iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: VIII Month of publication: August 2026

DOI: https://doi.org/10.22214/ijraset.2026.84514

Detection of Hospital Infections Related to Septicemia Among Patients Admitted to MK Nimr Hospital in Shendi City-Sudan

Mahasin A M. Yassin[1], Sanaa M A. Osman[1], Alawia Alatta Malik Ali[2], Amira Eltom Fawzi Osman[1], Amira Hassan AbdAlrahman Arman[3], Ines Belaiba Aloulou[4], Taisseir A Ahmed G Elseed[5]

[1]*Department of microbiology and immunology-faculty of medical laboratory science- University of Alzaiem Alazhari*

[2]*Red Crescent organization- Sudan- Volunteer in war campus- Medical zone*

[3]*Associate professor, faculty of medicine, university of Dongola department of community medicine –Sudan*

[4]*Register professional Master in Emergency Medicine – Sfax University- Tunisia*

[5]*Department of hematology-faculty of medical laboratory science- Alneelain University*

Abstract: Background: hospital acquired infection has become a major issue due to increased resistance around, here in Mk Nimr Hospital, as a consequences or relocation of people due to outbreak of war around the country, and diminished resources beside increased hospitalized patients, it observed that patients' death due to HAI as gaining infection after admission navigated thought toward this study, which was conducted as a community service in order to serve patients with outcomes of laboratory work. So blood samples were aimed to be cultured, isolated bacteria underwent to identification and sensitivity for drugs. This study was approved by Medical Laboratory Science college-Alzaeim Alazhari University-Microbiology department, as well as Hospital administration and patients. Data obtained were analyzed by statistical package of social science (SPSS) version 22.

Method: 52 Whole blood samples were collected then inoculated in media of blood culture, then Macconkey, blood agar, chocolate and CLED. Laboratory work was conducted according to what market provides, Macconkey media used was contained suppressor for gram positive bacteria, so extra media used was CLED for ensuring growth of gram positive in aerobic environment. Gram stain, identification through biochemical tests and antibiotic sensitivity tests were conducted.

Result: Blood samples cultured, no growth in 39 (75%) of samples and 13 (25%) with growth. Gram stain for growth bacteria revealed 3 (23.1%) gram positive cocci and 10 (76.9%) gram, negative bacilli, isolated organisms were S aureus (23.1%), E coli 7.1% and P aeruginosa 69.2%. Sensitivity test revealed s aureus was more sensitive to all drugs except resist to CXM (75%) and 100% AMC. E coli sensitive to all antibiotic except for AMC and CXM. P aeruginosa was 100 sensitive to AK, more than 75% to LEV, CIP, CN, NOR, 33% to AMC, CXM and more than 50% to CRO.

Conclusion: Gram-negative bacteria, particularly P. aeruginosa, were the leading cause of bloodstream infections, emphasizing the need for routine antimicrobial susceptibility testing to guide appropriate antibiotic therapy.

Keywords: Staphylococcus aureus, Escherichia coli, pseudomonas. aeruginosa, Hospital acquired infection

I. INTRODUCTION

Nosocomial infections, also known as healthcare-associated infections (HAI) (1-2), are infections contracted while receiving medical care that were not present at the time of admission. These infections can be hospital-acquired (nosocomial), long-term care-associated, outpatient care-associated, or home care-associated. Details regarding the burden of HCA. The difficulty of obtaining trustworthy data on infection, preventive, and control techniques limits its use outside of the hospital. HAIs, however, are the most common health issue in hospital settings, according to research. Worldwide, hospital-acquired infections have a high morbidity and mortality rate in both industrialized and developing nations. Infection occurs when a disease or pathogens are transferred to a susceptible patient host. In modern healthcare, these infections are associated with prosthetic devices, indwelling medical equipment, and invasive treatments including surgery (1—3).

A. Effect of HAI

Hospital-acquired infections increase the patient's emotional strain and functional impairment, and they can occasionally result in conditions that are incapacitating and lower their quality of life. One of the main causes of death is nosocomial infections.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VIII Aug 2026- Available at www.ijraset.com

There are significant financial costs. The biggest source of expense is the longer hospital stays for infected individuals. Long stays raise indirect expenses because of missed work in addition to direct expenditures for patients or payers. Costs are also increased by the requirement for isolation, higher drug use, and more laboratory and other diagnostic testing. By directing limited resources toward the treatment of potentially avoidable illnesses, hospital-acquired infections exacerbate the disparity in the distribution of resources for primary and secondary health care. Patients who are admitted to healthcare facilities are getting older, more of them have chronic illnesses, and more diagnostic and therapeutic treatments are being used (4).

Concerns with HAI Patient Safety and Outcomes: HAIs can aggravate a patient's illness, increase recovery time, and have major repercussions or even cause death. because avoiding them improves treatment outcomes and reduces unnecessary suffering. Monitoring helps in early detection and control of HAI. By quickly detecting infections, this helps stop hospital outbreaks. Healthcare workers can isolate cases, put infection control measures in place, and stop the spread of infection to other patients and employees thanks to early diagnosis Prevention of Antimicrobial Resistance (AMR): Since resistant bacteria are often implicated in healthcare-associated infections (HAIs), screening for them ensures that antibiotics are administered appropriately and helps prevent the formation of resistant strains. Indicator of Care Quality: The frequency of HAIs is considered a benchmark for assessing the quality of healthcare. Hospitals with reduced infection rates demonstrate improved sterilization, hygiene, and infection control practices (5—7).

Intensive care units (ICUs) have a greater prevalence of HAIs. According to a 2010 WHO multicenter study, 51% of ICUs had HAIs, which resulted in longer hospital stays and a higher risk of additional infections and consequences. According to reports, the prevalence of HAIs in neonates caused by bacteria that produce extended-spectrum beta-lactamases (ESBLs) can reach 11% (cumulative prevalence was 15% in Africa, 12% in South America, 11% in India, 7% in the rest of Asia, 4% in Europe, and 0% in Oceania), and it is rising by about 3.2% annually. ESBL-induced HAIs have a mortality rate of 36% compared to 18% for HAIs generated by other species, which is twice as high (8).

Clean healthcare facilities are more aesthetically pleasing, provide a sense of security, and boost patient happiness. Even while aesthetically pleasing facilities are now considered the norm in high-income nations, cleanliness affects both the safety and quality of care. Healthcare environmental hygiene (HEH), the microbiological component of cleanliness, has continued to be a neglected topic with minimal funding beyond what is deemed normal. There are few high-quality studies that connect HEH interventions to a decrease in healthcare-associated infections (HAI) or patient colonization with epidemiologically significant pathogens. The dearth of research critically assessing HEH's contribution to patient safety is one of the numerous causes of this (9).

B. Types of HAI

The most prevailing types of HAIs exhibiting increased risk of complications are non-ventilator-associated hospital-acquired pneumonia, urinary tract infections, and sepsis. These representative HAIs responsible for worldwide death are caused by multidrug-resistant (MDR) bacteria, including MDR Gram-negative bacilli, vancomycin-resistant enterococci (VRE), methicillin-resistant Staphylococcus aureus (MRSA), and Clostridioides difficile. The global burden produced by HAIs at the individual, community and public levels could be decreased by implementing appropriate infection prevention and control (IPC) policies and strategies. However, in the absence of IPC infrastructure, and due to inappropriate antibiotic use in clinical settings and industrial facilities contributing to environmental contamination, HAIs outbreaks could spread very quickly in healthcare facilities and outside (8).

C. Bacteria causing HAI

1) S. Aureus, or Staphylococcus aureus

A versatile Gram-positive coccus, S. aureus is a facultative aero-anaerobic bacterium that can cause a wide range of human diseases. It is both a commensal organism and an opportunistic pathogen. It is one of the most clinically relevant bacterial pathogens, causing anything from superficial skin infections (SSTIs) to potentially fatal illnesses like pneumonia, endocarditis, osteomyelitis, septic arthritis, and bacteremia (10).

S aureus remains widespread because of its ability to develop multidrug resistance (MDR). Methicillin-resistant S. aureus (MRSA) carries the mec gene within the staphylococcal cassette chromosome mec (SCCmec), which encodes penicillin-binding protein 2a (PBP2a). This protein has a low affinity for β-lactam antibiotics, allowing bacterial cell wall synthesis to continue despite antibiotic treatment. Consequently, MRSA is resistant to methicillin, oxacillin, nafcillin, most cephalosporins, and many other β-lactam antibiotics. (11-12).

2) Escherichia coli

The normal gut microbiota contains the gram-negative bacillus Escherichia coli (E. coli). However, certain strains of E. coli can cause illnesses in people, other mammals, and birds that range from extra intestinal infections like meningitis, sepsis, urinary tract infections, and respiratory tract infections to intestinal infections like diarrhea and dysentery. Pathogenic E. coli significantly affects public health in terms of morbidity and mortality, costing the global economy several billions of dollars each year. Because of the higher risk of hemolytic uremic syndrome, antibiotics are not typically used as a first-line treatment for diarrheal illnesses caused by E. coli, and they are also avoided in cases of bloody diarrhea. One of the first bacteria to colonize the gut after birth is the well-known commensal bacterium E. coli. However, E. coli can cause serious systemic infections in immunocompromised patients or in healthy people whose anatomical, physiological, and physical barriers have been weakened. Furthermore, some E. Coli strains differ from their commensal counterparts due to genetic variability and encode particular virulence features that allow them to infect a range of species (13).

Both commensal and pathogenic forms of Escherichia coli are responsible for a number of human illnesses, including over two million fatalities annually. Numerous watery epidemics are linked to pathogenic E. Coli strains, and STEC and EPEC have been repeatedly identified as the cause of waterborne outbreaks globally. Manure and other animal wastes, slaughterhouse wastewater, and wastewater treatment plant effluent can all contaminate the environment with pathogenic E. coli. The prevalence of the pathogenic E. coli strains in the environment has not been thoroughly investigated, despite the fact that numerous research has been conducted on the clinical aspects of these infections, including their mechanism of pathogenesis, diagnosis, and sources (14).

3) Pseudomonas aeruginosa

Pseudomonas aeruginosa is a gram-negative, nonglucose fermenter rod that is rarely seen in the human microbiota of healthy people. P. aeruginosa is a common pathogen in natural settings that can cause a wide range of illnesses in humans, including burns, lung infections, urinary tract infections, and septicemia. In the intensive care unit, it is the main reason for ventilated, related pneumonia.

Due to P. aeruginosa's inherent resistance to numerous antibiotic classes and its potential to develop practical resistance to all available antibiotics, nosocomial infections caused by these bacteria have been identified as a serious issue in hospitals in recent years. P. aeruginosa is a significant microbe to evaluate antibiotic resistance in clinical specimens because of all these characteristics. However, the distribution of these bacteria among hospital staff and in moist environments may serve as a reservoir for resistance genes. As a result, it is essential to assess how hospital staff and equipment contribute to the spread of resistance genes. These days, we can learn specific characteristics of germs isolated from clinical and environmental wards using genetic techniques backed by phenotypic testing. (15).

II. MARTIAL AND METHOD

This study was conducted as prospective cross section study, involving 52 patients admitted to Mk Nimer Hospital in Shendi City-River Nile State-Sudan, then later presented with signs of infections (fever, high TWBC and CRP) after 24 to 48 hours of hospitalization.

-Whole blood samples were collected then inoculated in media of blood culture, then Macconkey, blood agar, chocolate and CLED. Laboratory work was conducted according to what market provides, Macconkey media used was contained suppressor for gram positive bacteria, so extra media used was CLED for ensuring growth of gram positive in aerobic environment.

-The 52 whole blood samples were inoculated in blood culture media, 10 ml form each patient, cultured samples were incubated in incubator at 37 Co observing growth of bacteria.

-After 24-hours incubation, samples were sub-cultured in Blood agar and chocolate blood agar aerobic and anaerobic environment. Anaerobic incubation was conducted in anaerobic jar providing CO2 (via candle). After 24-hours passed, growth observed and the anaerobic incubation furthered for another 24 hours, then 7 and 10 days to ensure growth possibilities. Bacteria growth undergone further tests.

-Gram stain was conducted for growth bacteria to demonstrate gram positive and negative bacteria; the thing leads to identification step by biochemical tests.

Biochemical tests for identification of causative bacteria of HAI.

G - ve bacteria	G +ve bacteria
Oxidase Test	Catalase Test
Kliger's Iron Agar (KIA)	Motility Agar
Motility Agar	Coagulase Test
Urease test	
Indole test	

Sensitivity tests

Sensitivity tests for treatment protocol, isolated bacteria were sub cultured in Mueller Hinton Agar media. Antibiotic used were working on gram negative and gram positive stains. Selected result according to sensitive and resist to certain antibiotic. Antibiotic used were ciprofloxacin (CIP), levofloxacin (LEV), norofloxacin (NOR), ceftrixone(CRO), Amikacin (AK), Amoxicillin – clavulanate (AMC) and, gentamycine (CN) Cefuroxime (CXM).

III. RESULT

This study was conducted in Shendi City-Mk-Nimr Hospital for detection hospital acquired infections causes by bacteria, patients involved were 52, more than 50% were males, their age ranges from 18-85 years, 15.4% were selected from ICU and 84.6% from ward due to increased count of WBC which ranged from 9-40 ($\times 10^9$/L) as in table 1. Blood samples cultured, no growth in 39 (75%) of samples and 13 (25%) with growth as in figure 1.

Table 1: Demographic and Clinical Characteristics of the Study Population (N = 52)

	Age	**Frequency**	**Percent**	**Mean ± SD (Range)**
Gender	Male	28	53.8	-
	Female	24	46.2	
Age	≤ 30 years	8	15.4	49.0 ± 16.4 (18 – 85)
	31 - 50 years	24	46.2	
	> 50 years	20	38.5	
Admission area				
ICU		8	15.4	
ward		44	84.6	
TWBC ($\times 10^9$/L)	< 11	10	19.2	18.0 ± 8.2 (9 – 40)
	12 - 20	2	3.8	
	> 20	40	76.9	

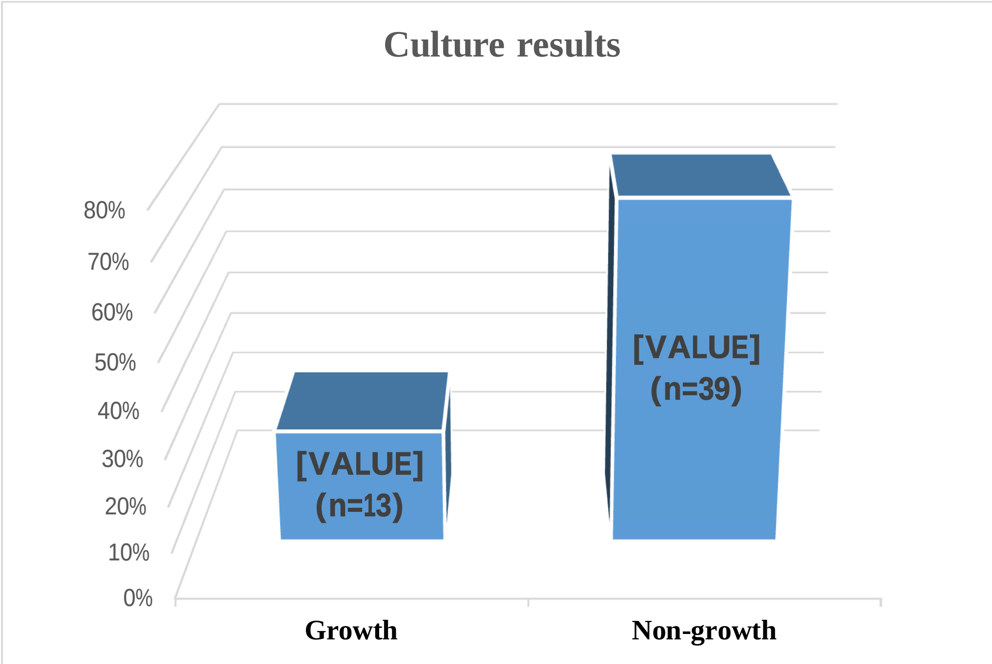

Figure 1: Culture results of specimens (N = 52)

Gram stain for growth bacteria revealed 3 (23.1%) gram positive cocci and 10 (76.9%) gram, negative bacilli, isolated organisms were S aureus (23.1%), E coli 7.1% and P aeruginosa 69.2% as in table 2.

Table 2: Distribution of Microbiological Findings (N = 13)

		Frequency	Percent
Gram stain finding	Gram-positive cocci	3	23.1
	Gram-negative bacilli	10	76.9
Isolated Organisms	*Staphylococcus aureus*	3	23.1
	Escherichia coli	1	7.7
	Pseudomonas aeruginosa	9	69.2

Analysis for culture outcomes (growth and no growth) with demographics of patients, showed that no association as no significant differences obtained indicated by P value for each comparison was >0.05 as in table 3.

Table 3: Association Between Demographic/Clinical Variables and Culture Result

Variable	Category	Culture Result		P. value
		Growth (n=13)	Non-growth (n=39)	
Gender	Male	6 (46.2%)	22 (56.4%)	0.521
	Female	7 (53.8%)	17 (43.6%)	
Age Group	≤ 30 years	1 (7.7%)	7 (17.9%)	0.402
	31 – 50 years	8 (61.5%)	16 (41.0%)	
	> 50 years	4 (30.8%)	16 (41.0%)	
TWBC (×10⁹/L)	< 11	1 (7.7%)	9 (23.1%)	0.301
	12 – 20	0 (0.0%)	2 (5.1%)	
	> 20	12 (92.3%)	28 (71.8%)	

Analysis to find association of isolated bacteria with demographic data of patients, gender ranges and count of WBC each has no association with bacteria as p value for each was <0.05. while age groups showed significant changes indicator for association as p value obtained 0.029 as in table 4

Table 4: Association Between Demographic/Clinical Variables and Isolated Organisms

Variable	Category	Isolated organism			P .value
		Staphylococcus aureus	*Escherichia coli*	*Pseudomonas aeruginosa*	
Gender	Male	0 (0.0%)	1 (100.0%)	5 (55.6%)	0.131
	Female	3 (100.0%)	0 (0.0%)	4 (44.4%)	
Age Group	≤ 30 years	1 (33.3%)	0 (0.0%)	0 (0.0%)	0.029*
	31 – 50 years	0 (0.0%)	0 (0.0%)	8 (88.9%)	
	> 50 years	2 (66.7%)	1 (100.0%)	1 (11.1%)	
TWBC ($\times 10^9$/L)	< 11	1 (33.3%)	0 (0.0%)	0 (0.0%)	0.363
	12 – 20	2 (66.7%)	1 (100.0%)	7 (77.8%)	
	> 20	0 (0.0%)	0 (0.0%)	2 (22.2%)	

Sensitivity test revealed s aureus was more sensitive to all drugs except resist to CXM (75%) and 100% AMC. E coli sensitive to all antibiotic except for AMC and CXM. P aeruginosa was 100 sensitive to AK, more than 75% to LEV, CIP, CN, NOR, 33% to AMC, CXM and more than 50% to CRO as in table 5.

Table 5: Antibiotic sensitivity test

		LEV	CN	CIP	NOR	AK	AMC	CXM	CRO
S aureus	S	3	3	3	3	3	0	1	3
	R	0	0	0	0	0	3	2	0
E coli	S	1	1	1	1	1	0	0	1
	R	0	0	0	0	0	1	1	0
P aeruginosa	S	8	8	8	8	9	3	3	5
	R	1	1	1	1	0	6	6	4

IV. DISCUSSION

-In this study, concerning about HAI, patients involved screening showed show a male predominance in HAIs, agree with findings by Magill SS et al -2014 (16).

Quarter of blood cultured samples took form patients were having growth, most common bacteria isolated was P aeruginosa, then s aureus and less E coli.

-Our study has selected according to sign of infections elevated WBC count with time 24-48 hours after hospital admission, no association of growth state and ranges of WBC, age ranges, and gender, an agreement with R P Dellinger et al 2013 findings, revealed that WBC count alone is not a reliable predictor of specific bacterial pathogens or outcome (17).

Isolated bacteria have association with age ranges, but not with gender or TWBC, which partially in consistent with CDC 2020 report Gram-negative bacteria as the most frequent cause of HAIs, especially P. aeruginosa, Klebsiella, and E. coli (18), and partially agreement with finding by Zorgani A et al (2015): most frequently isolated organisms were Klebsiella pneumonia, Acinetobacter baumannii, and Pseudomonas aeruginosa (19).

-Our Sensitivity tests showed High sensitivity: Fluoroquinolones (CIP, LEV), Aminoglycosides (CN, AK), High resistance: β-lactams (AMC, CRO, CXM). Similar Findings by WHO 2025 (20), indicated rising resistance to β-lactams among GNB.P. aeruginosa often shows multi-drug resistance but may still respond to fluoroquinolones and aminoglycosides. A partial agreement with Zorgani A et al (2015) study, (30) as it found that extremely high resistance rates were observed among GNB to ampicillin, cefuroxime, amoxicillin-Clavulanate, and nitrofurantoin. Lower levels of resistance were exhibited to amikacin.

V. CONCLUSION

-This study involved 52 patients admitted to MK NIMER hospital for detection of HAI bacteria, most of detected bacteria was P. aeruginosa, with low frequencies of s. aureus and E coli.

-Resistance to drugs mostly involved CRO, AMC and CXM, indicator for overusing of antibiotics, which leading to microorganisms to adapted and developing resistance.

-The pattern of hospital acquired infections among patients, indicator for corrupted infection control.

Recommendation

-More research with expanding sample size should be considered for cover more patients and areas inside the hospital.

-Healthcare facilities should contain infection control SOPs working parallel with cleaning and sterilization routine workers, in order to maintain patients' lives after admitting to the hospital.

-Routine microbiological checkup should be addressed to ensuring applied infection control program.

-Awareness program should be applied for general community members about antibiotics and usages beside hazards of un necessary or without prescription to avoid resistance in coming future to ensure confine treatment options.

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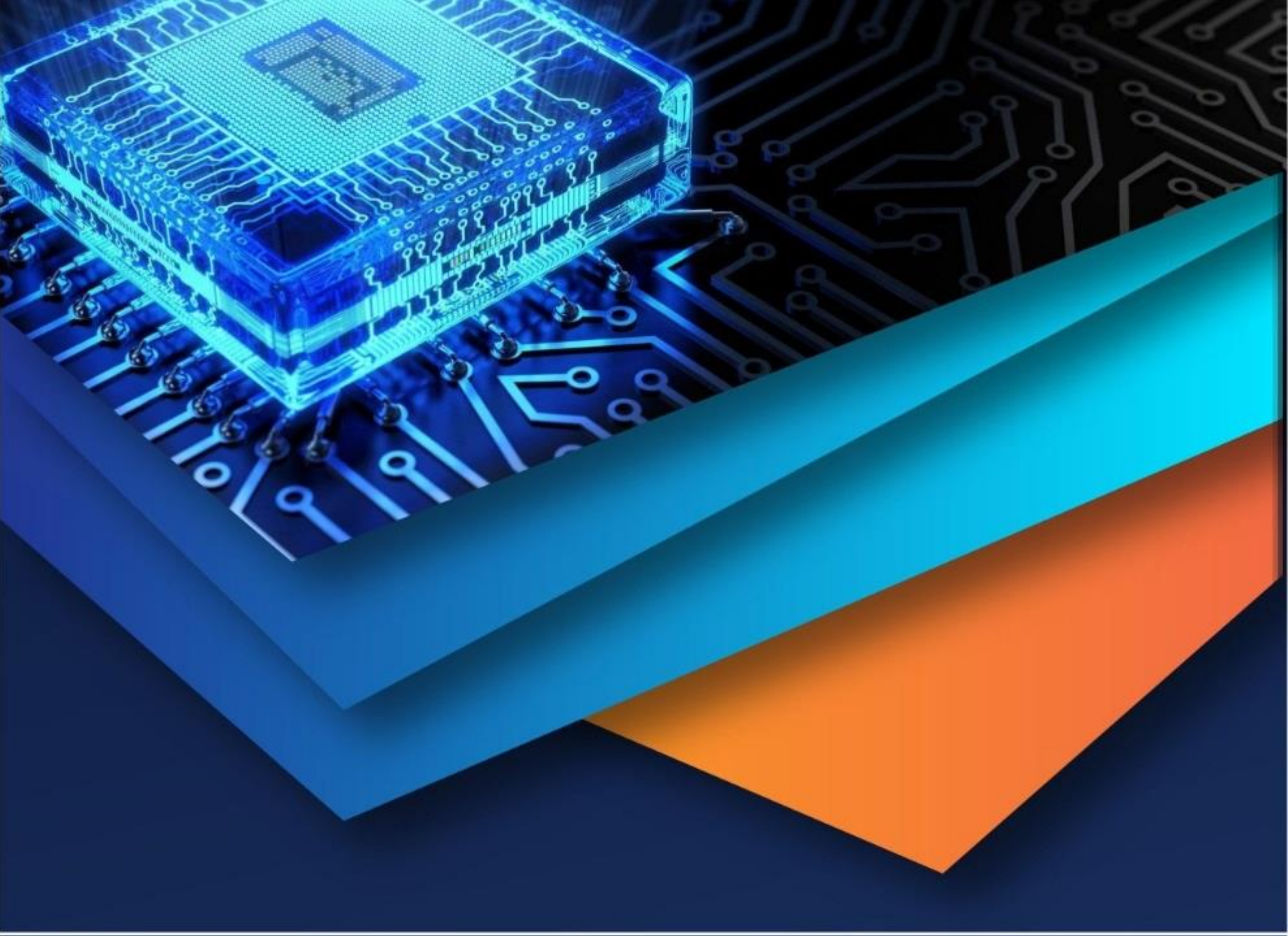

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