Daptomycin	35.0%		65.0%
Trimethoprim – Sulfamethoxazole	11.9%	2.1%	86.0%
Teicoplanin	4.9%	3.5%	91.6%
Vancomycin	10.5%	2.1%	87.4%
Clindamycin	10.5%	4.2%	47.6%
Erythromycin	52.4%	2.1%	45.5%
Linezolid	11.9%	3.5%	84.6%
Ciprofloxacin	7.0%	2.8%	90.2%
Tetracycline	61.1%	3.5%	35.4%

3.4 Table 2: Prevalence of Gram-negative isolates according to susceptibility to antimicrobials agents

Table. 2 showed the most antibacterial effect was Imepenim by (92.0%) followed by Meropenem (90.3%), Amikacin (77.9%) Trimeyhoprim Slfamethoxaole (49.6%), Piperacillin /Tazobctam (47.8%), Cefothixin (46.9%), Ciprofloxacin (44.2%), Colistin (43.4%), Ceftazidim (37.2%), Gentamycin (36.8%), Aztronam and Tetracyclin (35.4%), Cefipiem (31.9%), Cefotaxim (30.1%), Cefurxime (17.7%), Piperacillin (16.8%), Augmentin (15.0%), Ampcillin (8.0%) and Cephalothin (6.2%).

Table 2: prevalence of gram- negative isolates according to susceptibility to antimicrobials agent

Antibiotic	Susceptible	Intermediate	Resistant
Amikacin	77.9%	22.1%	
Gentamycin	36.8%	62.8%	0.9%
Imepinim	92.0%	4.4%	3.5%

Meropenem	90.33%	9.7%	
Cefalothin	6.2%	89.4%	4.4%
Cefuroxime	17.7%	78.8%	3.5%
Cefoxitin	46.9%	46.9%	6.2%
Ceftazidime	37.2%	61.9%	0.9%
Cefotaxime	30.1%	68.1%	1.8%
Cefepime	31.9%	65.5%	2.7%
Aztronam	35.4%	63.7%	0.9%
Ampicillin	8.0%	92.0%	3.5%
Piperacillin	16.8%	82.3%	0.9%
Augmentin	15.0%	73.5%	11.5%
Piperacillin – Tazobactam	47.8%	43.4%	8.8%
Colistin	43.4%	54.9%	1.8%
Trimethoprim – Sulfamethoxazole	49.6%	50.4%	
Ciprofloxacin	44.2%	53.1%	2.7%
Tetracycline	35.4%	61.1%	3.5%

4. Discussion

The term nosocomial infection is synonymous with hospital-acquired infection. An infection is considered nosocomial when it develops in a patient after 48 to 72 hours of hospitalization and was not incubating at the time of admission. (1)

Previous research findings were consistent with those of our study, defining nosocomial infection as any infection detected in the Intensive Care Unit (ICU) after 48 hours of admission, or within 48 hours following patient discharge.

Methicillin-resistant Staphylococcus species (MRSA) were first reported within one year of methicillin's introduction (1959–1960), with the first hospital outbreak of MRSA documented in 1968. Since that time, the incidence of MRSA infections in hospital settings has increased significantly worldwide.

In our study, Staphylococcus aureus resistant to methicillin (MRSA) accounted for 5.7% of all bacterial isolates tested. However, methicillin-resistant coagulase-negative staphylococci (MRCoNS) were identified at a higher frequency (27.4%).

When analyzing bloodstream infection (BSI) isolates, Gram-positive bacteria represented 59.4% of all organisms identified. Among these, MRSA was the most prevalent species (13.9%), while methicillin-resistant coagulase-negative staphylococci were reported at 28.7%.

Regarding ventilator-associated pneumonia (VAP), aerobic Gram-negative bacilli were responsible for approximately 60% of cases. The most commonly isolated organisms included Pseudomonas aeruginosa, Acinetobacter species, Proteus species, Escherichia coli, and Klebsiella species. In contrast, Staphylococcus aureus accounted for 20–30% of VAP cases, and its incidence continues to rise.

Overall, our study demonstrated a predominance of Gram-positive bacteria (59.4%), although Gram-negative organisms also constituted a substantial proportion of isolates.

5. CONCLUSIONS

Despite the widespread availability of antibiotics, nosocomial infections remain a major challenge in modern healthcare. Effective control of hospital-associated pathogens is crucial, as these infections result in significant economic losses and decreased productivity.

Transmission within healthcare facilities—often facilitated by healthcare workers—can be minimized through strict adherence to infection prevention and control (IPC) measures.
The inappropriate and excessive use of antibiotics continues to be a key factor in the emergence of multidrug-resistant organisms, which complicates treatment and limits therapeutic options. Hospitals should therefore establish comprehensive infection control programs to enable systematic surveillance, comparison, and reduction of infection rates. Such initiatives should be implemented in accordance with Centers for Disease Control and Prevention (CDC) guidelines. Moreover, there is a pressing need for collaboration and the exchange of best practices among healthcare institutions to curb the spread of nosocomial infections and promote sustainable infection control strategies.

6. RECOMMONDATIONS

- **Scientific Evidence:**
  Infection control practices should be guided by **evidence derived from well-designed randomized controlled trials**, ensuring that preventive strategies are both effective and scientifically validated.
- **Hand Hygiene:**
  Frequent hand washing remains the **most critical and effective intervention** for preventing the transmission of infections within healthcare settings. Proper hand hygiene should be promoted as a **universal standard of care** among healthcare personnel.
- **Use of Personal Protective Equipment (PPE):**
  Gloves, gowns, and masks play an important role in minimizing infection transmission. However, their **inappropriate or excessive use** can lead to **unnecessary financial burdens** on healthcare services and may reduce compliance when not properly justified.
- **Behavioral and Ethical Considerations:**
  Some healthcare workers may become **defensive or distressed** when their poor hygiene practices are addressed. It is essential to approach such situations with **professional sensitivity**, emphasizing that lapses in hygiene can contribute to **disease transmission** and **patient harm**, thereby complicating infection control efforts.
- **Elimination of Endogenous Pathogens and Cross-Contamination Prevention:**
  Infection control should also aim to **reduce endogenous sources of nosocomial pathogens** by limiting **oropharyngeal, intestinal, and skin colonization**. In addition, hospitals must implement strict measures to **prevent cross-contamination** and **control potential reservoirs** of infection that may be transmitted **from patient to patient or from healthcare personnel to patients**.

7. REFERENCES

1. Jain Atul, Singh K. Recent Advances in the Management of Nosocomial Infections, Review article. JK Science, 2007:9:1.
2. Mehta A. Rosenthal VD, et al. Device-associated nosocomial infection rates in intensive care units of seven Indian cities. Journal of Hospital Infection (2007) 67, 168-174, www.sciencedirect.com
3. PRAKASH SK. Nosocomial infection an overview. In:Maulana Azad Medical College, New Delhi: 2001;6: 1-13.
4. HÄUBLER S. Sociomicrobiology: New approaches to understand chronic infectious diseases. Helmholtz Centre Infect Res 2007; 4: 301-305.

5. Girard R. Guide technique d'hygiène hospitalière. Alger, Institut de la Santé publique et Lyon, Fondation Marace Mérieux, 1990.
6. Rosenthal VD, Guzman S. Orellano PW. Nosocomial infections in medical-surgical intensive care units in Argentina: attributable motality and lenght of stay. Am J Infect Control 2003; 31(5):291-5.
7. WAHINGTON CW, ALLEN SD, JANDA WM, KONEMANEW, PROCOP GW. Koneman's color atlas and textbook of diagnostic microbiology. 6 ed: Lippincott Williams & Wilkins; 2006.
8. BROOKS GF, CARROLL KC, BUTEL JS, MORSE SA.Jawetz, Melnick, Adelberg's Medical microbiology.24 ed: McGraw-Hill Companies Inc; 2007.
9. CONTRERAS GA, DIAZ CA, CORTES L, REYES J, VANEGASS, PANESSO D, RINCÓN S, DÍAZ L, PRADA G, MURRAYBE, ARIAS CA. Nosocomial outbreak of Enterocco-cus gallinarum: untaming of rare species of ente-rococci. J Hosp Inf 2008; 70: 346-532.
10. MAROTHI YA, AGNIHOTRI H, DUBEY D. Enterococcalresistance-an overview. Indian J Med Microbiol2005; 23: 241-249.
11. GOULD M. Antibiotic policies to control hospital-ac-quired infection. J Antimicrob Chemother 2008;10: 100-115.
12. Bryan C S, Reynolds K L, Brenner E R. Analysis of 1,186 episodes of gram-negative bacteremia in non-university hospitals: the effects of antimicrobial therapy. Rev Infect Dis. 1983;5:629-638. [PubMed}

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.