



St. Paul's Hospital Millennium Medical College

School of Medicine

Graduate Study Program

Department of Medical Microbiology, Immunology and Parasitology

**Incidence of Bloodstream Infection, Bacterial etiology,
Antimicrobial Susceptibility Profile and Risk Factors among
patients under Hemodialysis, with Intervention Assessment in Addis
Ababa, Ethiopia: A Multi-Center Prospective Cohort Study**

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Master of Medical Microbiology**

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Addis Ababa, Ethiopia

I. Approval by the Board of Examination

As a member of the examining board of the final MSc open defense, we hereby certify that we have read and evaluated the thesis entitled “Incidence of Bloodstream Infection, Bacterial etiology, Antimicrobial Susceptibility Profile and Risk Factors among patients under Hemodialysis, with Intervention Assessment in Addis Ababa, Ethiopia: A Multi-Center Prospective Cohort Study” presented by Moti Wodajo Deressa. The thesis has been examined and approved in its present form as fulfilling the requirements for the Degree of Master of Science in Medical Microbiology.

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II. Supervisors' Approval

This is to certify that the thesis prepared and presented by Moti Wodajo Deressa: “Incidence of Bloodstream Infection, Bacterial etiology, Antimicrobial Susceptibility Profile and Risk Factors among patients under Hemodialysis, with Intervention Assessment in Addis Ababa, Ethiopia: A Multi-Center Prospective Cohort Study” and submitted in fulfillment of the requirements for the Degree of Master of Science (MSc) in Medical Microbiology complies with the regulation of the College and meets the accepted standards with respect to originality and quality.

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III. Declaration

I, the undersigned, declare that the thesis entitled “Incidence of Bloodstream Infection, Bacterial etiology, Antimicrobial Susceptibility Profile and Risk Factors among patients under Hemodialysis, with Intervention Assessment in Addis Ababa, Ethiopia: A Multi-Center Prospective Cohort Study” submitted for the Degree of Master of Science (MSc) to St. Paul’s Hospital Millennium Medical College is my own work and has not previously been submitted at another university. The materials obtained from other sources have been duly acknowledged and cited.

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Abbreviations and Acronyms

AGN	Acute Glomerulonephritis
AKI	Acute Kidney Injury
AMR	Antimicrobial-Resistant
AST	Antimicrobial Susceptibility Testing
AVF / AVFs	Arteriovenous Fistulas
AVG / AVGs	Arteriovenous Grafts
BAP	Blood Agar Plate
BSI / BSIs	Bloodstream Infection(s)
CAP	Chocolate Agar Plate
CDC	Centers for Disease Control and Prevention
CKD	Chronic Kidney Disease
CKD-MBD	Chronic Kidney Disease-Mineral and Bone Disorder
CRBSIs	Catheter-Related Bloodstream Infections
CVC / CVCs	Central Venous Catheters
DM	Diabetes Mellitus
eGFR	Estimated Glomerular Filtration Rate
ESRD / ESKD	End-Stage Renal (Kidney) Disease
EUCAST	European Committee on Antimicrobial Susceptibility Testing
HAIs	Healthcare-Associated Infections
HD	Hemodialysis
IPC	Infection Prevention and Control
KDOQI	Kidney Disease Outcomes Quality Initiative
LIA	Lysine Iron Agar Test
LMICs	Low- and Middle-Income Countries
MAP	MacConkey Agar Plate
MDRO / MDROs	Multidrug-Resistant Organism(s)
MIICSH	Menelik II Comprehensive Specialized Hospital
MHA	Mueller-Hinton Agar
MRSA	Methicillin-Resistant Staphylococcus Aureus
SIM	Sulfur-Indole-Motility Test
SPHMMC	St. Paul's Hospital Millennium Medical College
SSA	Sub-Saharan Africa
TSB	Tryptic Soy Broth Agar
TNT-CVC	Temporary Non-Tunneled Central Venous Catheters
TSI	Triple Sugar Iron
VRE	Vancomycin-Resistant Enterococcus
VRBL	Violet Red Bile Lactose Agar
ZMH	Zewditu Memorial Hospital

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Abstract

Background: Hemodialysis (HD) patients face high infection risk from frequent healthcare contact and biofilm-prone access. In Ethiopia, limited dialysis access and lack of multicenter data hinder understanding of infection patterns. This study integrated clinical, microbiological, and environmental surveillance across three hospitals in Addis Ababa to address these gaps.

Objectives: This study aimed to assess the incidence of bloodstream infection, bacterial etiology, temporal association between environmental pathogen with incidence of infection, antimicrobial susceptibility profile, risk factors, and the impact of intervention on incidence of infection among patients undergoing HD.

Methods: Multicenter prospective cohort study, conducted from May 16, 2024, to May 14, 2025, at 3 centers in Addis Ababa, Ethiopia, enrolled 168 patients (153 Chronic Kidney Disease, 15 Acute Kidney Injury) undergoing maintenance HD. Clinical data were collected via structured KoBo Toolbox questionnaires and aseptic blood cultures during bloodstream infection. Environmental swabs and water samples were taken biannually. Microbiological analysis used selective enrichment and biochemical tests. Antimicrobial susceptibility test was performed using the Kirby-Bauer disk diffusion method. Statistical analysis used IBM SPSS v27.0.

Results: The study found a 16.6% BSI rate among HD patients, with 4.7% developing sepsis. Gram-negative bacteria, mainly *Klebsiella* spp., were predominant. Environmental contamination reached 65.2%, especially in water systems and dialysis beds, with marginal concordance ($p = 0.062$) to clinical isolates. MDR was observed in all clinical CoNS and environmental *P. aeruginosa*, with MRSA also detected among *S. aureus* isolates. Repeated central venous catheter exposure (AOR: 0.048, $p = 0.001$) and low hemoglobin (AOR: 0.635, $p = 0.015$) were key risk factors for infection. A water pipeline replacement and improved infection control significantly reduced BSI incidence ($p < 0.001$).

Conclusion: The study highlights a high infection burden in HD patients, with *Klebsiella* spp. and *P. aeruginosa* as dominant Gram-negative bacteria. Overlap between clinical and environmental isolates revealed the presence of strong contamination which associate with infection link. Findings support stronger infection control could improve outcomes.

Keywords: Hemodialysis, Bloodstream Infection, Bacteria, Antimicrobial Resistance, Risk factor

1. Introduction

1.1. Background

The urinary system comprises organs that play an important role in filtering blood waste, balancing body fluids, regulating blood pressure, and particularly the kidneys play a pivotal role in this regard (1,2). Chronic Kidney Disease (CKD) is defined as either kidney damage characterized by excessive excretion of urinary albumin or a decline in kidney function, indicated by an estimated Glomerular Filtration Rate (eGFR) of less than 60mL/min/1.73m² lasting for three or more months, whereas Acute Kidney Injury (AKI), denotes a sudden and often reversible reduction in kidney function, as measured by increased creatinine or decreased urine volume. At this stage, hemodialysis (HD), though it has a potential infection risk that contributes to morbidity and mortality, is used as modality for managing end-stage renal disease (ESRD) (1).

HD patients are at high risk of infections, which have remained the main cause of morbidity and mortality. Due to their frequent exposure to the healthcare environment, biofilm-prone vascular access and frequent antibiotic use, their tendency to be susceptible to bloodstream infection (BSI) or sepsis is higher than adults not on HD. Specifically, surveillance has consistently revealed that there was an increased infection risk with central venous catheters (CVCs) compared with arteriovenous fistulas or grafts, while fistula-first strategies reduce catheter-associated BSI and associated adverse outcomes (3,4). Mainly in U.S., the report to National Healthcare Safety Network (NHSN) showed that pathogen profile in HD associated BSI have been broadly similar, with *Staphylococcus aureus* alone attributed 34.2% (3). Similarly, Gram-negative bacteria such as *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* can persist and multiply in HD water supplies and related equipment, potentially leading to septicemia or endotoxemia due to their high numbers. These bacteria form biofilms (glycocalyxes) by adhering to surfaces, creating a protective layer that is nearly impossible to eliminate, and complicate the empiric therapy because of their resistance pattern (5).

These patterns imply that, in Ethiopia, challenges such as delayed patient referrals, a shortage of dialysis machines, high patient volumes, difficulties with surgical access, and inconsistent consumable supplies have extended the reliance on CVCs, thereby increasing the risk of BSI (6).

1.2. Statement of the Problem

Globally, based on a systematic review and meta-analysis studies, CKD prevalence was 13.4% for stages 1 to 5 but for stages 3 to 5 alone, it was 10.6%, especially in low-resource regions, it implied that there was an increase in absolute burden (29.3%) with a high economic cost to health systems since 1990 (7,8). In low- and middle-income countries (LMICs), CKD patients being on the patient waiting list obliged to face delayed HD initiation or totally unable to access the renal replacement therapy (RRT) on account of being inaccessible for most of the population, expensive, concentrated in the capital city, regulated poorly. In high-income countries (HIC), however, RRT, which is crucial in the management of CKD, is accessible in contrast with LMICs (6–8). For example, in the United States of America, more than 500,000 patients are on long-term dialysis therapy, served by more than 7,000 dialysis units, while in much of sub-Saharan Africa (SSA), dialysis provision averages less than 20 patients per million population (pmp) (9).

In the context of Ethiopia, although there is an increase in HD capacity within the last decade, it is still insufficient with significant disparities across the country. The dialysis units have been centralized in Addis Ababa and peritoneal dialysis has not been utilized in many centers, especially for adult population, and access has frequently varied according to ability to pay out of pocket (6). During our study period, data obtained from the Hospitals' Management Information Systems (HMIS) indicated that 2,752 CKD patients were registered on waiting list across three public hospitals in Addis Ababa: 1,104 at Center St. Paul's Hospital Millennium Medical College (SPHMMC) and 1,648 at Centers Menelik II Comprehensive Specialized Hospital (MIICSH) and Zewditu Memorial Hospital (ZMH) combined. These facilities had only 29 functional dialysis machines in total (7 at SPHMMC, 14 at MIICSH, and 8 at ZMH), resulting in a minimum waiting time of three years or more before patients could initiate maintenance HD. In contrast, the prevalence of treated kidney failure (kidney replacement therapy, KRT) was reported at 2,436 pmp in the United States and 1,188 pmp across Europe in 2021, whereas Ethiopia's HD-related prevalence was estimated at 10 pmp, indicating extremely constrained access to RRT (6,9,10). This gap reflects the level of unmet need in Ethiopia.

Both the Global Burden of Disease (GBD) study and the World Health Organization (WHO) have highlighted that the rising burden of diabetes, hypertension, and obesity in LMICs is fueling

CKD at a greater rate, which in turn increases vulnerability to infections, but nephrology and dialysis centers have not developed proportionally (7,8).

Therefore, this project aimed to identify the incidence of bloodstream infection, common causative pathogen, level of resistance, link between environmental contaminants and impact of intervention among those HD patients at three different hospitals in Addis Ababa, Ethiopia.

1.3. Justification of the Study

Ethiopia has limited multicenter data describing the incidence, microbial etiology, antimicrobial susceptibility patterns, and risk factors for HD-associated infections. Available information came mainly from single-center reports, which showed infection to be a major cause of hospitalization and death, frequent reliance on central venous catheters, and the presence of multi-drug-resistant organisms (5,6). These studies were restricted in scope, applied variable definitions and laboratory methods, and did not consistently report standardized approaches to infection prevention or empiric antibiotic selection.

Furthermore, no previous study in Ethiopia has comprehensively integrated clinical surveillance with microbiological confirmation and environmental sampling across multiple dialysis centers. This has left critical knowledge gaps regarding the true burden of infection, the contribution of environmental contamination, and the antimicrobial resistance profile of locally circulating pathogens. To address these gaps, the present study was conducted in three public hospitals in Addis Ababa, applying uniform case definitions and standardized microbiological methods to assess the incidence, etiology, and determinants of HD-associated infections.

1.4. Significance of the Study

This study addressed the lack of data on HD-associated BSI or sepsis in Ethiopia. It measured the incidence rates, identified bacterial causes with their resistance profiles, and compared clinical and environmental isolates to reveal overlaps in pathogen distribution. By including environmental sampling from surfaces, staff gowns, and water supply lines, the research uncovered potential transmission routes within dialysis units – an area previously overlooked. The findings highlight critical infection risks for Ethiopian HD patients and provide evidence to guide improved prevention strategies, vascular access practices, and antibiotic use.

2. Literature

Globally, CKD is a growing public health concern with all-age mortality went up by 41.5% between 1990 and 2017, and in 2017 alone, 1.2 million people died from it, which is an indicative of a major health burden. That same year, there were 697.5 million recorded cases with 9.1% global prevalence. Since 1990, CKD prevalence for all age group rose by 29.3% (8).

HD, which accounts for 69% of all RRT and 89% of all dialysis, is a life-sustaining modality, though the outcomes remain poor. Almost 50% of mortality among patients under HD is due to cardiovascular disease (CVD) indicating a higher mortality rate than many types of cancer, while vascular access BSI are frequent. In fact, the outcome measures are highly variable across regions, countries, centers and segments of the population (11).

Patients undergoing HD confront a significantly high risk of infections and sepsis, specifically, the annual mortality rate from sepsis reported to be up to 300 times higher than that of the general population (12). The 2020 surveillance in US revealed that people on HD had *S. aureus* BSI rate of 100 times higher than adults who were not on dialysis, and 4,840 dialysis centers reported 14,822 BSI to Centers for Disease Control and Prevention (CDC), in which one third of them were caused by *S. aureus* leading to more hospital stays and higher medical expenses (3).

Due to comorbidities and repeated vascular access procedures, HD patients face high risk of infection (11). In low-resource settings, for instance, Ethiopia, the risk to acquire BSI is at high magnitude. The study findings by Mengistu *et al.* (2022) revealed that 35 HD units (11 public), with most of them are still concentrated in Addis Ababa, were providing HD for 1,132 patients making the prevalence ten pmp. At the start of dialysis, as most of the cases tented to be on emergency, usage of temporary catheters was very common (6).

2.1. HD Patient Profiles and Treatment Features

Primary causes of CKD: Globally, diabetic kidney disease is the leading cause of CKD accounting 50% of the cases. Most patients on dialysis have CKD caused by diabetes or hypertension (HTN). In US, diabetic nephropathy (DN) is the most common cause of ESRD followed by HTN, while glomerulonephritis (GN), polycystic kidney disease and other causes are in lesser proportions (13,14). In low-resource setting like Ethiopia the figure reported

hypertensive nephropathy (HN) was the leading cause of CKD in 40.4%, GN in 38.1% and severe malaria in 33.3% of dialysis patients (10).

In other study the difference in disease prevalence may reflect the disparity in disease prevalence, where HTN was the most frequent one followed by CVD (15). Acute kidney injury (AKI) can also lead the patient to dialysis, either for a short period of time or progressing to CKD but it varies from place to place as the usual triggers of AKI can be infections, dehydration, toxins, or medications. In malaria endemic countries like Ethiopia, severe malaria and acute glomerulonephritis (AGN) were ranked as the top causes of AKI. On the hand, due to an exposure to toxic substances or ischemia, an occurrence of an acute tubular necrosis (ATN) can cause AKI, which either recover by its own or let the patient die prior to accessing dialysis service (10).

Common Comorbidities: HD patients often have several comorbidities. Most have HTN, either as etiology or result of CKD, and many have diabetes mellitus (DM). In accordance to the study done by Workie *et al.* (2022), HTN 313 (80.3%) was the leading comorbidity followed by anemia 245 (62.8%) and diabetes 112 (28.7%). In the study, over 90% of ESKD patients had at least one comorbidity (16), with HTN and DM are the most co-occurring traditional risk factors. In dialysis patient, CVD has high rate of mortality due to specific disease like left ventricular hypertrophy (LVH) accounting up to 75% of CKD patients at dialysis initiation, heart failure, coronary artery disease (CAD), dyslipidemia, longstanding diabetes and HTN as well as uremia-related vascular calcification (16,17). Hepatitis B and C have been concerned as one of the top concerns in dialysis unit (18,19). HIV/AIDS can also impact especially those patients who have high risk of TB (20,21). CKD anemia, reduced erythropoietin production, iron deficiency (10), chronic kidney disease - mineral and bone disorder (CKD-MBD), hyperphosphatemia, secondary hyperparathyroidism, and malnutrition or inflammation are common issues reported in dialysis patients undergoing HD (17). To manage CKD anemia, the routine administration of erythropoiesis-stimulating agents (ESAs) and iron supplements is common in high-income settings, which contrasts with the practice in low-income settings (22).

Global Disparities in Access to Kidney Transplantation: Though there is unequal availability of kidney transplant worldwide, it inevitably offers an improved quality of life and increased survival rate than dialysis services provided for renal failure patients (23). In U.S. unlike liver

and heart transplants, kidney allocation is primarily based on waiting time but not illness severity, and the patient become eligible for waitlist when their eGFR drops to ≤ 20 ml/min/1.73 m², and in 2019 alone 24,273 kidney transplants were performed, where 72% was from deceased donors, bringing the total number of patients living with a functioning transplant to 229,887, a 40% increase since 2008 (23,24), while the annual number of dialysis patients receiving a transplant rose 52% from 17,342 in 2012 to 26,362 in 2022, and kidney donation rates among decedents climbed nearly 22% between 2018 and 2022 (24). However, the reality in low-resource settings like Ethiopia is starkly different, where transplant opportunities are not just limited, but critically scarce. In Ethiopia, the first kidney transplant center was established in September, 2015 at SPHMMC by MoH with the cooperation of the University of Michigan. Despite the launch of a national program in 2015, Ethiopia's transplant capacity remained severely limited, with only 137 live-donor kidney transplants performed over the subsequent five years - roughly 34 transplants per year (25), in which the figure is dwarfed by the immense scale of the crisis, as it represents a mere fraction of the thousands of ESRD patients in the country. Consequently, for the vast majority of Ethiopians with kidney failure, a life-saving transplant is not a remote possibility but a near impossibility, leaving them dependent on dialysis or with no treatment options at all.

Dialysis Adequacy: HD adequacy refers to how effectively a dialysis session removes waste products, especially urea from a patient's blood. In our study, Kt/V, measure of dialysis adequacy was used. For thrice weekly HD, Kidney Disease Outcomes Quality Initiative (KDOQI) recommend a single pool Kt/V of 1.2 per session targeting at around 1.4 to ensure the minimum clearance per unit of patient volume, otherwise, if not achieved, uremic complications occur (26). In the study conducted in USA, for patients on maintenance HD, "single pool" Kt/V of 1.19 was delivered, which is slightly below the KDOQI recommendation, indicating that the inadequate dialysis may contribute to further complications like sepsis (12). But in the case of resource limited settings, as patients may undergo HD less than three times per week on account of either cost of each HD session or dialysis machine, it led into inadequate dialysis. This highlighted by the fact that only 28% of HD sessions met the minimum adequacy standards set by KDOQI (27). Due to financial and resource constraints in Ethiopia, the majority of patients receive only two dialysis sessions per week instead of the standard three, resulting in inadequate solute clearance and fluid control. Consequently, most of these chronic HD patients are

considered under-dialyzed by international standards, which can lead to complications and a higher risk of infections (6,16,28). To gauge dialysis adequacy, healthcare providers carefully assess pre- and post-dialysis vital signs, weight changes, and biochemical measures to manage blood pressure and volume, which often improves with fluid removal, although intradialytic hypotension can be a risk (26,29). The body mass index (BMI) in HD populations varies, with some patients being malnourished, a known predictor of worse survival, while others may be overweight or obese (30).

Types of Vascular Access: Vascular access is a critical determinant of infection risk in HD patients. Among the three main types, arteriovenous fistulas (AVFs), arteriovenous grafts (AVGs), and central venous catheters (CVCs), where guidelines strongly recommend AVFs. This preference is due to AVFs having the lowest infection rate, as they are surgically created from the patient's own vessels without foreign material, while grafts have a higher infection risk and catheters have the highest (3,10,31). CVCs present the highest risk of BSI by providing a direct entry point for bacteria into the bloodstream. Despite this, they are frequently used, especially for initiating dialysis; over 80% of patients in the U.S. like our study centers dialysis services are firstly initiated by temporary non-tunneled central venous catheters (TNT-CVC) and at least 73-81% of children begin treatment with a catheter, as creating other access types in small vessels is challenging (3,32–34). Reflecting limited access to pre-dialysis care and surgical fistula creation in Addis Ababa, Ethiopia, only 74.5% of ESKD patients had an AVF, while a significant 19.5% on aggregate still relied on catheters for maintenance dialysis (10). The type of vascular access is a crucial element in preventing and tracking dialysis related infections, primarily because CVCs are the number one source of this risk globally (3,31,35).

2.2. Incidence and Burden of BSI in HD

As a major cause of hospitalization and mortality in HD patients, BSIs, particularly bacteremia and sepsis are a key focus for elimination by the CDC (11,36–38). According to a 2014 U.S. national surveillance report, the overall incidence of BSI among dialysis patients was 0.64 episodes per 100 patient-months. This average rate doesn't show the full picture, as BSI rates are much higher for patients with catheters and lower for those with fistulas (4).

Among patients receiving maintenance dialysis, infections represent the primary cause of hospitalization and the second most common cause of mortality (39). Although infections remain a major concern in all regions, countries like Japan and several European nations have lower access related infection rates compared to the U.S., largely due to their higher rates of AVF use and faster removal of high-risk catheters (3,40). Data from lower income countries indicates a significantly higher risk of catheter related infections; for instance, Indian studies report infection rates that are 2-5 times greater than U.S. benchmarks, a disparity likely driven by predominant catheter use and infection control challenges (41–43). Small studies from SSA point to a high rate of infectious complications, though comprehensive infection surveillance in the region is rare (44). According to a systemic review of dialysis outcomes in Ethiopia, infection emerged as a significant mortality predictor, as several included studies demonstrated an elevated risk of death in patients experiencing an infectious event (45,46). In fact, local audits confirm this, frequently citing sepsis as a leading immediate cause of death, surpassed only by cardiovascular events (15).

While a pediatric dialysis population is smaller, resulting in fewer total cases, infections still constitute a major complication for these patients (33). With limited data specific to pediatric population, recent review studies identified infections related to catheters as a significant cause of morbidity for children undergoing HD (33,47,48).

Infections in HD population are characterized not only by their frequency but also by significantly poor patient outcomes (11). When hospitalized with sepsis, they are more likely to die because their bodies have a reduced capacity to handle severe illness and their immune systems do not function properly (49,50). A Multidisciplinary Digital Publishing Institute (MDPI) review noted that the increasing incidence of multidrug-resistant organism (MDRO) infections is directly linked to deteriorating patient outcomes (51). Many unplanned hospital stays for HD patients are due to infections, most often related to their dialysis access (39,52). Therefore, measuring the burden of infection requires looking at both how often it occurs and the heavy consequences it takes. It is reflected in prolonged hospitalizations, the administration of IV antibiotics, the need to perform additional access procedures like removing and replacing catheters, as well as significant indirect costs (31).

2.3. Bacterial Etiology of HD-Associated Infections

Bacterial pathogens are the primary cause of infections associated with medical devices and vascular access. Gram-positive organisms overwhelmingly cause vascular access BSI, with *S. aureus* alone accounting for 32-53% of cases, followed by coagulase-negative staphylococci (CoNS) at 20-32%. Together, both *S. aureus* and CoNS cause roughly half of all BSIs in HD patients, with CoNS, a less virulent skin commensal, often initiating these infections by forming biofilms on catheter surfaces (4,5). Beyond staphylococci, other Gram-positive bacteria like *Enterococcus* species pose a significant risk, frequently causing catheter infections and endocarditis in HD patients, a threat underscored by the fact that *Enterococcus faecalis* is a primary cause of high mortality infective endocarditis worldwide, especially in vulnerable and elderly populations (53). While not as prevalent as other pathogens, Streptococci remain a source of notable infections in dialysis patients, such as pneumonia or sepsis caused by *Streptococcus pneumoniae*, which are distinct from access site complications (5).

The landscape of infections is shifting; while Gram-positives are still the main cause, Gram-negative pathogens are being identified more frequently and constitute a significant portion of the burden (38,54). According to 2022 data on BSIs in U.S. dialysis patients, the most frequently isolated Gram-negative pathogens were *Escherichia coli* with 5.1%, *Klebsiella* species with 4.2%, and *Enterobacter cloacae* accounts for 3.3% (54). A recent single-center study in Israel revealed an unusually high prevalence of Gram-negative BSIs, which were responsible for 46.3% of all BSI events among their HD patient cohort. This recent study by Pravda *et al.* (2024) identified a major shift in the cause of BSIs in their HD patients, with Gram-negative bacteria, specifically *K. pneumoniae* (18.5%), *E. coli* (14.8%), and *P. aeruginosa* (9.3%) – becoming the most common isolates. The authors hypothesize this change is due to pathogens from Healthcare-Associated Infections (HAIs) or urinary sources to become more prominent (38). The hospital environment itself is a significant risk factor, rendering dialysis patients susceptible to HAIs from Gram-negative pathogens such as *Klebsiella*, *Pseudomonas*, and *Acinetobacter*, leading to serious complications like pneumonia and central line associated BSIs (4). The prolonged retention of an infected catheter is a primary risk factor for polymicrobial infections in dialysis patients, where a single blood culture may yield a combination of pathogens such as staphylococci, enterococci, and Gram-negatives (55). Notwithstanding the considerable risks

presented by viral pathogens in the dialysis unit, including hepatitis B, hepatitis C, and SARS-CoV-2, the review is strictly limited to bacterial BSIs.

2.4. Patterns of Antimicrobial Resistance and Susceptibility

HD patients are vulnerable not only to infections but specifically to those caused by antimicrobial-resistant (AMR) bacteria. This elevated risk is driven by recurrent exposure to healthcare environments and frequent antibiotic use, which creates intense selection pressure for MDROs. Consequently, the HD patients carry a disproportionately high burden of formidable pathogens, including methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), and resistant Gram-negative bacteria, compared to the general population (5). Among key resistance patterns, MRSA is a primary concern, as 2014 National Healthcare Safety Network (NHSN) data, a U.S. CDC surveillance system, revealed that 39.5% of *S. aureus* isolates, the single most common cause of BSIs (30.6%), were methicillin-resistant (4), and a rate that showed little improvement, as 2020 U.S. data similarly reported that approximately 40% of *S. aureus* BSIs in dialysis patients were MRSA (3). Compared to vancomycin-susceptible strains, VRE infections lead to worse outcomes such as increased mortality and longer hospital stays, as confirmed by a meta-analysis that found VRE *faecium* bacteremia carried a significantly higher risk of death (RR 1.46) (56,57). Gram-negative bacteria accounted for 46.3% of all BSIs, of which nearly one-third (31.4%) of total BSIs were caused by resistant organisms (38).

In Ethiopia, a 2023 study by Weldetensae *et al.* found a catheter-related BSI (CRBSIs) incidence of 7.74 episodes per 1000 catheter days, with Gram-negative organisms causing the majority of cases (57.6%). Although *S. aureus* was responsible for 20% of BSIs, a high rate of cloxacillin resistance was observed in 86.2% of these isolates. Among the predominant Gram-negative organisms, 75% of *E. coli* isolates were resistant to ceftazidime (58). Reflecting substantial regional differences in resistance patterns, VRE prevalence in Ethiopia can be as low as 1.8% or as high as 60%, with a pooled estimate for Addis Ababa alone reaching 26.1%, (59), including a reported 7.7% VRE colonization in West Amhara, (60) and a 34.6 VRE proportion found at Felege-Hiwot Comprehensive Specialized Hospital in Bahir Dar (61). Recent study indicates that a large percentage of bacterial infections are difficult to treat, with studies finding that between 47% and 72% of bacteria tested were resistant to multiple types of antibiotics (62), particularly

for specific pathogens like *Klebsiella* species, a national meta-analysis found that overall antibiotic resistance to be 53.8%, with ampicillin resistance reaching 90.6% (63).

2.5. Risk Factors for Infection in HD Patients

Longer dialysis vintage, extended hospital stays, multiple or prolonged catheter use, advanced age, low white blood cell count, a history of blood transfusions and diabetes were identified as consistent risks for infection in HD patients by a 2020 systematic review examining intersecting patient and treatment factors (64). The most significant modifiable factor in preventing *S. aureus* BSIs is the choice of vascular access, with U.S. surveillance showing that CVCs carry a markedly higher risk than fistulas: adjusted rate ratios were 6.2 times higher according to NHSN data and 4.3 times higher in Emerging Infections Program (EIP) data (3). A meta-analysis found that diabetes and longer catheter duration were independent risk factors for catheter related BSI, increasing the odds by 2.52 and 2.06 respectively, while also finding correlations between risk and the number of catheterizations and low albumin levels, illustrating that risk increases with exposure (65). Data from one cohort demonstrates a time-dependent risk for bacteremia, with 81.1% (69 episodes) of infections occurring after 6 months of catheter dependence, whereas only 14.2% (12 episodes) and 4.7% (4 episodes) occurred at 0-90 days and 90-180 days, respectively (66). The quality of a facility's infection control is a critical risk factor, according to a two-year observational study which found that inter-facility BSI rates among catheter-dependent HD patients varied significantly, with some provider groups having an adjusted relative risk nearly double that of others (67).

Underscoring the risks in resource-constrained settings, a study conducted at HD center of Ayder Comprehensive Specialized Hospital in Ethiopia reported a high CRBSIs rate of 7.74 per 1,000 catheter-days with a predominance of Gram-negative bacteria (57.6%), and identified prolonged catheter use, a history of CVC infection, low hemoglobin, and high white blood cell count as independently associated risk factors (58). As a clear sign of how malnutrition and immune dysfunction amplify hazards, low albumin strongly predicted in-hospital death from infection for HD patients admitted with a suspected infection (68), while large scale studies have also found that lower albumin is associated with more frequent hospital admissions for infectious causes (69). Even in the highly catheter dependent field of pediatric HD, where a study of 1,277 children found 79.7% used a CVC, facility-level practices are a key modifiable factor; centers

that dynamically improved their catheter care protocols saw infection rates fall from 2.71 to 0.71 per 100 patient-months (33).

2.6. HD-Related Infections in the Ethiopian Context

Ethiopia's limited dialysis infrastructure, with only 35 units nationwide as it revealed in a 2021 survey of dialysis services, is heavily concentrated in Addis Ababa and dominated by private providers. This lack of widespread access forces many patients into emergency treatment, with roughly 16% starting dialysis as “crash landers” via temporary catheters (6,18). According to a study at Jimma Medical Center, the need for emergency vascular access was universal for AKI patients and nearly so for CKD patients (95.7%). The predominant method for this access was a jugular venous catheter, utilized in 95.2% of AKI cases and 95.7% of CKD cases. Regarding treatment frequency, a twice-weekly HD schedule was most common for both groups (85.1% of CKD and 76.2% of AKI patients) (10).

Causes of AKI and CKD may vary with regional patterns. In accordance to a cross-sectional study conducted at Jimma Medical Center, the most common causes of AKI among dialysis patients were AGN (38.1%) and severe malaria (33.3%), both showing a significant association ($p < 0.001$) (10). Highlighting the challenge of diagnosing TB in ESRD patients, a study conducted across eight dialysis centers in Addis Ababa found a 27% prevalence among those on HD. However, only 5.6% of cases had microbiological confirmation, and pulmonary TB was the most common form identified (21).

Despite mixed infrastructure indicators, Addis Ababa's HD centers demonstrate strength in infection control, with a multicenter screen reporting low HBsAg (1.2%) and anti-HCV (2.8%) seroprevalence, which points to effective viral IPC practices (19). Recent reports show that patients outside Addis Ababa face severe barriers to dialysis, as 66% of Ethiopia's 35 HD units are concentrated in the capital. This centralization forces approximately 77% of all patients to seek treatment in the city, creating geographic inequity and often delaying critical procedures like timely fistula creation (18). The national challenge of AMR in Ethiopia is underscored by both high resistance rates and systemic limitations in surveillance. Pooled analyses show a worrying overall resistance of approximately 53.75% in *Klebsiella* species with ampicillin resistance at $\approx 90.56\%$, and multicenter studies confirm a high burden of ESBL-producing organisms. Compounding this threat is the limited capacity for antimicrobial susceptibility

testing (AST) outside of referral laboratories, which hinders effective monitoring and treatment (63,70,71). Recent government efforts in Ethiopia are enhancing infection control on two key fronts. A new advanced IPC training program for frontline workers was launched in 2023, and, in a parallel policy move, national hepatitis strategic plans now give explicit priority to dialysis populations (72,73). The cumulative evidence necessitates a strategic response focused on several key areas. This includes prioritizing the creation of permanent vascular access (AVF or AVG), mitigating catheter related risks through reduced duration, augmenting dialysis machine capacity, and implementing systematic microbiology surveillance to optimize empiric therapeutic strategies through local antibiograms.

In summary, patients receiving HD are highly susceptible to severe BSI, most commonly caused by *S. aureus*. The risk is even higher for older patients, those with diabetes, HTN, other health problems, or who use CVC for dialysis. In Ethiopia, the situation is more critical because of limited dialysis resources and frequent use of temporary catheters. This research aims to understand the specific bacteria causing BSIs, their resistance to antibiotics, and the main risk factors for patients in three public hospitals in Addis Ababa, Ethiopia.

3. Objectives

3.1. General Objective

This study aimed to assess the incidence of bloodstream infection, bacterial etiology, temporal association between environmental pathogen with incidence of infection, antimicrobial susceptibility profile, risk factors, and the impact of intervention on incidence of infection among patients undergoing HD.

3.2. Specific Objectives

The specific objectives of the study were:

- To investigate the incidence of bloodstream infection (BSI) at selected dialysis centers in Addis Ababa from May 16, 2024 to May 14, 2025.
- To identify potential risk factors associated with the occurrence of BSI during the study period.
- To identify the bacterial etiologies responsible for BSI in this population.
- To determine antimicrobial susceptibility profiles of bacterial isolates.
- To assess clinical outcome among patients undergoing HD during the study period.
- To determine the temporal association between clinical and environmental bacterial isolates during the study period.
- To evaluate the impact of targeted infection control intervention on incidence of infection.

4. Methods and Materials

4.1. Study setting

This multicenter prospective cohort study was conducted at three public hospitals in Addis Ababa, Ethiopia: SPHMMC, MIICSH, and ZMH, where 168 eligible patients receiving HD were systematically followed to investigate the incidence of bloodstream infection, the bacterial etiologies, their antimicrobial susceptibility profiles, and to identify potential risk factors of infection among them.

4.2. Study design and period

The multicenter prospective cohort study was carried out for one year, from May 16, 2024 to May 14, 2025.

4.3. Study participants

168 eligible patients undergoing maintenance HD at the three hospitals were enrolled using consecutive and purposive sampling techniques. Patients of all ages and genders, with either AKI or CKD, were included if they met the inclusion criteria and provided informed consent or assent. Patients were excluded if they had a recent history of BSI or antibiotic use, recent surgery unrelated to dialysis procedures, or were transient HD patients, and as for female if pregnant.

4.4. Sample size

The sample size was calculated using the single population proportion formula. The assumed prevalence of bacterial infections among HD patients was 10.4% based on previous study (15). A 95% confidence interval ($Z = 1.96$) and a 5% margin of error were used in the calculation, resulting in an initial sample size of 143.19. To account for a 10% non-response rate, the sample size was adjusted upward. Accordingly, the sample size for this study was determined to be 160 participants. However, during the actual study period, a total of 168 participants were enrolled.

Practically, in accordance with the HMIS, a total of 2,752 CKD patients were found registered on the waiting list across the three public hospitals: 1,104 at SPHMMC and 1,648 at MIICSH and ZMH combined. Due to scarcity of dialysis machines – 7 at SPHMMC, 14 at MIICSH, and 8 at

ZMH – the minimum waiting time for patients to begin maintenance HD was three years or more.

During the study period, 164 CKD patients were undergoing maintenance HD across these hospitals (41 from SPHMMC, 96 from MIICSH, and 27 from ZMH). Among them, 153 patients were willing to participate in the study. After screening, 144 participants were initially included (40 from SPHMMC, 88 from MIICSH, and 16 from ZMH). Subsequently, 9 additional patients were enrolled from the waiting list – 6 from SPHMMC, 1 from MIICSH, and 2 from ZMH – to replace those who received kidney transplants, were transferred to other centers or countries, or passed away. This brought the total number of CKD patients included in the study to 153, resulting in a participation rate of approximately 93.3%.

In contrast, the provision of HD for AKI patients was structured differently due to extreme resource limitations. These public hospitals offered short-term dialysis care to AKI patients for a maximum of one month. Beyond this period, AKI patients were expected to continue dialysis – if needed – at locally available private HD centers. At SPHMMC, 30 AKI patients were assessed: 13 were included in the study, 17 were excluded based on eligibility, and an additional 14 patients declined participation. At MIICSH, 11 AKI patients were approached: only 1 was included, and the remaining 10 were unwilling to participate. Similarly, at ZMH, out of 22 AKI patients approached, only 1 was included, while 21 declined participations. All included patients were eligible and provided informed consent. In total, 63 AKI patients were approached, and 15 AKI patients were included, resulting in response rate of approximately 23.8%.

4.5. Study variables

4.5.1. Dependent variables

The study investigated the following dependent variables

- Incidence of bloodstream infection,
- Microbiological profile of isolated pathogens
- Antimicrobial resistance pattern
- Bacterial profile of environmental isolates
- Impact of intervention on incidence of infection

4.5.2. Independent variables

The study explored a range of independent variables including

- Demographic factors, which included patient age, sex, education level, employment status, income, occupation, and marital status.
- Clinical factors, which captured medical history, dialysis vintage, cause of kidney failure, comorbid conditions, and transplant status.
- Dialysis parameters, which enquired about type of dialysis, date started, dialysis center name, frequency, location, session length, vascular access type, blood flow rate and Kt/V.
- Medications, which asks about prescription medications currently taken, including dose and frequency.
- Lab parameters, which questions about kidney function evaluation tests, lab results leading to kidney failure/ESRD diagnosis, and factors influencing the decision to start dialysis.

4.6. Data Collection Tools and Procedures

Structured questionnaires, initially pre-tested at SPHMMC, were designed to capture socio-demographic, clinical, dialysis adequacy, and medication data. Based on the pretest results, amendments were made, and the revised questionnaires were uploaded to KoBo Toolbox for data collection.

4.7. Collection of Clinical Specimen

During episodes of bloodstream infection, blood cultures were collected aseptically from patients using two blood culture bottles, with a total volume of 16-20 mL obtained from each participant. In case where infective endocarditis was suspected, three separate bottles were collected to increase the likelihood of detecting the causative organism. Although standard blood cultures set often include both aerobic and anaerobic bottles, in this study, all procedures were performed under aerobic conditions only, with no specific anaerobic culturing performed. Catheter tip specimens were also collected from one AKI patient when BSI was suspected in ICU ward. Two catheter segments, from distal portion, approximately 5 cm in length, were aseptically removed and placed into sterile Falcon tubes for microbiological analysis.

4.8. Collection of Environmental Swabs and Water Samples

In addition to clinical specimens, environmental swabs and water samples were collected to assess potential environmental reservoirs of infection. Sampling was conducted biannually, with two rounds of environmental data collection carried out six months apart over a one-year study period – specifically on May 24, 2024, and November 1, 2024. Environmental samples were obtained from specific high-touch patient-contact surfaces, namely the beds and chairs in the dialysis unit, as well as from personal protective apparel, specifically the gowns worn by healthcare providers, using sterile, saline-moistened cotton swabs. In addition, water samples were collected from the water lines of the dialysis machines and from the hospital’s central water treatment unit, using sterile 100 ml bottles. The swab samples were then transported using Amies transport media to preserve microbial viability, while the water samples in their sterile bottles were transported separately. Furthermore, as an exception, at SPHMMC – where Ethiopia’s only kidney transplant ward is located – additional water samples were collected from dialysis machine water line and the water treatment unit within the transplant ward, in addition to those taken from the dialysis unit as in all the three centers.

4.9. Microbiological Procedures

Once the samples were collected, microbiological procedures were carried out at SPHMMC’s Infectious Disease Research and Molecular Laboratory (IDReaM Lab) based on Standard Operating Procedures (SOPs), except for the membrane filtration of all water samples which was performed at Ethiopian Public Health Institute (EPHI). The protocol was tailored to the nature of the sample type – clinical or environmental – and included selective enrichment, culturing, and confirmatory testing.

For blood samples, blood culture bottles were incubated at 37°C for an initial 24-48 hours to promote the growth of both fastidious and non-fastidious bacteria. Following incubation, sub-culturing was conducted onto Blood Agar Plate (BAP), Chocolate Agar Plate (CAP), and MacConkey Agar Plate (MAP). BAP and CAP were then incubated aerobically at 37°C in a 5% CO₂ candle jar for a duration ranging from 24 to 48 hours, whereas MAP were incubated aerobically at 37°C for 18 to 24 hours; MAP with no growth after 24 hours were discarded, whereas BAP and CAP with no growth were incubated for another 24 hours. The blood culture

bottles were retained in the incubator for a total of up to 7 days to allow the recovery of slow-growing or fastidious organisms, and were monitored daily for growth indicators such as turbidity and hemolysis. On the 6th day, bottles that flagged positive, with the same procedure indicated above sub-cultured onto BAP and MAP but if remained with no signs of microbial growth after the full incubation period were considered culture-negative and were discarded according to standard biosafety protocols.

For environmental samples such as swabs taken from high contact surfaces including patient beds, chairs, and healthcare provider gowns, the samples were directly streaked onto BAP, CAP, and MAP. Then BAP and CAP were incubated aerobically at 37°C in a 5% CO₂ candle jar for 24 to 48 hours and MAP were for 18 to 24 hours.

Water samples which were transported to the laboratory underwent a different process involving membrane filtration. Each sample was passed through a 0.45 µm sterile membrane filter, which was then placed on Tryptic Soy Broth (TSB) agar for a short enrichment period of 2 hours. After enrichment, the membranes were transferred onto MAP and incubated at 37°C for 18 to 24 hours to allow for the growth and differentiation of Gram-negative bacteria, particularly coliforms. The use of MAP, despite the Food Safety and Standards Authority of India's (FSSAI's) standard (74) recommendation of Chromogenic Coliform Agar (CCA) and Violet Red Bile Lactose (VRBL) agar for detecting coliforms and *E. coli*, was scientifically justified in this study. MAP served as a validated selective and differential medium ideal for resource-limited settings where chromogenic media may not be accessible. It allows for the differentiation of lactose-fermenting coliforms, such as *E. coli* and *Klebsiella*, which form pink to red colonies, from non-lactose fermenters, which remain colorless.

For all sample types, microbiological identification began with Gram staining to categorize organisms into Gram-positive or Gram-negative bacteria. Gram-positive cocci were differentiated using catalase and coagulase tests, particularly to distinguish *S. aureus* from CoNS. For Gram-negative rods, biochemical tests, including Triple Sugar Iron (TSI) slants, urease test, citrate utilization test, Sulfur-Indole-Motility (SIM) test, Lysine Iron Agar (LIA) test, oxidase test and indole test were performed, enabling comprehensive bacterial identification.

AST was performed using the standardized Kirby-Bauer disk diffusion method. Mueller-Hinton Agar (MHA) served as the testing medium for all isolates. Based on the European Committee on

Antimicrobial Susceptibility Testing (EUCAST) Clinical Breakpoint v13.0 guidelines, antimicrobial disc concentrations used for susceptibility testing included the following antibiotic discs for Gram-positive isolates: ceftazidime (30 µg), chloramphenicol (30 µg), ciprofloxacin (5 µg), clindamycin (2 µg), doxycycline (30 µg), oxacillin (1 µg), erythromycin (15 µg), gentamicin (10 µg), , penicillin (10 µg), tetracycline (30 µg), trimethoprim-sulfamethoxazole (1.25/23.75 µg), and vancomycin (30 µg). For Gram-negative isolates, the discs included amikacin (30 µg), amoxicillin-clavulanic acid (20/10 µg), ampicillin (10 µg), aztreonam (30 µg), cefepime (30 µg), cefotaxime (30 µg), ceftriaxone (30 µg), ceftazidime (30 µg), chloramphenicol (30 µg), ciprofloxacin (5 µg), gentamicin (10 µg), imipenem (10 µg), meropenem (10 µg), piperacillin-tazobactam (100/10 µg), tobramycin (10 µg), and trimethoprim-sulfamethoxazole (1.25/23.75 µg). The bacterial inoculum was standardized to match a 0.5 McFarland turbidity standard, and plates were incubated aerobically at 37°C for 16 to 18 hours. Following incubation, the zones of inhibition around each antibiotic disk were measured, and the results were interpreted according to the EUCAST Clinical Breakpoint v13.0 (2023) (75,76).

4.10. Data Quality Assurance and Control

To ensure quality of data, checks for questionnaire completeness was applied to patient records collected via KoBo Toolbox. These measures, combined with laboratory data, provided a reliable dataset. Prior to sample collection, six dialysis units' nurses of the study centers received proper one day training on standardized procedures for clinical sample collection specific to the study. Laboratory analyses were conducted in accordance with Standard Operating Procedures (SOPs) encompassing the pre-analytical, analytical, and post-analytical phases. All procedures were carried out by well-trained laboratory professionals. To ensure sterility, 5% of each batch of basic culture media (BAP, CAP, MAP and MHA) were incubated aerobically at 37°C for 24-48 hours and the quality control of antibiotic disks was performed weekly using standardized ATCC reference strains (*S. aureus* ATCC 25923, *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, *Acinetobacter baumannii* ATCC 196066, *Klebsiella pneumoniae* ATCC 700603). Antimicrobial susceptibility testing was performed following EUCAST guidelines, utilizing bacterial suspensions standardized to a 0.5 McFarland turbidity. Gram staining and biochemical assays were validated with known control organisms to ensure accuracy. Critical equipment – including incubators, autoclaves, and refrigerators – underwent routine calibration, with temperature logs

maintained and sterilization verified using appropriate indicators. Throughout all laboratory procedures, aseptic techniques were rigorously applied, and Level II Biosafety Protocols were followed to ensure safe handling of clinical and environmental samples.

4.11. Operational definition

CKD: A condition characterized by abnormalities in kidney structure or function, present for more than three months, with health implications. It is defined by a sustained eGFR <60 mL/min/1.73 m² or markers of kidney damage such as albuminuria or structural abnormalities.

AKI: A sudden decline in kidney function occurring over hours to days, diagnosed using KDIGO criteria, where an increase in serum creatinine by ≥ 0.3 mg/dL within 48 hours, or ≥ 1.5 times baseline within 7 days, or urine output <0.5 mL/kg/h for 6 hours.

BSI: The presence of viable bacteria in the bloodstream, confirmed by positive blood cultures, often accompanied by systemic signs of infection such as fever, chills, or hypotension.

Sepsis: A life-threatening organ dysfunction caused by a dysregulated host response to infection. Operationally defined by an increase in the Sequential Organ Failure Assessment (SOFA) score of ≥ 2 points from baseline, according to the Sepsis-3 criteria.

HD: A renal replacement therapy that removes waste products and excess fluid from the blood through a dialyzer, typically performed three times per week for patients with end-stage renal disease.

MDRO: Bacteria that is non-susceptible to at least one agent in three or more antimicrobial categories, as defined by international consensus guidelines.

Risk Factors for infection or sepsis in HD patients: Characteristics or exposures that increase the likelihood of developing infection or sepsis among HD patients.

4.12. Ethical consideration

Ethical clearance for this study was obtained from the Institutional Review Board (IRB) of SPHMMC with PM23/1207 reference number on 13/05/2024. Following this initial approval, the IRB clearance letter and the study proposal paper were submitted to Addis Ababa Health Bureau to seek authorization for conducting the study at MIICSH and ZMH. The Bureau reviewed the

submission and issued an official letter of support, endorsing the study and requesting full cooperation from the respective hospitals and their staff. Subsequently both additional hospitals granted formal permission to proceed with data collection, based on the Bureau's endorsement. The study objectives, procedures, and ethical safeguards were clearly communicated to hospital administrators and relevant personnel prior to implementation.

Informed written consent was obtained from all participants after providing a detailed explanation of the study's purpose, procedures, potential risks, and benefits. For participants under the age of 18 – written assent was obtained. For adult participants – particularly older individuals who were unable to read or write – consent was provided by their legally authorized representative or close family member. Confidentiality was rigorously maintained by assigning barcodes to participants and ensuring that no personally identifiable information was recorded. To support patient care, preliminary blood culture results were communicated within 24 to 48 hours via cellphone call to the responsible internist, resident, or general practitioner at the ward, and finally, confirmed results were subsequently provided in printed form to the attending physicians.

4.13. Data management and analysis

All collected data, including bacterial identification, antimicrobial susceptibility profiles, clinical outcomes from the three infection incidences, and environmental sampling results, were manually entered into Microsoft Excel. These datasets were brought together and merged with the downloaded data from KoBo Toolbox – which included socio-demographic, clinical, dialysis adequacy, and medication data – using participant barcodes, medical record numbers (MRNs), and the unique identifiers (_uuid) automatically generated by KoBo Toolbox to ensure accurate matching. After data cleaning, the merged dataset was imported into IBM Statistical Package for the Social Sciences (SPSS) version 27.0, where all statistical analyses were conducted.

Descriptive statistics were used to summarize the data: for continuous variables, both mean (SD) and median (IQR) were reported to account for distribution characteristics. Categorical variables were described using frequencies and percentages. For group comparisons, chi-square tests (χ^2) were applied to categorical variables. Paired sample t-tests were performed to evaluate changes in continuous variables across different time points. Univariate and multivariate logistic

regression models were used to identify predictors of BSIs. Crude odds ratios (COR) and adjusted odds ratios (AOR) were reported with 95% confidence intervals (CI), and a p-value less than 0.05 was considered statistically significant. Graphs and figures were generated using R version 4.2.2 with the RcmdrPlugin.KMggplot2 package (R Core Team, 2021).

5. Result

5.1. Sociodemographic Characteristics

We enrolled a total of 168 patients in the study, of whom 60 (35.7%) were female and 108 (64.3%) were male. The median age of the participants was 44 years, with an interquartile range (IQR) of 34 to 56.75 years, indicating a predominance of middle-aged individuals. Specifically, among those with AKI, the median age was 39.5 years (IQR: 27.5-48.5), while those with CKD had a median age of 45 years (IQR: 34-57). Among those enrolled, 153 (91.1%) were diagnosed with CKD, while 15 (8.9%) presented with AKI. The socio-economic impact of kidney disease was substantial: 61 participants (36.4%) reported having quit their jobs due to illness-related limitations, and 9 students (5.4%) were unable to continue their education (**Table 1**).

Table 1. Sociodemographic Characteristics of the Cohort, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	AKI (n=15)	CKD (n=153)	χ^2 (p-value)
Study Center			
MIICSH	1 (0.6)	89 (53)	19.54 (0.000057)
SPHMMC	13 (7.7)	46 (27.4)	
ZMH	1(0.6)	18(10.7)	
Age (Median (IQR))	39.5 (27.5 - 48.5)	45 (34 - 57)	15.8 (0.272)
Gender			
Female	7 (4.2)	53 (31.5)	0.86 (0.353)
Male	8 (4.8)	100 (59.5)	
Marital Status			
Single	5 (3)	44 (26.2)	2.52 (0.641)
Married	7(4.2)	82 (48.8)	
Separated	1(0.6)	2 (1.2)	
Widowed	1(0.6)	11 (6.5)	
Divorced	1 (0.6)	14 (8.3)	
Residence			
Rural	5 (3)	16 (9.5)	6.54 (0.0105)
Urban	10 (6)	137 (81.5)	
Education level			
Unable to read and write	1(0.6)	7 (4.2)	7.56 (0.182)
Primary education	4 (2.4)	21(12.5)	
Secondary education	3 (1.8)	30 (17.9)	

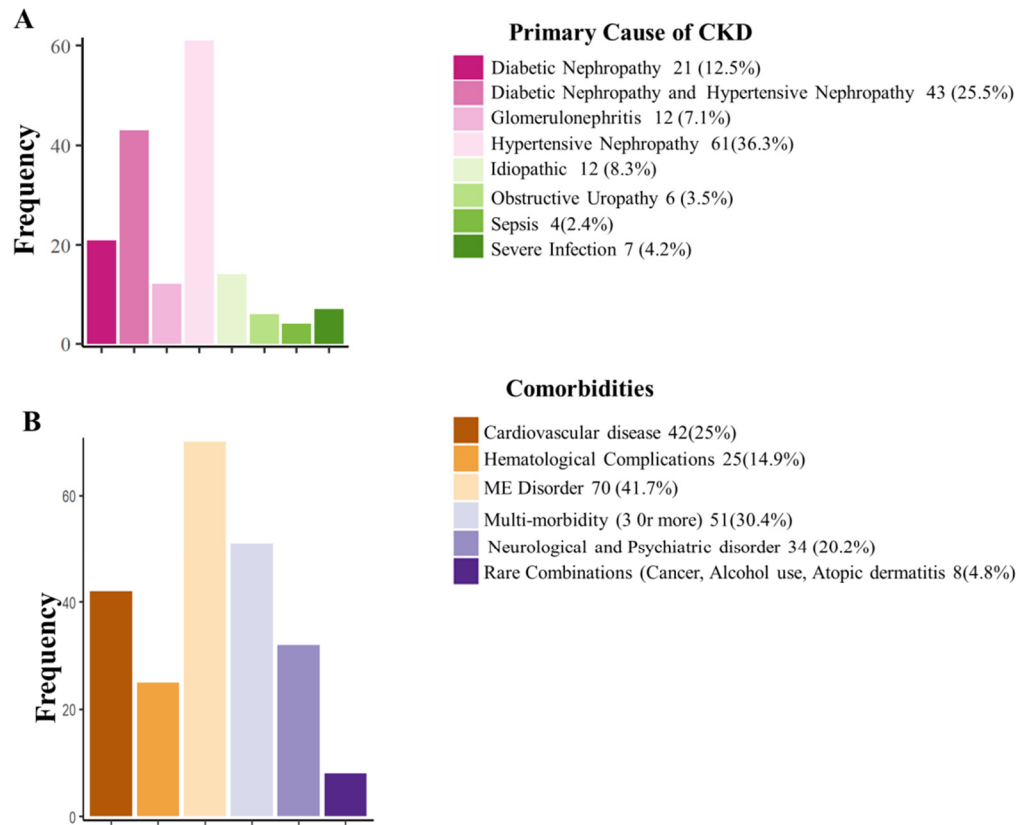
Diploma Level	0 (0)	43 (25.6)	
Undergraduate degree	6 (3.6)	36 (21.4)	
Postgraduate degree	1 (0.6)	16 (9.5)	
Work status			
Student	2 (1.2)	10 (6)	
Quit studying due to kidney failure	1 (0.6)	8 (4.8)	
Unemployed	0 (0)	17 (10.2)	
Employed Full time	5 (3)	26 (15.4)	6.18 (0.723)
Employed part time	2 (1.2)	15 (9)	
Quit work due to kidney failure	4 (2.4)	57(34)	
Retired	1 (0.6)	20(11.9)	
Annual Income			
Less than 12,000 Birr	6 (3.6)	93 (55.4)	
12,000 Birr - 120,000 Birr	6 (3.6)	53 (31.5)	6.57 (0.0373)
240,000 Birr or more	3(1.8)	7 (4.2)	
Family History of Kidney disease			
Yes	0 (0)	7 (4.2)	0.72 (0.397)
No	15 (8.9)	146 (86.9)	

5.2. Clinical and Disease related Characteristics of the cohort

5.2.1. Primary causes of CKD and Comorbidities

Among patients receiving maintenance HD, hypertensive nephropathy was the most frequent primary cause of CKD, accounting for 61 cases (36.3%). Co-occurrence of diabetic nephropathy and hypertensive nephropathy was identified in 43 patients (25.5%), indicating a substantial overlap between metabolic and vascular contributors to renal impairment. Diabetic nephropathy alone was responsible for CKD in 21 patients (12.5%), further emphasizing the role of diabetes as a major etiological factor (**Figure 1(A)**). Metabolic and endocrine (ME) disorders were the most common comorbidity affecting 70 patients (41.7%), with chronic kidney disease-mineral and bone disorder being the most prevalent condition (41.7%). Cardiovascular conditions were identified in 42 individuals (25.0%), with hypertensive retinopathy being the leading diagnosis in 14 cases (33.3%), followed by coronary artery disease (CAD) in 4 cases (9.5%) and atherosclerosis in 3 cases (7.1%). Whereas neurological and psychiatric disorders were reported in 34 individuals (20.2%), with uremic encephalopathy being the most prevalent condition

(47.1%), followed by peripheral neuropathy associated with uremic encephalopathy (29.4%) (Figure 1(B); Table 2).



ME = Metabolic and Endocrine Disorders

Figure 1 (A) Primary causes of CKD. (B). Comorbidities prevalence among CKD and AKI patients receiving HD, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Table 2. Comorbidity Profile across Major Disease Domains, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Comorbidities category	n (%)
Metabolic and Endocrine Disorders (n=70)	
CKD-MBD	34 (48.6)
Diabetic Retinopathy	6 (8.6)
Diabetic Retinopathy: CKD-MBD	9 (12.9)
Cardiovascular Conditions (n=42)	
Hypertensive Retinopathy	14 (33.3)
Coronary Artery Disease	4 (9.5)

Atherosclerosis	3 (7.1)
Neurological and Psychiatric (n=34)	
Uremic Encephalopathy	16 (47.1)
Peripheral Neuropathy: Uremic Encephalopathy	10 (29.4)
Depression: Anxiety: Delirium	7 (20.6)
Hematologic Complications (n=27)	
Anemia of Chronic Disease	25 (92.6)
MSK and Dermatologic (n=22)	
Pruritus	8 (36.4)
Osteoarthritis	4 (18.2)
Lung Disease or Disorders (n=28)	
ARDS	4 (14.3)
Pulmonary Tuberculosis	4 (14.3)
Pulmonary Hypertension	3 (10.7)
GI and Hepatic Conditions (n=17)	
GI Bleeding: Gastritis	4 (23.5)
LD associated with Hepatitis C	4 (23.5)
Autoimmune/Systemic (n=13)	
Rheumatoid Arthritis	4 (30.8)
Lupus	3 (23.1)
Recurrent Infections (n=13)	
Recurrent Dialysis Access Infections	9 (69.2)
Cancer Types (n=6)	
Multiple Myeloma	4 (66.7)
CKD-MBD = Chronic Kidney Disease-Mineral and Bone Disorder; ARDS = Acute Respiratory Distress Syndrome; ME = Metabolic and Endocrine Disorders; MSK = Musculoskeletal; GI = Gastrointestinal; LD = Liver Disease	

5.2.2. Renal Disease Severity, Biopsy insights, and Adherence

The majority of patients (82.5%) in this study were in Stage 5 CKD, defined by an eGFR below 15 mL/min/1.73 m². A smaller proportion were in earlier stages: Stage 4 (11.7%), Stage 2 (2.9%), and Stage 3a and 3b (each 1.5%). Transplant evaluation was conducted for 28.8% of them, while 71.2% had not undergone assessment. Among those evaluated, 36.4% were found ineligible for transplant. A total of 13.6% had received a kidney transplant, and another 13.6% were either awaiting transplant or undergoing re-evaluation due to prior graft failure (**Table 3**). Of the 168 patients in the study, 150 (89.3%) indicated practicing fluid restriction, while 18 (10.7%) did not. Despite the high number of patients claiming adherence, 65.3% did not follow

fluid restriction on any day of the week, indicating a significance gap between reported intention and actual behavior. Regarding dietary practices, 81.5% of patients stated that they were following a special renal diet, while 18.5% were not (**Table 3**).

Table 3. Severity of Renal Disease and Adherence to Fluid and Dietary Recommendations, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

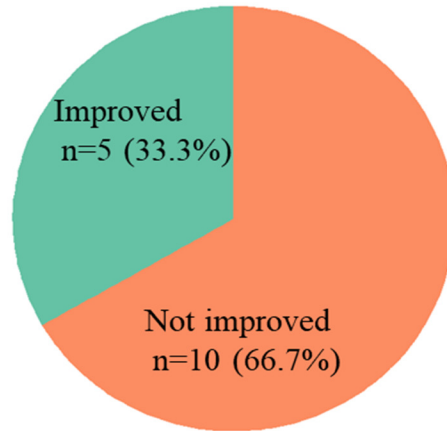
Variables	n (%)
CKD Stages	
Stage 2: eGFR (60-89 mL/min/1.73 m ²)	4 (2.9)
Stage 3a: eGFR (45-59 mL/min/1.73 m ²)	2 (1.5)
Stage 3b: eGFR (30-44 mL/min/1.73 m ²)	2 (1.5)
Stage 4: eGFR (15-29 mL/min/1.73 m ²)	16 (11.7)
Stage 5: eGFR (< 15 mL/min/1.73 m ²)	113 (82.5)
Transplant Evaluation Status	
Yes	44 (28.8)
No	109 (71.2)
Transplant Assessment Result	
Ineligible for transplant	16 (36.4)
Eligible and received kidney transplant	6 (13.6)
Eligible and actively awaiting transplant	5 (11.4)
Eligible but temporarily deferred	1 (2.3)
Eligible with living donor under evaluation	5 (11.4)
Eligible pending desensitization	1 (2.3)
Age-restricted candidacy	3 (6.8)
Eligible but declined transplant	1 (2.3)
Prior transplant failure requiring re-evaluation	6 (13.6)
Fluid Restriction	
Yes	150 (89.3)
No	18 (10.7)
Fluid Restriction Adherence	
0 day	98 (65.3)
1-2 days	21 (14.0)
3-4 days	18 (12.0)
5-6 days	8 (5.3)
Everyday	5 (3.3)
On Special Renal Diet	
Yes	137 (81.5)
No	31 (18.5)

Among AKI patients studied, the majority (91.7%) underwent a kidney biopsy within the past three months, indicating recent clinical concern. The primary reasons for biopsy included unexplained kidney failure in 41.7% of cases, and followed by suspected GN (25.0%). Biopsy findings revealed that rapidly progressive glomerulonephritis (RPGN) was the most common diagnosis (41.7%) (**Table 4**). Regarding recovery, only 33.3% of patients reported partial improvements in kidney function, while 66.7% showed no recovery, highlighting the severity and poor prognosis often associated with AKI in this cohort (**Figure 2**).

Table 4. Findings of Kidney Biopsies in AKI, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Variable	n (%)
Most recent Kidney Biopsy	
Within the past 3 months	11 (91.7)
6-12 months ago,	1 (8.3)
Reason for Kidney Biopsy	
Kidney allograft	1 (8.3)
Suspected GN	3 (25)
Unexplained KF	5 (41.7)
Unexplained KF; PBU; Suspected GN	1 (8.3)
Unexplained KF; Suspected GN	2 (16.7)
Biopsy Findings	
AIN	1 (8.3)
ATI; Ischemic ATN	2 (16.7)
ATI; RPGN; Ischemic ATN	1 (8.3)
CIN	1 (8.3)
DN	1 (8.3)
IgA Nephropathy; RPGN	1 (8.3)
RPGN	5 (41.7)

KF = Kidney failure; GN = Glomerulonephritis; PBU: Significant protein or blood in urine; AIN = Acute Interstitial Nephritis; ATI = Acute Tubular Injury; ATN = Acute Tubular Necrosis; RPGN = Rapidly Progressive Glomerulonephritis; CIN = Chronic Interstitial Nephritis; DN = Diabetic Nephropathy; IgA = Immunoglobulin A



AKI Patients (n=15) Kidney function Improvement

Figure 2. Proportion of Patients with Kidney Function Improvement, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

5.2.3. HD Related Characteristics of patients

Most patients had been on dialysis for a considerable duration, with 58.9% in the intermediate vintage group (12-59 months) and 29.8% in the long vintage group (≥ 60 months). Only a small proportion had recently initiated HD (1.2%) or were in the early phase (10.1%). Regarding vascular access, patients in the cohort used multiple types at different times during the study period. Arteriovenous fistula (AVF) was the most commonly used access, recorded in 34.5% of cases. Temporary non-tunneled central venous catheters (TNT-CVC) were also frequently used, appearing in 14.9% of patients. Several individuals transitioned between access types over time, due to clinical needs that may require changes based on availability, complications, or treatment progression. Most patients (92.9%) received HD three times per week, aligning with standard treatment protocols (**Table 5**).

Table 5. HD Related Characteristics, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	n (%)
Dialysis Vintage (months)	
Recent HD initiation (0-2)	2 (1.2)
Early vintage (3-11)	17 (10.1)
Intermediate vintage (12-59)	99 (58.9)
Long vintage (≥ 60)	50 (29.8)

Vascular Access Types	
AVF	58 (34.5)
AVF; AVG; TNT-CVC	2 (1.2)
AVF; AVG; TNT-CVC; PT-CVC	3 (1.8)
AVF; PT-CVC	14 (8.3)
AVF; TNT-CVC	46 (27.4)
AVF; TNT-CVC; PT-CVC	11 (6.5)
PT-CVC	7 (4.2)
TNT-CVC	25 (14.9)
TNT-CVC; PT-CVC	2 (1.2)
HD Session	
2 times per week	12 (7.1)
3 times per week	156 (92.9)
Blood Flow Rate	
Less than 300 ml/min	32 (19)
300-400 ml/min	118 (70.2)
More than 400 ml/min	18 (10.7)
Time of Each Dialysis	
1 and ½ hours	13 (7.7)
3 hours	32 (19)
3 and ½ hours	58 (34.5)
4 hours	65 (38.7)
AVF = Arteriovenous Fistula; AVG = Arteriovenous Graft; TNT-CVC = Temporary Non-Tunneled Central Venous Catheter; PT-CVC = Permanently Tunneled Central Venous Catheter	

5.2.4. Overall Intradialytic Vital Signs and Adequacy

A paired-samples t-test was conducted to assess the statistical significance of changes between pre-dialysis and post-dialysis measurements. Table 6 shows changes in patient measurements before and after dialysis during recruitment and two BSI incidences. At recruitment, systolic and diastolic blood pressure decreased significantly after dialysis ($p < 0.001$), while pulse rate remained stable. Weight also dropped significantly, and dialysis adequacy was good ($Kt/V = 1.5$). At the first incidence, blood pressure and weight again decreased significantly, but dialysis adequacy was lower ($Kt/V = 1.18$) and BMI was underweight. At the second incidence, blood pressure changes were not significant, though weight reduction remained significant ($p = 0.003$). Dialysis adequacy was borderline ($Kt/V = 1.2$). Overall, the table indicates that during BSI

episodes patients had lower dialysis adequacy and unstable vital signs compared to the recruitment period.

Table 6. Overall Intradialytic Vital Signs and Adequacy, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

During Cohort Recruitment				
Variables	Pre dialysis Mean (SD)	Post dialysis Mean (SD)	t	P-value
SBP in mmHg	145 (25.1)	132 (21.6)	9.3	<0.001
DBP in mmHg	84.5 (16.3)	77 (14.2)	6.6	<0.001
Pulse rate in bpm	82.2 (13.3)	82 (12.3)	0.2	<0.814
Weight in kg	57.2 (12.1)	53.9 (14.7)	36.4	<0.001
BMI	20.1 (4)			
Kt/V value	1.5 (0.3)			
At First Incidence				
Variables	Pre dialysis Mean (SD)	Post dialysis Mean (SD)	t	P-value
SBP in mmHg	131.7 (44.8)	114.3 (35.5)	3.5	<0.002
DBP in mmHg	76 (24.2)	69.3 (21.5)	2.1	<0.050
Pulse rate in bpm	95.5 (32.1)	90.7 (28.8)	0.7	<0.493
Weight in kg	56.7 (12.8)	54.4 (12.8)	29.4	<0.000
BMI	19.3 (4.3)			
Kt/V value	1.18 (0.21)			
At Second Incidence				
Variables	Pre dialysis Mean (SD)	Post dialysis Mean (SD)	t	P-value
SBP in mmHg	125 (35.4)	114.4 (31.2)	1.1	<0.322
DBP in mmHg	72.2 (17.2)	72.2 (17)	0	<1.000
Pulse rate in bpm	91 (31.4)	85.6 (32.3)	0.1	<0.385
Weight in kg	63.4 (15.2)	61.3 (15.6)	6.2	<0.003
BMI	21 (5.3)			
Kt/V value	1.2 (0.22)			

SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; BMI = Body Mass Index; Kt/V = Dialyzer clearance of urea $\times$ dialysis time $\div$ volume of urea distribution

5.3. Incident of BSI and its patterns

The overall incident of BSI was 16.6% (28/168), of which 22 (13.1%) (22/168) patients had only one incident of infection, 5 patients (2.9%), (5/168)) had a double incident of infection whereas 1 patient (0.6%), (1/168)) had three episodes of infection during the study period. The incident of sepsis was 4.7% (8/168) (**Figure 3**).

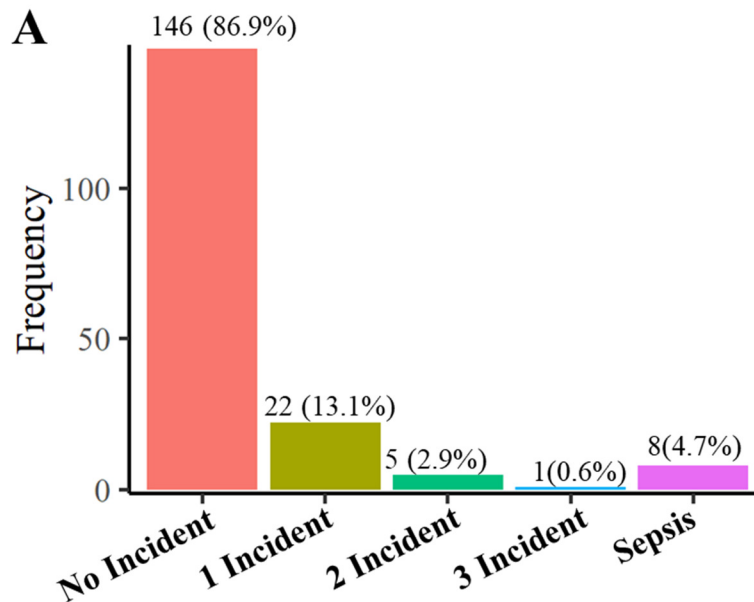


Figure 3. Distribution of BSI Episodes and Subsequent Sepsis Progression, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

5.4. Association of Laboratory Parameters with BSI and its patterns

Baseline assesment of hematological parameters showed association with incidence of infection. Hemoglobin and hematocrit levels were significantly reduced in the infected group ($p < 0.001$ and $p < 0.01$, respectively). The median WBC count was slightly lower in the infected group compared to the non-infected group. Neutrophil percentage was modestly higher among infected individuals. Platelets counts were also lower in the infection group. Red cell indices – RDW and MCV – showed no notable differences between groups (**Figure 4**).

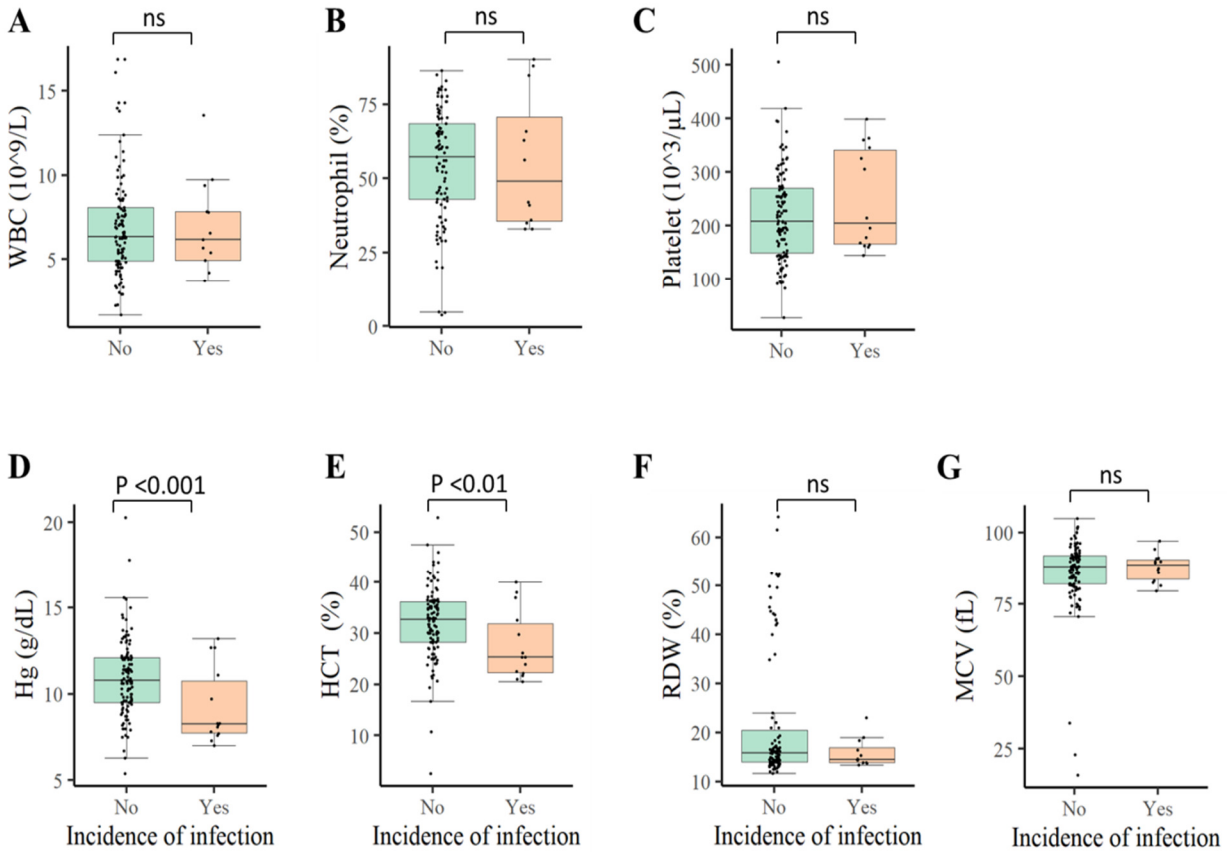


Figure 4. Association Between Baseline CBC Count and BSI, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Beside the above figure illustrated to show the association between BSI and CBC count, the renal function tests revealed chronically impaired renal function, as evidenced by latest elevated serum creatinine (mean 8.0 ± 4.7 mg/dL) and reduced eGFR (mean 13.3 ± 13.3 mL/min/1.73 m²). Among patients who developed sepsis during the study, C-Reactive Protein (CRP) levels were markedly elevated, with a mean value of 148 ± 30.0 mg/L and a median of 153.5 mg/L (IQR: 118.3–171.5) (Table 7).

Table 7 Hematological and Biochemical Markers of BSI risks and its patterns, Addis Ababa, Ethiopia (May, 2024- April, 2025)

Variables	Mean (SD)	Median (IQR: Q1-Q3)
White Blood Cell Count (10 ⁹ /L)	6.9 (3.0)	6.3 (4.9-8.1)
Neutrophils (%)	54.7 (19.1)	56.2 (41.7-69.3)
Platelet Count (10 ⁹ /L)	220.8 (84.2)	207.5 (154.8,274.5)
Red Cell Distribution Width (%)	21.2 (12.8)	15.8 (14-19.1)
Hemoglobin (gm/dL)	10.8 (2.3)	10.7 (9.3-12.1)
Hematocrit (%)	31.5 (7.2)	32.4 (27-36.1)
Mean Corpuscular Volume (fl)	86.1 (12)	88 (82.3-91.9)
Ferritin (ng/mL)	1074.3 (790.9)	1084.5 (393.3-1563.8)
Transferrin Saturation (%)	55.2 (66.8)	40.5 (24.3-52.6)
Serum Iron (ug/dL)	76.9 (40.1)	69.5 (51.3-91.8)
Total Iron-Binding Capacity (ug/dL)	221.8 (66.7)	200 (179-255)
Serum Creatinine (gm/dL)	7.3 (4.2)	7.2 (4.7-9)
Serum Albumin (gm/dL)	3.7 (0.6)	3.8 (3.6-4.1)
Blood Urea Nitrogen (gm/dL)	83.6 (106.8)	60.7 (40.7-105.5)
eGFR (mL/min/1.73 m ²)	18.9 (26.5)	10 (7.6-16.2)
Sodium (mmol/L)	135.3 (6.1)	136 (131.7-138)
Potassium (mmol/L)	4.9 (1.1)	5 (4.3-5.5)
Calcium (gm/dL)	2.4 (2.6)	1.1 (0.9-3.3)
Phosphate (gm/dL)	11 (50.9)	4.5 (3.3-6)
Parathyroid Hormone (pg/mL)	1031.4 (706.7)	903.9 (468.6-1410.8)
25 Hydroxyvitamin D (ng/mL)	37.5 (18.1)	32.1 (25.2-49.7)
C-Reactive Protein (mg/L)	148 (30.0)	153.5 (118.3-171.5)
Erythrocyte Sedimentation Rate (mm/hr)	92.7 (42.0)	72 (65-141)
Prothrombin Time (seconds)	24.7 (16.1)	20.3 (12.2-41.6)
Activated Partial Thromboplastin Time (seconds)	56 (30.2)	45.9 (34.6-87.5)
Uric Acid (gm/dL)	5.4 (2.1)	5.65 (3.85-7.15)
Latest Serum Creatinine level (mg/dL))	8.0 (4.7)	7.0 (5.0-10.0)
Latest eGFR (mL/min/1.73 m ²)	13.3 (13.3)	9.4 (6.3-13.8)

5.5. Clinical Bacterial Isolates

A total of 21 bacterial isolates were identified across three BSI incidences. Most were recovered during the first incidence (n = 17, 81.0%), followed by the second (n = 4, 19.0%), while no bacterial growth was observed in the third. In the first incidence, 7 isolates (41.2%) were Gram-positive and 11 (58.8%) Gram-negative. CoNS were the most frequent Gram-positive (n = 6), found mainly at SPHMMC (66.7%), with smaller proportions at MIICSH and ZMH. *S. aureus* was isolated once at MIICSH. Among Gram-negative isolates, *Klebsiella* spp. (n = 4) and *P. aeruginosa* (n = 4) were most common, with *Klebsiella* mainly at SPHMMC (75.0%) and *P. aeruginosa* mainly at MIICSH (75.0%). *Enterobacter* spp. and *E. coli* were each isolated once at SPHMMC. Overall BSI occurrence was highest at SPHMMC (50.0%), followed by MIICSH (27.3%) and ZMH (22.7%). Recurrent BSI was rare, seen only once at SPHMMC, while sepsis progression occurred in 6 cases, most at MIICSH (50.0%) (**Table 8**).

During the second incidence, all cases were reported from SPHMMC, with 4 isolates evenly split between Gram-positive (CoNS and *S. aureus*) and Gram-negative (*Citrobacter* spp. and *Klebsiella* spp.). All patients (100.0%) had illness, confirmed BSI, and recurrent BSI, with one case (25.0%) progressing to sepsis. The third incidence involved a single case from the AICU at SPHMMC, where the patient developed illness, BSI, recurrent BSI, and sepsis (**Table 9; Table 10**).

Table 8. Bacterial Isolates from Clinical Samples across the three Study Centers – Incidence 1, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	Study Center, n (%)		
	SPHMMC	MIICSH	ZMH
Ward / Unit at Inc 1			
Dialysis Unit	9 (52.9)	5 (29.4)	3 (17.6)
Adult Emergency	1 (16.7)	4 (66.7)	1 (16.7)
AICU	2 (28.6)	3 (42.9)	2 (28.6)
Occurrence of illness: Yes	11 (50.0)	6 (27.3)	5 (22.7)
Presence of BSI: Yes	11 (50.0)	6 (27.3)	5 (22.7)
Recurrent BSI			
Yes	1 (100.0)	0 (0.0)	0 (0.0)
No	10 (47.6)	6 (28.6)	5 (23.8)

Infection progress to sepsis			
Yes	1 (16.7)	3 (50.0)	2 (33.3)
No	9 (60.0)	3 (20.0)	3 (20.0)
Bacterial growth at Inc 1			
Yes	9 (52.9)	5 (29.4)	3 (17.6)
No	1 (25.0)	1 (25.0)	2 (50.0)
Bacterial ID result			
Gram-Positive Bacteria	4 (57.1)	2 (28.6)	1 (14.3)
Gram-Negative Bacteria	5 (50.0)	3 (30.0)	2 (20.0)
No Growth Observed	1 (25.0)	1 (25.0)	2 (50.0)
Gram Positive Isolate			
CoNS	4 (66.7)	1 (16.7)	1 (16.7)
<i>S. aureus</i>	0 (0.0)	1 (100.0)	0 (0.0)
Gram Negative Isolate			
<i>Enterobacter</i> spp.	1 (100.0)	0 (0.0)	0 (0.00)
<i>E. coli</i>	1 (100.0)	0 (0.0)	0 (0.0)
<i>Klebsiella</i> spp.	3 (75.0)	0 (0.0)	1 (25.0)
<i>P. aeruginosa</i>	0 (0.0)	3 (75.0)	1 (25.0)
Inc 1 = Incidence 1			

Table 9. Bacterial Isolates from Clinical Samples across the three Study Centers – Incidence 2, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	Study Center, n (%)		
	SPHMMC	MIICSH	ZMH
Ward / Unit at Inc 2			
Dialysis Unit	3 (100.0)	0 (0.0)	0 (0.0)
AICU	2 (100.0)	0 (0.0)	0 (0.0)
Occurrence of illness: Yes	5 (100.0)	0 (0.0)	0 (0.0)
Presence of BSI: Yes	5 (100.0)	0 (0.0)	0 (0.0)
Recurrent BSI: Yes	5 (100.0)	0 (0.0)	0 (0.0)
Infection progress to sepsis			
Yes	1 (100.0)	0 (0.0)	0 (0.0)
No	2 (100.0)	0 (0.0)	0 (0.0)
Bacterial growth: Yes	4 (100.0)	0 (0.0)	0 (0.0)
Bacteria ID result			
Gram-Positive Bacteria	2 (100.0)	0 (0.0)	0 (0.0)
Gram-Negative Bacteria	2 (100.0)	0 (0.0)	0 (0.0)
Gram-Positive Isolate			

CoNS	1 (100.0)	0 (0.0)	0 (0.0)
<i>S. aureus</i>	1 (100.0)	0 (0.0)	0 (0.0)
Gram-Negative Isolate			
<i>Citrobacter</i> spp.	1 (100.0)	0 (0.0)	0 (0.0)
<i>Klebsiella</i> spp.	1 (100.0)	0 (0.0)	0 (0.0)

Inc 2 = Incidence 2

Table 10. Bacterial Isolates from Clinical Samples across the three Study Centers – Incidence 3, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Variable	Study Center, n (%)		
	SPHMMC	MIICSH	ZMH
Ward / Unit at Inc 3: AICU	1 (100.0)	0 (0.0)	0 (0.0)
Occurrence of illness: Yes	1 (100.0)	0 (0.0)	0 (0.0)
Presence of BSI: Yes	1 (100.0)	0 (0.0)	0 (0.0)
Recurrent BSI: Yes	1 (100.0)	0 (0.0)	0 (0.0)
Infection progress to sepsis: Yes	1 (100.0)	0 (0.0)	0 (0.0)
Bacterial growth: No Growth	1 (100.0)	0 (0.0)	0 (0.0)

Inc 3 = Incidence 3

5.6. Environmental Bacterial Isolates

A total of 46 environmental samples were collected across the three study centers (11). Most samples were collected from dialysis units (91.3%), with SPHMMC contributing the largest share (38.1%), followed by MIICSH (33.3%) and ZMH (28.6%). Sampling was done in two rounds, equally distributed across centers on May 24, 2024 and November 1, 2024 (around six months apart). Sources included dialysis beds (40% SPHMMC, 40% MIICSH, 20% ZMH), chairs (33.3% each), medical gowns (33.3% each), water-line and its treatment units, where SPHMMC dominated as it included the water system in transplant unit.

Bacterial growth was observed in 65.2% of samples, with SPHMMC accounting for 43.3%, MIICSH 33.3%, and ZMH 23.3%. Gram-negative bacteria were predominant (86.7%), especially *Klebsiella* spp. (46.2%), mainly from SPHMMC (66.7%). Other Gram-negative isolates included *Enterobacter* spp. (8.7%), *P. aeruginosa* (8.7%), *Citrobacter*, *Acinetobacter*, *Shigella*, and *E.*

coli. Gram-positive bacteria were less frequent (13.3%), with CoNS found only at SPHMMC and *Bacillus* spp. only at MIICSH (Table 11).

Table 11. Bacterial Isolates from Environmental Samples across the three Study Centers, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	Study Center, n (%)		
	SPHMMC	MIICSH	ZMH
Ward / Unit			
Dialysis unit	16 (38.1)	14 (33.3)	12 (28.6)
Transplant Services	4 (100.0)	0 (0.0)	0 (0.0)
Sample collection Round			
1st round	10 (43.5)	7 (30.4)	6 (26.1)
2nd round	10 (43.5)	7 (30.4)	6 (26.1)
Collection Date/time			
5/24/2024	10 (43.5)	7 (30.4)	6 (26.1)
11/1/2024	10 (43.5)	7 (30.4)	6 (26.1)
Sample Source			
Dialysis Bed	4 (40.0)	4 (40.0)	2 (20.0)
Dialysis Chair	2 (33.3)	2 (33.3)	2 (33.3)
Medical Gown	4 (33.3)	4 (33.3)	4 (33.3)
WLDU	4 (50.0)	2 (25.0)	2 (25.0)
WLTU	2 (100.0)	0 (0.0)	0 (0.0)
WTDU	2 (33.3)	2 (33.3)	2 (33.3)
WTTU	2 (100.0)	0 (0.0)	0 (0.0)
Bacterial growth			
Yes	13 (43.3)	10 (33.3)	7 (23.3)
No	7 (43.8)	4 (25.0)	5 (31.3)
Bacteria ID Result			
Gram-Positive Bacteria	1 (25.0)	3 (75.0)	0 (0.0)
Gram-Negative Bacteria	12 (46.2)	7 (26.9)	7 (26.9)
Gram-Positive Isolate			
CoNS	1 (100.0)	0 (0.0)	0 (0.0)
NP / <i>Bacillus</i> spp.	0 (0.0)	3 (100.0)	0 (0.0)
Gram-Negative Isolate			
<i>Acinetobacter</i> spp.	0 (0.0)	0 (0.0)	2 (100.0)
<i>Citrobacter</i> spp.	1 (100.0)	0 (0.0)	0 (0.0)
<i>Enterobacter</i> spp.	2 (50.0)	1 (25.0)	1 (25.0)
<i>E. coli</i>	0 (0.0)	0 (0.0)	1 (100.0)
<i>Klebsiella</i> spp.	8 (66.7)	1 (8.3)	3 (25.0)

<i>P. aeruginosa</i>	1 (25.0)	3 (75.0)	0 (0.0)
<i>Shigella</i> spp.	0 (0.0)	2 (100.0)	0 (0.0)

NP = Non-pathogenic bacteria; WLDU = Water-line in Dialysis Unit; WLTU = Water-line in the Transplant Unit; WTDU = Water Treatment for Dialysis Unit; WTTU = Water Treatment for the Transplant Unit

5.7. Concordance of Environmental and Clinical Isolates

The analysis of bacterial isolates collected from both environmental and patient sources across the three study centers revealed important patterns in distribution, timing, and potential transmission pathways. A total of 51 isolates were identified, with 30 recovered from environmental samples (**Table 13**) and 21 from patient specimens (**Table 12**). Environmental sampling was conducted biannually targeting high-contact and water-associated surfaces including dialysis beds, dialysis chairs, medical gowns, water-line systems in dialysis and transplant units, and water-treatment systems. In contrast, patient isolates were obtained continuously throughout the study period from blood cultures, and exceptionally from one catheter tip, reflecting real-time clinical presentations of BSIs.

Table 12. Clinical Isolates Types and Collection Dates for Comparative Concordance with Environmental Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

At First Incidence			
Isolate Type	Collection Type	Collection Date	Study Center
CoNS	Catheter Tip	11/13/2024	MIICSH
CoNS	Blood	6/22/2024	SPHMMC
CoNS		10/24/2024	SPHMMC
<i>Klebsiella</i> spp.		10/1/2024	SPHMMC
CoNS		7/1/2024	SPHMMC
<i>Enterobacter</i> spp.		6/24/2024	SPHMMC
<i>S. aureus</i>		8/16/2024	MIICSH
<i>Klebsiella</i> spp.		10/17/2024	ZMH
<i>Klebsiella</i> spp.		10/4/2024	SPHMMC
<i>Klebsiella</i> spp.		9/25/2024	SPHMMC
CoNS		10/7/2024	SPHMMC
<i>P. aeruginosa</i>		11/3/2024	ZMH
<i>P. aeruginosa</i>		8/29/2024	MIICSH
<i>P. aeruginosa</i>		9/13/2024	MIICSH

CoNS		10/24/2024	ZMH
<i>E. coli</i>		1/25/2025	SPHMMC
<i>P. aeruginosa</i>		9/3/2024	MIICSH
At Second Incidence			
Isolate Type	Collection Type	Collection Date	Study Center
CoNS		11/14/2024	
<i>S. aureus</i>	Blood	2/21/2025	SPHMMC
<i>Klebsiella</i> spp.		9/28/2024	
<i>Citrobacter</i> spp.		2/1/2025	

Klebsiella spp. was the most prevalent organism, representing 40.0% of environmental isolates and 23.8% of patient isolates. Environmental *Klebsiella* was recovered from dialysis beds, chairs, gowns, and water-line systems across all centers, while patient isolates were exclusively from blood cultures collected between September 25 and October 17, 2024 in SPHMMC, MIICSH, and ZMH. *P. aeruginosa* was found in environmental samples (13.3%) from beds, chairs, gowns, and water-treatment systems (May–Nov 2024), with patient isolates detected between August 29 and November 13, 2024 in MIICSH and ZMH, showing parallel timing and shared sources (**Table 14**).

Table 13. Environmental Isolates Types and Collection Dates for Comparative Concordance with Clinical Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Isolate Type	Collection Source	Collection Date	Study Center
CoNS	Dialysis Bed	1-Nov-24	SPHMMC
NP / <i>Bacillus</i> spp.	Dialysis Bed, Dialysis Chair	1-Nov-24	MIICSH
<i>Acinetobacter</i> spp.	Dialysis Chair, Medical Gown	24-May-24, 01-Nov-24	ZMH
<i>Citrobacter</i> spp.	Medical Gown	1-Nov-24	SPHMMC
<i>Enterobacter</i> spp.	Water-Line in Dialysis Unit, Water-Line in the Transplant Unit, Water-Treatment for Dialysis Unit, Water-Treatment for the Transplant Unit	24-May-24	SPHMMC, MIICSH, ZMH
<i>E. coli</i>	Dialysis Bed	24-May-24	ZMH

<i>Klebsiella</i> spp.	Dialysis Bed, Dialysis Chair, Medical Gown, Water-Line in Dialysis Unit	24-May-24, 01-Nov-24	SPHMMC, MIICSH, ZMH
<i>P. aeruginosa</i>	Dialysis Bed, Dialysis Chair, Medical Gown, Water- Treatment for Dialysis Unit	24-May-24	SPHMMC, MIICSH
<i>Shigella</i> spp.	Medical Gown	1-Nov-24	MIICSH

Enterobacter spp. (13.3%) appeared in water-line and treatment units (May–Nov 2024), with patient cases on June 24 and October 20, 2024 in SPHMMC and ZMH, suggesting reservoir potential. *E. coli* was isolated from a dialysis bed at SPHMMC in the first round and later from a patient blood culture on January 25, 2025, though the eight-month gap limits direct correlation. *Citrobacter* spp. was recovered from both a patient blood sample (Feb 1, 2025) and a medical gown at SPHMMC during the second round, strongly implying a direct environmental link (Table 14).

Table 14. Cross-Source Concordance of Bacterial Isolates across Clinical and Environmental Samples, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Isolate Type	Env't (n, %)	Pt (n, %)	Sample Source(s)		MPS	Study Center
			Env'tal	Pt		
CoNS	1 (3.3%)	7 (33.3%)	DB	Blood, C-Tip	Pt	SPHMMC, MIICSH, ZMH
NP/ <i>Bacillus</i> spp.	3 (10.0%)	0 (0.0%)	DB, DC	—	Env't	MIICSH
<i>S. aureus</i>	0 (0.0%)	2 (9.5%)	—	Blood	Pt	SPHMMC, MIICSH
<i>Enterobacter</i> spp.	4 (13.3%)	1 (4.8%)	WLDU, WLTU, WTDU, WTTU	Blood	Env't	SPHMMC, MIICSH, ZMH
<i>E. coli</i>	1 (3.3%)	1 (4.8%)	DB	Blood	Pt	SPHMMC
<i>Klebsiella</i> spp.	12 (40.0%)	5 (23.8%)	DB, DC, MG, WLDU	Blood	Env't	SPHMMC, MIICSH, ZMH

<i>P. aeruginosa</i>	4 (13.3%)	4 (19.0%)	DB, DC, MG, WTDU	Blood	Pt	MIICSH, ZMH
<i>Citrobacter</i> spp.	1 (3.3%)	1 (3.8%)	MG	Blood	Equal	SPHMMC
<i>Acinetobacter</i> spp.	2 (6.7%)	0 (0.0%)	DC, MG	—	Env't	ZMH
<i>Shigella</i> spp.	2 (6.7%)	0 (0.0%)	MG	—	Env't	MIICSH

($\chi^2 = 16.24$, $df = 9$, and a P-value ≈ 0.062); Env't = Environment; Pt = Patient; MPS = Most Prevalent Source; DB = Dialysis Bed; DC = Dialysis Chair; MG = Medical Gown; WLDU = Water-line in Dialysis Unit; WLTU = Water-line in the Transplant Unit; WTDU = Water Treatment for Dialysis Unit; WTTU = Water Treatment for the Transplant Unit

CoNS were mainly patient-derived (33.3% of patient isolates vs. 3.3% environmental), detected environmentally on dialysis beds at MIICSH, with patient cases spanning June–Nov 2024 across all centers, suggesting low-level contamination linked to catheter-related BSIs. NP/*Bacillus* spp., *Acinetobacter* spp., and *Shigella* spp. were exclusively environmental, recovered from chairs and gowns in MIICSH and ZMH, with no patient isolates, reflecting low pathogenicity or effective infection control. In contrast, *S. aureus* was only found in patient blood cultures at SPHMMC and MIICSH, highlighting its clinical importance and absence from environmental reservoirs.

As shown in Table 14, the Pearson Chi-square test ($\chi^2 = 16.24$, $df = 9$, $p \approx 0.062$) suggested a marginal association between isolate type and source, but the result is not statistically significant at the 0.05 level (Table 14).

5.8. Antibiotic Susceptibility and First-line Treatment Effectiveness

CoNS displayed multidrug resistance, with 100% resistance to ciprofloxacin, clindamycin, doxycycline, erythromycin, trimethoprim sulfamethoxazole, and vancomycin, plus high resistance to gentamicin (83.3%) and penicillin (75%). Across the incidents, one *S. aureus* isolate was identified as methicillin resistant (MRSA), while the other was methicillin sensitive (MSSA). Among Gram negatives, *E. coli* and *Enterobacter* spp. had notable cephalosporin resistance (cefepime 50% in *E. coli*), while *Klebsiella* spp. were completely resistant to gentamicin (100%). *P. aeruginosa* exhibited a classic multidrug - resistant profile with 100% resistance to ciprofloxacin, trimethoprim-sulfamethoxazole, and amikacin (Table 15).

Table 15. Antibiotic Susceptibility Patterns of Clinical Bacterial Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Antibiotic, n (%)	CoNS	<i>S. aureus</i>	<i>Ent. spp.</i>	<i>E. coli</i>	<i>Kleb. spp.</i>	<i>P. aerug.</i>	<i>Citro. spp.</i>
AMC							
R			0 (0.0)	1 (25.0)	2 (50.0)	0 (0.0)	1 (25.0)
I			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
S			1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)
AMP = R			0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)
ATM							
I			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
S			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
CTX							
R			0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)
S			0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)
FOX							
R	4 (80.0)	1 (20.0)					
S	0 (0.0)	1 (100.0)					
OXA = R	0 (0.0)	1 (100.0)					
C							
R	2 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
S	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (80.0)	0 (0.0)	1 (20.0)
CIP							
R	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)
I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	1 (100.0)	0 (0.0)	1 (16.7)	3 (50.0)	1 (16.7)	1 (16.7)
DA							
R	2 (100.0)	0 (0.0)					
I	0 (0.0)	0 (0.0)					
S	4 (80.0)	1 (20.0)					
DOX							
R	1 (100.0)	0 (0.0)					
I	1 (100.0)	0 (0.0)					
S	5 (100.0)	0 (0.0)					
E = R	6 (100.0)	0 (0.0)					
CN							
R	5 (83.3)	1 (16.7)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)
I	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

S	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (25.0)	2 (50.0)	1 (25.0)
IPM = S			1 (16.7)	0 (0.0)	3 (50.0)	2 (33.3)	0 (0.0)
P = R	6 (75.0)	2 (25.0)					
SXT							
R	7 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (80.0)	0 (0.0)	1 (20.0)
VA							
R	3 (100.0)	0 (0.0)					
S	4 (100.0)	0 (0.0)					
AK							
R			0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)
S			0 (0.0)	1 (20.0)	2 (40.0)	1 (20.0)	1 (20.0)
FEP							
R			1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
S			0 (0.0)	0 (0.0)	2 (28.6)	4 (57.1)	1 (14.3)
CRO							
R			0 (0.0)	0 (0.0)	2 (66.7)	1 (33.3)	0 (0.0)
S			0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)
CAZ = S			0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)
MEM = S			0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)

R = Resistant; I = Intermediate / Susceptible, increased exposure; S = Sensitive; CoNS = Coagulase-Negative Staphylococci; *Ent. spp.* = *Enterobacter* species; *Kleb. spp.* = *Klebsiella* species; *P. aerug.* = *P. aeruginosa*; *Citro. spp.* = *Citrobacter* species; AMC = Amoxicillin-Clavulanic Acid; AMP = Ampicillin; ATM = Aztreonam; FOX = Cefoxitin; C = Chloramphenicol; CIP = Ciprofloxacin; DA or D = Clindamycin; DOX = Doxycycline; E = Erythromycin; CN = Gentamicin; IPM = Imipenem; OXA = Oxacillin; P = Penicillin; VA = Vancomycin; AK = Amikacin; FEP = Cefepime; CTX = Cefotaxime; CRO = Ceftriaxone; MEM = Meropenem; TZP = Piperacillin-Tazobactam; TOB = Tobramycin; SXT = Trimethoprim-Sulfamethoxazole (Co-trimoxazole); CAZ = Ceftazidime

As for first-line antibiotics resistance, CoNS showed the highest resistance (87.5%), with complete resistance to multiple drugs including clindamycin, doxycycline, erythromycin, gentamicin, trimethoprim-sulfamethoxazole, and vancomycin (100%). *S. aureus* had low resistance (12.5%), while *Enterobacter* spp., *Citrobacter* spp. and *E. coli* each showed 14.3%. Moderate resistance was observed in *Klebsiella* spp. and *P. aeruginosa* (28.6% each), with *Klebsiella* fully resistant to cefepime and piperacillin-tazobactam (100%) (**Table 16**).

Table 16 Efficacy of First-Line Antibiotics on Clinical Gram-Positive and Gram-Negative Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Category	CoNS	<i>S. aureus</i>	<i>Ent. spp.</i>	<i>E. coli</i>	<i>Kleb. spp.</i>	<i>P. aerug.</i>	<i>Citro. spp.</i>
Ineffective							
FLA, n (%)							
Yes	7 (87.5)	1 (12.5)	1 (14.3)	1 (14.3)	2 (28.6)	2 (28.6)	1 (14.3)
No	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	3 (60)	2 (40.0)	
FLA, n (%)							
AMC			0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)
FOX	5 (100.0)	0 (0.0)					
C	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	
CIP	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	
DA or D	2 (100.0)	0 (0.0)					
DOX	1 (100.0)	0 (0.0)					
E	6 (100.0)	0 (0.0)					
CN	4 (100.0)	0 (0.0)					
P	5 (83.3)	1 (16.7)					
SXT	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	
VA	3 (100.0)	0 (0.0)					
AK			0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	
AMP			0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)
FEP			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	
CTX			0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	
CRO			0 (0.0)	0 (0.0)	2 (66.7)	1 (33.3)	
CAZ			1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)	
MEM			0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	
TZP			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	
TOB			0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	

FLA = First-line Antibiotics; *Ent. spp.* = *Enterobacter* species; *Kleb. spp.* = *Klebsiella* species; *P. aerug.* = *P. aeruginosa*; *Citro. spp.* = *Citrobacter* species; AMC = Amoxicillin-Clavulanic Acid; AMP = Ampicillin; ATM = Aztreonam; FOX = Cefoxitin; C = Chloramphenicol; CIP = Ciprofloxacin; DA or D = Clindamycin; P = Penicillin; DOX = Doxycycline; E = Erythromycin; CN = Gentamicin; VA = Vancomycin, AK = Amikacin; AMC = Amoxicillin-Clavulanic Acid; AMP = Ampicillin; FEP = Cefepime; CTX = Cefotaxime; CRO = Ceftriaxone; CAZ =

Ceftazidime; MEM = Meropenem; TZP = Piperacillin-Tazobactam; TOB = Tobramycin; SXT = Trimethoprim-Sulfamethoxazole (Co-trimoxazole)

5.9. Environmental Antibiotic Resistance Profile

Antibiotic susceptibility testing of environmental isolates revealed varied resistance profiles across both Gram-positive and Gram-negative bacteria. Among Gram-positive isolates, CoNS showed complete resistance (100.0%) to ciprofloxacin, clindamycin, erythromycin, gentamicin, and trimethoprim-sulfamethoxazole (**Table 17**).

Table 17. Antibiotic Susceptibility Patterns of Environmental Gram-Positive Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Variable	Gram-Positive Isolate, n (%)	
	CoNS	NP / <i>Bacillus</i> spp.
CIP = R	1 (100.0)	
DA or D = R	1 (100.0)	
E = R	1 (100.0)	None of antibiotics was tested
CN = R	1 (100.0)	
SXT = R	1 (100.0)	
VA = S	1 (100.0)	

CoNS = Coagulase-Negative Staphylococci; NP = Non-pathogenic bacteria; R = Resistant; S = Sensitive; CIP = Ciprofloxacin; DA or D = Clindamycin; E = Erythromycin; CN = Gentamicin; SXT = Trimethoprim-Sulfamethoxazole (Co-trimoxazole); VA = Vancomycin

Klebsiella spp. carried the highest resistance burden among Gram-negative isolates, showing resistance to amoxicillin-clavulanic acid (80.0%), cefepime (37.5%), ceftriaxone (66.7%), ceftazidime (46.7%), cefuroxime (100.0%), ciprofloxacin (54.5%), gentamicin (42.9%), meropenem (55.6%), piperacillin-tazobactam (71.4%), and trimethoprim-sulfamethoxazole (90.9%). *P. aeruginosa* showed complete resistance to aztreonam (100.0%) and tobramycin (100.0%). *Enterobacter* spp. demonstrated resistance to gentamicin (57.1%), amikacin (20.0%), cefepime (25.0%), ceftazidime (13.3%), and ciprofloxacin (18.2%) (**Table 18**).

Table 18 Antibiotic Susceptibility Patterns of Environmental Gram-Negative Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Variable	Gram-Negative Isolate, n (%)						
	<i>Aci.</i> spp.	<i>Citro.</i> spp.	<i>Ent.</i> spp.	<i>E. coli</i>	<i>Kleb.</i> spp.	<i>P.</i> <i>aerug.</i>	<i>Shi.</i> spp.
AK							
R	2 (20.0)	0 (0.0)	2 (20.0)	0 (0.0)	2 (20.0)	4 (40.0)	0 (0.0)
I	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	1 (12.5)	0 (0.0)	1 (12.5)	6 (75.0)	0 (0.0)	0 (0.0)
AMC							
R	0 (0.0)	1 (10.0)	0 (0.0)	1 (10.0)	8 (80.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)
AMP = R	0 (0.0)	1 (33.3)	0 (0.0)	1 (33.3)	1 (33.3)	0 (0.0)	0 (0.0)
ATM =R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)
FEP							
R	2 (25.0)	0 (0.0)	2 (25.0)	1 (12.5)	3 (37.5)	0 (0.0)	0 (0.0)
I	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	2 (66.7)	0 (0.0)
S	0 (0.0)	1 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)
CTX = S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)
CRO							
R	2 (16.7)	1 (8.3)	0 (0.0)	1 (8.3)	8 (66.7)	0 (0.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (66.7)	0 (0.0)	2 (33.3)
CAZ							
R	2 (13.3)	1 (6.7)	2 (13.3)	1 (6.7)	7 (46.7)	2 (13.3)	0 (0.0)
I	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)	1 (33.3)	1 (33.3)	0 (0.0)
S	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
CFM							
R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
C							
R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.7)
CIP							
R	2 (18.2)	0 (0.0)	2 (18.2)	1 (9.1)	6 (54.5)	0 (0.0)	0 (0.0)
I	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)
S	0 (0.0)	1 (10.0)	1 (10.0)	0 (0.0)	3 (30.0)	3 (30.0)	2 (20.0)
CN							

R	0 (0.0)	0 (0.0)	4 (57.1)	0 (0.0)	3 (42.9)	0 (0.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)
IPM = S	0 (0.0)	0 (0.0)	4 (33.3)	0 (0.0)	3 (25.0)	3 (25.0)	2 (16.7)
MEM							
R	2 (22.2)	0 (0.0)	0 (0.0)	1 (11.1)	5 (55.6)	1 (11.1)	0 (0.0)
I	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)
S	0 (0.0)	0 (0.0)	3 (37.5)	0 (0.0)	3 (37.5)	2 (25.0)	0 (0.0)
TZP							
R	2 (28.6)	0 (0.0)	0 (0.0)	0 (0.0)	5 (71.4)	0 (0.0)	0 (0.0)
I	0 (0.0)	0 (0.0)	3 (60.0)	1 (20.0)	1 (20.0)	0 (0.0)	0 (0.0)
S	0 (0.0)	1 (9.1)	1 (9.1)	0 (0.0)	4 (36.4)	3 (27.3)	2 (18.2)
TOB = R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)
SXT							
R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (90.9)	0 (0.0)	1 (9.1)
S	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)

Aci. spp. = *Acinetobacter* species; *Citro. spp.* = *Citrobacter* species; *Ent. spp.* = *Enterobacter* species; *E. coli* = *Escherichia coli*; *Kleb. spp.* = *Klebsiella* species; *P. aerug.* = *P. aeruginosa*; *Shig. spp.* = *Shigella* species; R = Resistant; I = Intermediate / Susceptible, increased exposure; S = Sensitive; AK = Amikacin; AMC = Amoxicillin-Clavulanic Acid; AMP = Ampicillin; ATM = Aztreonam; FEP = Cefepime; CTX = Cefotaxime; CRO = Ceftriaxone; CAZ = Ceftazidime; CFM = Cefixime; C = Chloramphenicol; CIP = Ciprofloxacin; CN = Gentamicin; IPM = Imipenem; MEM = Meropenem; TZP = Piperacillin-Tazobactam; TOB = Tobramycin; SXT = Trimethoprim-Sulfamethoxazole (Co-trimoxazole)

5.10. Empirical Antibiotic Treatment and Guideline Alignment

Empirical antibiotic therapy was initiated in several cases following blood sample collection but prior to the availability of culture results. In the first incidence, treatment was given to 57.1% (4/7) of Gram-positive cases. Among CoNS isolates (n = 6), three cases (50.0%) received empirical antibiotics, while three did not. The single *S. aureus* isolate was treated empirically. The antibiotics used for Gram-positive isolates included ceftriaxone (50.0%), gentamicin (25.0%), meropenem (50.0%), and vancomycin (25.0%). In the second incidence, neither of the two Gram-positive isolates received empirical therapy before culture confirmation (**Table 19**).

Table 19 Clinical Alignment of Empirical Antibiotic Use, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Inc	IET	CoNS	<i>S. aureus</i>	<i>Ent. spp.</i>	<i>E. coli</i>	<i>Kleb. spp.</i>	<i>P. aerug.</i>	<i>Citro. spp.</i>
1	Yes	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	3 (75.0)	1 (25.0)	
	No	3 (100.0)	0 (0.0)	1 (16.7)	1 (16.7)	1 (16.7)	3 (50.0)	
	CRO	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	
	CN	1 (100.0)	0 (0.0)					
	MEM	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	
	VA	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	
	FEP			0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	
2	No	1 (50.0)	1 (50.0)			1 (50.0)		1 (50.0)
3	YES							
	MEM							
	TZP							
	VA							

Inc = Incidence; IET = Initiated Empirical Treatment; *S. aureus* = *Staphylococcus aureus*; *Ent. spp.* = *Enterobacter* species; *E. coli* = *Escherichia coli*; *Kleb. spp.* = *Klebsiella* species; *P. aerug.* = *P. aeruginosa*; *Citro. spp.* = *Citrobacter* species; CRO = Ceftriaxone; CN = Gentamicin; MEM = Meropenem; VA = Vancomycin; FEP = Cefepime; TZP = Piperacillin-Tazobactam

For Gram-negative isolates in the first incidence (n = 10), empirical treatment was given in 4 cases (40.0%). This included three *Klebsiella* spp. isolates (75.0%) and one *P. aeruginosa* isolate (25.0%). *Enterobacter* spp., *E. coli*, and the remaining *P. aeruginosa* isolates were not treated empirically. The antibiotics used were cefepime (50.0% of treated *Klebsiella* and *P. aeruginosa* cases), ceftriaxone (100.0% of treated *Klebsiella* cases), meropenem (100.0% of treated *Klebsiella* cases), and vancomycin (50.0% of treated *Klebsiella* cases). Vancomycin use in Gram-negative infections does not follow EUCAST guidance, as it has no activity against Gram-negative organisms (**Table 20**).

In the second incidence, neither *Citrobacter* spp. nor *Klebsiella* spp. received empirical therapy. In the third incidence, although the final culture showed no bacterial growth, empirical treatment was given with meropenem, piperacillin-tazobactam, and vancomycin. The patient did not survive, and therefore the appropriateness of these antibiotics could not be evaluated (**Table 19**).

5.11. MDR Trends of Clinical and Environmental Isolates

In clinical isolates recovered during the first incidence, all Gram-positive bacteria were MDR positive, with CoNS accounted for 85.7% and the single *S. aureus* 14.3%. In the second incidence, CoNS again exhibited MDR whereas *S. aureus* revealed MDR negative. Among Gram-negative clinical isolates, *P. aeruginosa* displayed an equal distribution of MDR positive and MDR negative strains (50.0% each). *Klebsiella* spp. showed 25.0% MDR positive during the first incidence, with all isolates from the second incidence being MDR negative (100.0%). (Table 20).

Table 20 MDR Profiles of Clinical Bacterial Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Bacterial Group	Isolate Type	MDR, n (%)	
		Positive	Negative
Gram-Positive	CoNS	6 (85.7)	0 (0.0)
	<i>S. aureus</i>	1 (14.3)	0 (0.0)
	CoNS (2 nd Inc)	1 (100.0)	0 (0.0)
	<i>S. aureus</i> (2 nd Inc)	0 (0.0)	1 (100.0)
Gram-Negative	<i>P. aeruginosa</i>	2 (50.0)	2 (50.0)
	<i>Klebsiella</i> spp.	1 (25.0)	3 (75.0)
	<i>E. coli</i>	0 (0.0)	1 (100.0)
	<i>Klebsiella</i> spp. (2 nd Inc)	0 (0.0)	1 (100.0)
	<i>Citrobacter</i> spp. (2 nd Inc)	0 (0.0)	1 (100.0)

2nd Inc = On the second incidence

Environmental isolates showed a distinct pattern, with Gram-positive CoNS exhibiting 100.0% multidrug resistance, while no other Gram-positive isolates were recovered. Gram-negative environment isolates showed higher MDR prevalence: *Acinetobacter* spp., *Citrobacter* spp., *E. coli*, and *P. aeruginosa* all exhibited 100.0% MDR. *Enterobacter* spp. showed 75.0% MDR, with 25.0% of isolates being non-resistant. *Klebsiella* spp. had a moderate MDR rate of 66.7%, while *Shigella* spp. were entirely MDR negative (100.0%) (Table 21).

Table 21 MDR Profiles of Environmental Bacterial Isolates, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Bacterial Group	Isolate Type	MDR, n (%)	
		Positive	Negative
Gram-Positive	CoNS	1 (100.0)	0 (0.0)
	<i>Acinetobacter</i> spp.	2 (100.0)	0 (0.0)
	<i>Citrobacter</i> spp.	1 (100.0)	0 (0.0)
	<i>Enterobacter</i> spp.	3 (75.0)	1 (25.0)
Gram-Negative	<i>E. coli</i>	1 (100.0)	0 (0.0)
	<i>Klebsiella</i> spp.	8 (66.7)	4 (33.3)
	<i>P. aeruginosa</i>	4 (100.0)	0 (0.0)
	<i>Shigella</i> spp.	0 (0.0)	2 (100.0)

5.12. Risk Factors for the Incidence of BSIs in HD patients

A Logistic regression analysis was conducted to identify variables significantly associated with BSIs. In the univariate analysis, the repeated exposure to central venous catheter (ReCVC) showed a strong and statistically significant association with BSIs, with a crude odds ratio (OR) of 0.062 (95% CI: 0.018-0.216, $p < 0.001$). This association remained significant in the multivariate model, where the adjusted OR was 0.048 (95% CI: 0.008-0.300, $p=0.001$), indicating that ReCVC is an independent risk factor for BSIs. The autoimmune and systemic disease (AIS) was also significant in the univariate model (OR = 0.197, 95% CI: 0.058-0.671, $p = 0.009$), but lost significance after adjustment (adjusted OR = 0.153, 95% CI: 0.012-1.908, $p = 0.145$), suggesting its effect may be influenced by other variables. Chronic lung disease or disorders (LDD), showed a significant association in the univariate analysis (OR = 0.278, 95% CI: 0.103-0.746, $p = 0.011$), but the adjusted model yielded a non-significant result (adjusted OR = 0.248, 95% CI: 0.054-1.138, $p = 0.073$). Hemoglobin (Hb) levels were significantly associated with BSIs in both models, with a crude OR of 0.663 (95% CI: 0.487-0.903, $p = 0.009$) and an adjusted OR of 0.635 (95% CI: 0.439-0.917, $p = 0.015$), confirming Hb as an independent predictor. Glomerulonephritis (GN) was significant in the univariate analysis (OR = 0.329, 95% CI: 0.117-0.925, $p = 0.035$), but not in the multivariate model (adjusted OR = 0.753, 95% CI: 0.112-5.080, $p = 0.771$), indicating that its association with BSIs may be confounded by other factors (Table 22).

Table 22 Univariate and Multivariate Logistic Regression Analysis, Addis Ababa, Ethiopia (May, 2024 – April, 2025)

Predictor	Univariate Logistic Regression		Multivariate Logistic Regression	
Variable	COR (95% CI)	p-value	AOR (95% CI)	p-value
ReCVC	0.062 (0.018-0.216)	<0.001	0.048 (0.008-0.300)	0.001
AIS	0.197 (0.058-0.671)	0.009	0.153 (0.012-1.908)	0.145
LDD	0.278 (0.103-0.746)	0.011	0.248 (0.054-1.138)	0.073
Hb	0.663 (0.487-0.903)	0.009	0.635 (0.439-0.917)	0.015
GN	0.329 (0.117-0.925)	0.035	0.753 (0.112-5.080)	0.771

COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio; ReCVC = Repeated exposure to Central Venous Catheter; AIS = Autoimmune and Systemic Disease; LDD = Chronic Lung Disease or Disorders; Hb = Hemoglobin; GN = Glomerulonephritis

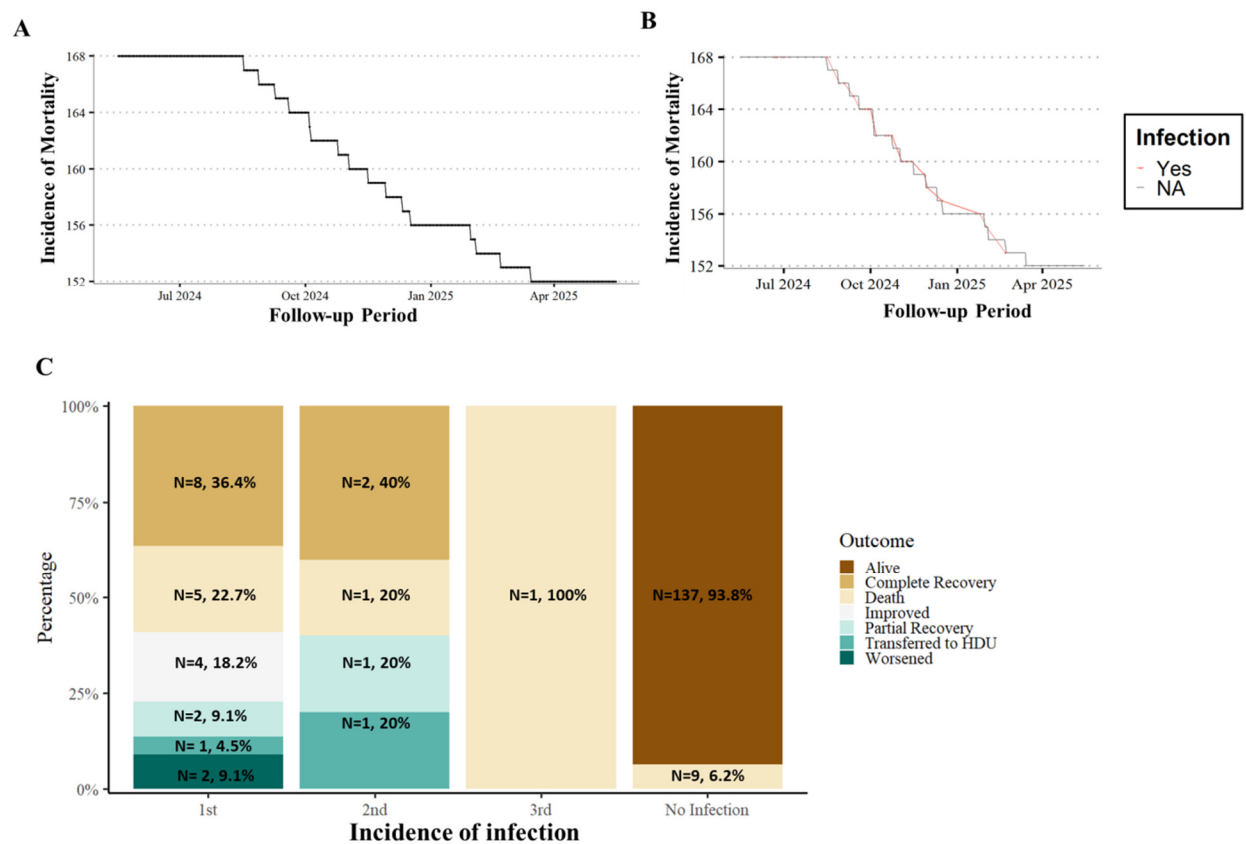
5.13. Outcome of Follow-up

We conducted a follow-up for 168 patients undergoing HD, assessing their outcomes between May, 2024 and April, 2025. Mortality outcomes were shaped not only by time but also by infection status, with the gradual decline in survival highlighting the overall trend (**Figure 5A**) and the disproportionate impact of infections underscoring the earlier losses observed within the cohort (**Figure 5B**). Mortality was higher among patients with BSIs, particularly with repeated episodes, while patients without infection had significantly better survival (**Figure 5B**).

Specifically, the evaluation of patient outcomes based on the number of BSI episodes showed clear differences in recovery and mortality rates. Among patients who experienced a first BSI episode (N =22), the most common outcome was complete recovery, seen in 8 patients (36.4%). This was followed by death in 5 patients (22.7%), clinical improvement in 4 patients (18.2%), partial recovery in 2 patients (9.1%), transfer to a high-dependency unit (HDU) in 1 patient (4.5%), and clinical worsening in 2 patients (9.1%).

For those with a second BSI episode (N = 5), 2 patients (40.0%) recovered completely, while 1 patient (20.0%) died, 1 patient (20.0%) improved, and 1 patient (20.0%) had partial recovery. In the case of a third BSI episode (N = 1), the only outcome was death (100.0%), indicating a poor prognosis with repeated infections.

In comparison, patients who did not develop any BSI (N = 146) had significantly better outcomes. The majority were alive (137; 93.8%), and only 9 patients (6.2%) died. These results suggest that repeated infections are linked to worse clinical outcomes, including higher mortality, while patients without infection had much better survival rates (**Figure 5 C**).



HDU = High Dependency Unit

Figure 5 Clinical Outcomes and Infection Trends, Addis Ababa, Ethiopia (May, 2024 – April, 2025). (A) Incidence of Mortality; (B) Kaplan-Meier Survival Curves; (C) Patient Outcomes by Infection Incidence

5.14. Incident After Intervention

The study revealed a statistically significant reduction in BSIs incidence following the implementation of a comprehensive intervention strategy ($p < 0.001$). As depicted in Figure 6 Panel A, BSIs cases dropped sharply after the intervention compared to the preceding period. This outcome reflects the effectiveness of a combined approach that directly targeted the source

of bacterial contamination. The strategy included treating the water that goes to dialysis machine using bleach, a complete replacement of water pipelines in the high-risk transplant unit, and stricter infection control protocols in the centers. These coordinated actions led to a decline in infections rate. Follow-up water sampling further confirmed the success of the intervention, showing no bacterial growth in the water supply (**Figure 6A**).

Figure 6 Panel B shows the trend before the intervention, from June to November, 2024, where the curve rises steeply, showing a steady rise in BSIs cases over time (**Figure 6B**). In contrast, Panel C presents the post-intervention period from December, 2024 to April, 2025, where the curve flattens significantly, reflecting a slower rate of new infections (**Figure 6C**).

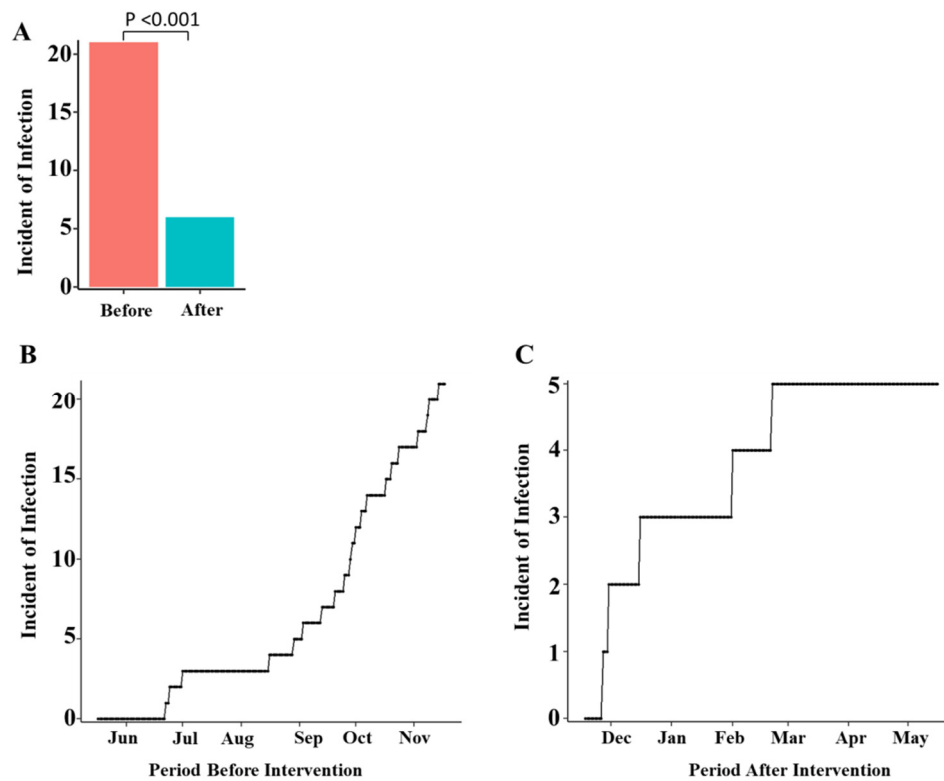


Figure 6. Intervention Effect on BSIs Incidence, Addis Ababa, Ethiopia (May, 2024 – April, 2025). (A) BSI Reduction Following Intervention; (B) BSI Trend Before Intervention (May – November, 2024); (C) BSI Trend After Intervention (December, 2024 – April, 2025)

6. Discussion

6.1. Principal Findings, Comparison and Interpretation

CKD and AKI represent significant public health challenges globally, and particularly in low-resource settings such as Ethiopia. Among the 168-study cohort, 91.1% were diagnosed with CKD and 8.9% with AKI, reflecting a predominance of chronic cases typically associated with maintenance HD services. This contrasts with Jimma Medical Center, where a review showed a more balanced cohort: 69.1% CKD and 30.9% AKI among HD patients (10). Such variation in CKD-to-AKI ratios across facilities may reflect differences in referral patterns, admission criteria, and the dialysis unit's operational focus. (10).

The median age of 44 years, with an interquartile range of 34 to 56.75, corresponds closely with a retrospective cohort study conducted in the Amhara region reported a median age of 45 years (16), while the Jimma Medical Center documented a mean age of 42.7 years (10). Kandari S. *et al.* (2025) also reported a mean age of 44.06 years among HD patients in North India (41). These findings collectively confirm that kidney failure requiring HD mainly affects productive middle-aged individuals (~45 years) in Ethiopia and SSA.(77).

The cohort showed male predominance (64.3%), which is consistent with findings by Lissane S. *et al.* (2023) in Addis Ababa (61.9%) and Workie S. *et al.* (2022) in the Amhara region (61.5%) (16,28). The Jimma Medical Center study by Tafese S. *et al.* (2024) reported an even higher male ratio of 69.1% (10). The findings show a regional male predominance in HD populations, likely linked to gender disparities in healthcare and social factors. CKD also imposed a socioeconomic burden, with 36.4% reporting job loss and 5.4% unable to continue education, underscoring its impact on productivity and mobility. Comparable studies in Ethiopia have reported similarly high rates of unemployment among HD patients. In Addis Ababa, unemployment rates of 48.7% and 49.7% were documented (28,77), while another retrospective study conducted by Desta *et al.* (2023) across three centers reported a rate of 41.0% (15). These findings underscore the substantial economic hardship faced by patients undergoing HD.

Income data showed high financial vulnerability, with 55.4% earning under 12,000 Birr annually and only 4.2% above 240,000 Birr. This highlights major economic challenges for HD patients, as most rely on out of pocket payments in Ethiopia and SSA. (16). Such reliance contributes to

frequent treatment discontinuation and poor clinical outcomes (8). Income data showed high financial vulnerability, with 55.4% earning under 12,000 Birr annually and only 4.2% above 240,000 Birr.

The predominance of HN as the leading cause of CKD in this cohort (36.3%) is consistent with regional data from Ethiopia and broader SSA. Studies from the Amhara region by Workie *et al.* (2022) and Jimma Medical Center by Tafese S. *et al.* (2024) reported HN as the primary etiology in 51.6% and 40.4% of patients, respectively (10,16). The notable co-occurrence of HN and DN in 26% of cases further reflects the rising burden of dual pathology, a trend similarly observed in Ethiopian CKD populations (78). DN alone accounted for 12.5% of cases, aligning with findings from Jimma Medical Center (14.9%) and Amhara (29.8%) cohorts (10,16).

The predominance of metabolic and endocrine disorders (41.7%) in this cohort, particularly CKD-MBD (48.6%), aligns with global and regional data on the systemic consequences of end-stage renal disease. Studies from African HD populations have reported CKD-MBD prevalence rates ranging from 45.6% in Addis Ababa, Ethiopia to 58% in Nigeria, confirming its central role in the residual syndrome of dialysis patients (11,79).

Cardiovascular conditions were the second most common comorbidity (25.0%), with hypertensive retinopathy, CAD, and atherosclerosis being the leading diagnoses. This finding is consistent with Ethiopian HD cohorts, Desta D. *et al.* (2023) studied at three centers and Betiru S. *et al.* (2023) studied at SPHMMC and Myungsung Christian Medical Center (MCM), Addis Ababa, Ethiopia, where CVD is reported in over half of patients (53.2%) and HTN (66.9%) remains the most frequent underlying condition as well as the dual pathology rate (42%) (15,46).

Neurological and psychiatric disorders affected 20.2% of patients, mainly uremic encephalopathy (47.1%) and neuropathy (29.4%), consistent with Ethiopian cohorts where encephalopathy was the leading dialysis indication (66%) (10). Similarly, peripheral neuropathy is frequently observed in advanced uremia and contributes to the neuropsychiatric symptom burden in this population (16).

Stage 5 CKD was predominant in this cohort (82.5%), consistent with Ethiopian data. Garedow AW *et al.* (2024) reported 67.8% of hospitalized CKD patients in Stage 5, with nearly all in Stage 3 or above (78). This pattern reflects systemic barriers such as later referral, financial

constraints, and limited availability of dialysis centers, which delay initiation of renal replacement therapy until patients are critically ill (16).

The low rate of transplant evaluation (28.8%) and high ineligibility rate (36.4%) observed in this study closely mirror findings from Annose RT *et al.* (2024) cohorts, in Addis Ababa, Ethiopia, where only 31.58% of patients had active transplant plans (18). These figures highlight the multifactorial barriers to transplantation, including socioeconomic disparities, cultural and religious opposition, and the requirement for related donors as shown by Shimels T *et al.* (2020) conducted at SPHMMC (25). Financial instability further compounds these challenges, often rendering patients medically ineligible due to poor health maintenance (16).

Despite 89.3% of patients reporting fluid restriction practices, 65.3% failed to adhere on any day of the week, revealing a significant gap between intention and behavior. This discrepancy is widely documented in HD populations as studied by Flythe JE *et al.* (2020), KDIGO (Kidney Disease: Improving Global Outcomes) Controversies Conference group based in Japan and USA, and is attributed to the psychological burden of fluid control, which patients often find overwhelming (29). Non-adherence to fluid restriction contributes to chronic volume overload, exacerbating hypertension and cardiovascular risk (11). In contrast, dietary adherence was relatively higher (81.5%), aligning with local studies that reported 84.1% compliance (78). This may reflect stronger patient engagement with nutritional counseling and its perceived benefits in maintaining strength and reducing inflammation and infection (11).

The predominance of biopsy-confirmed inflammatory etiologies in this AKI cohort, particularly RPGN at 41.7%, reflects the diagnostic complexity and severity of kidney injury in this setting. The high biopsy rate (91.7%) is consistent with nephrology best practices when faced with unexplained kidney failure or suspected glomerular disease, and aligns with regional data from Jimma Medical Center, where AGN was the leading cause of AKI requiring dialysis (38.1%) (10). This pattern contrasts with AKI profiles in high-income countries, where ATN is more common, and underscores the inflammatory and infectious burden driving AKI in low-resource environments (10,13).

The poor recovery rate observed – 66.7% of patients showing no improvement in kidney function – further highlights the grave prognosis associated with AKI in this cohort. This finding is supported by regional studies reporting high mortality and low recovery among AKI patients

undergoing dialysis, with only 47.6% achieving discharge (10). The severity of RPGN and AGN, both associated with irreversible structural damage, combined with late presentation and systemic barriers such as financial constraints and limited access to sustained renal replacement therapy, contributes to these poor outcomes (8,16).

Intermediate (58.9%) and long vintage (29.8%) patients indicate favorable survival profile. Eyob AB *et al.* (2023) and Desta D. *et al.* (2023) reported median survival of 46.2–65 months, showing many patients live beyond five years with successful long-term HD (15,46). However, the systematic review by Abbasi SH *et al.* (2020) confirmed that prolonged dialysis duration is also associated with increased exposure to HAIs due to repeated vascular access interventions and cumulative risk (64).

AVF was the most common access (34.5%), with TNT-CVCs in 14.9%. Although AVF use aligns with KDOQI guidelines, the rate is lower than reports from SPHMMC (64%, Eyob AB *et al.* 2023) and Lok CE *et al.* (2020), suggesting barriers to AVF creation or maintenance (29,46). B.M. Belay *et al.* (2025) and M. Alqahtani *et al.* (2025) showed that the reliance on TNT-CVC was concerning, as CVC were strongly associated with increased infection rates and mortality risk, with an adjusted hazard ratio of 3.91 compared to AVF (45,80).

The finding that 92.9% of patients receive HD thrice per week is highly encouraging and reflects strong adherence to international standards for dialysis adequacy (26). This contrasts sharply with other Ethiopian centers located in Jimma and Addis Ababa, where financial constraints often limit patients to two sessions per week or less (10,28).

The observed fluctuations in blood pressure, weight, and dialysis adequacy (Kt/V) across the study phases underscore the acute physiological vulnerabilities to BSIs inherent to the HD population. The significant rise in systolic and diastolic blood pressure during the first incidence ($p = 0.002$ and $p = 0.050$) was consistent with acute intradialytic stress, likely triggered by infectious events such as CRBSIs. Lok *et al.* (2020), the KDOQI clinical practice guideline for vascular access, described hallmark symptoms – headache, chills, and fever – occurring 15-30 minutes after HD initiation, often linked to endotoxin-mediated cytokine release (31). This aligns with the systematic instability observed in our cohort. Moreover, the initial recruitment phase showed significant BP variability ($p < 0.001$), reflecting extracellular volume expansion commonly seen in CKD patients, where hypertension prevalence ranges from 60% to 90% due to

sodium and water retention (26). Garedow *et al.* (2024) further support this, reporting a mean SBP of 158.17 ± 26.39 mmHg in Ethiopian CKD patients (78).

The decline in dialysis adequacy from Kt/V 1.5 to 1.18 is particularly concerning, as it meets the threshold for vascular access dysfunction – a drop of > 0.2 units on a stable prescription (31). This inadequacy is independently associated with increased mortality risk as indicated in studies of Schamroth Pravda *et al.* (2024) (OR 0.208, $p = 0.025$) and Lok *et al.* (2020) (31,38). BMI fluctuations (19.3 to 21.1) suggest protein-energy wasting, a common HD complication that increases infection risk. (11). Low serum albumin, often accompanying PEW, is a recognized predictor of sepsis as indicated by the study by Locham S. *et al.* (2021) in USA (52). Collectively, these findings reinforce the need for vigilant monitoring of BP, weight, and Kt/V as integrated markers of systemic risk, access integrity, and infection control in HD care (26,64).

The incidence of BSIs in this cohort (16.6%) is consistent with the 17.5% BSIs rate reported in chronic HD populations by Schamroth Pravda *et al.* (2024) in Israel (38). It is moderately higher than the general hospital BSI prevalence of 14.8% reported by Deress *et al.* (2025) in Gondar, Ethiopia, and the 14.2% CRBSI rate documented by Sedhain *et al.* (2019) in Nepal (62,81). However, it remains substantially lower than the rates reported by Weldetensae *et al.* (2023) in Mekelle, Ethiopia (38.2%), Nanyunja *et al.* (2022) in Uganda (41.0%), Opoku-Asare *et al.* (2023) in Ghana (34.2%), and El-Kady *et al.* (2021) in Saudi Arabia (29.5%) (44,58,82,83). This alignment underscores the universal vulnerability of HD patients to BSIs, regardless of geographic or resource setting.

The sepsis incidence of 4.7% in this study further emphasizes the severity of infectious complications in HD patients. Sepsis is globally recognized as the second leading cause of death in ESRD patients, following CVD, with mortality rates up to 100 times higher than in the general population (11,12). In the Ethiopian context, infection has been identified as a major independent predictor of mortality, with an adjusted hazard ratio of 2.89 (45). This confirms that even a modest sepsis rate in HD populations translates into a disproportionately high mortality risk, especially in resource-limited settings where early detection and aggressive management may be constrained.

The recurrence of BSIs in 3.5% of patients (2.9% with two episodes, 0.6% with three) reflects a troubling pattern of repeated infectious exposure. This recurrence rate is consistent with

international findings, such as the 3.9% recurrence rate reported by Schamroth Pravda *et al.* (2024) through retrospective study covering 2014-2018 in Israel (38), and is often linked to unresolved vascular access issues or environmental contamination as shown by Weldetensae *et al.* (2023) retrospective study covering 2016-2022 in Ethiopia (58). Prior CVC infection raises the risk of recurrence nearly 12-fold, and CVC presence increases mortality (AHR 3.91), underscoring the need to minimize catheter use and shift to safer long - term access (45).

HD patients with BSIs showed reduced hemoglobin and hematocrit ($p < 0.001$, $p < 0.01$), with low hemoglobin a key risk factor (AOR 2.78) (58). This aligns with regional data reporting average hemoglobin levels as low as 7.82 ± 1.99 g/dL in similar HD populations (10). Elevated ESR (92.7 mm/hr) and low albumin (3.7 g/dL) indicate chronic inflammation, malnutrition, and higher sepsis risk in HD patients (52,78). Persistent uremia, evidenced by high BUN (83.6 mg/dL) and serum creatinine (8.0 mg/dL), overall underscores inadequate clearance and immunocompromise, which heighten susceptibility to MDR infections (38,84).

In our cohort, patients who developed sepsis demonstrated markedly elevated CRP levels, with a mean of 148 mg/L and a median of 153.5 mg/L (IQR: 118.3–171.5). These values are consistent with the range reported in other studies, though the reporting styles vary considerably. For instance, Soliman *et al.* (2022) in Egypt reported mean CRP values of 16.82 ± 3.76 mg/dl (equivalent to 168.2 ± 37.6 mg/L) in septic patients compared to 0.45 ± 0.1 mg/dl in healthy controls, highlighting a clear distinction between infected and non-infected groups (85). Similarly, Hajji *et al.* (2022) in Tunisia described extremely elevated CRP levels in catheter-related infections, with a mean of 198.9 mg/L and a wide range extending up to 899 mg/L, underscoring the heterogeneity of inflammatory responses (86).

Other studies have emphasized diagnostic thresholds rather than mean values. Bitar *et al.* (2023) in Finlan defined severe infection as $\text{CRP} \geq 100$ mg/L, a cutoff that aligns closely with the median values observed in our septic population (87). He *et al.* (2024) in China further explored diagnostic accuracy, reporting an Area Under the Receiver Operating Characteristic (AUROC) of 0.76 for CRP in differentiating sepsis from non-septic inflammation, and identifying a threshold of 59.25 mg/L for Gram-negative sepsis with moderate sensitivity and specificity (88). Compared to these thresholds, our findings suggest that CRP levels in sepsis patients are not only elevated but often exceed the diagnostic cutoffs proposed in prior studies.

Population-based studies have also used categorical distributions. Alifa and Nasution in Indonesia reported CRP intervals of <90, 90–200, and >200 mg/dl, with the highest values exceeding 200 mg/dL (89). Deme *et al.* (2024) in Ethiopia categorized CRP as <3, 3–5, and >5 mg/dl, noting that 89.1% of participants had values above 5 mg/dL (90). While these thresholds are lower than those observed in our septic cohort, they highlight the utility of categorical reporting in describing prevalence.

The predominance of Gram-negative bacterial isolates in this HD cohort – accounting for 58.8% of isolates during the first BSI incidence – is a notable epidemiological finding. This finding is lower than the 63.5% Gram-negative rate reported in a recent Ethiopian Multicenter Study conducted at University of Gondar by Deress T *et al.* (2025) (62), and aligns with the 57.6% Gram-negative CRBSI rate observed by Weldetensae *et al.* (2023) (58). The consistency across these studies confirms a regional shift in BSI etiology, diverging from historical global patterns where Gram-positive organisms dominated as the study by Miller LM *et al.* (2016) indicated that Gram-positive accounted for 40% to 80% whereas Gram-negative caused 20% to 40% of CRBSIs (43).

The specific isolation of *Klebsiella* spp. and *P. aeruginosa* – each comprising 36.4% of Gram-negative isolates in the first incidence – further reinforces the HAIs nature of these infections. *Klebsiella* spp. was predominantly isolated at SPHMMC (75%), while *P. aeruginosa* was more frequent at MIICSH (75%), suggesting center-specific environmental reservoirs. As studied in Universitas Academic Hospital, Bloemfontein, South Africa, by Shanhuayashe Godknows *et al.* (2024), these pathogens are well-known for their biofilm-forming capacity and resistance profiles, particularly in moist hospital environments (91). Their presence aligns with findings from Deress T *et al.* (2025) (63.5% of bacterial isolates) and Weldetensae *et al.* (2023) (57.6% of CRBSIs) (58,62), and reflects the broader trend of Gram-negative dominance in SSA, such as Ghana's 52.9% Gram-negative bacteria rate as indicated by Opoku-Asare B *et al.* (2023) in Ghana (44).

Among Gram-positive isolates, CoNS demonstrated a marked prevalence in the first incidence, with a center distribution of SPHMMC (66.7%), MIICSH (16.7%), and ZMH (16.7%). This pattern is consistent with global HD data, where CoNS is the leading cause of catheter-related

infections due to its commensal nature and resistance traits (43). The single *S. aureus* isolate at MIICSH further emphasizes the shift away from traditional Gram-positive dominance.

The recurrence of BSI in 3.5% of patients and the progression to sepsis in 4.7% of cases during all incidences are clinically significant. This recurrence pattern aligns with the 3.9% global recurrence rate observed by Schamroth Pravda *et al.* (2024) in Israel (38), and is further supported by Weldetensae *et al.* (2023) in Ethiopia, who identified prior CVC infection as a strong independent risk factor for CRBSI (AOR: 11.9) (58). These complications underscore the clinical severity of BSI in HD patients, though they are notably lower than the rates reported by Workie *et al.* (2022), who documented a sepsis-related mortality rate of 12.2% among dialysis patients admitted with infection, highlighting a more severe outcome profile in their cohort (16). The observed sepsis rate of 4.7% across all BSI incidences in our study still reflects a significant clinical burden, reinforcing the global recognition of sepsis as the second leading cause of mortality in ESRD patients, following CVD (11,12). Moreover, the presence of bacteremia in these cases is particularly concerning, as it has been shown in the study of Schamroth Pravda *et al.* (2024), to increase mortality risk substantially, with an adjusted odds ratio of 2.566 (38).

The second BSI incidence at SPHMMC showed high recurrence, with 25% progressing to sepsis. Isolates (19%) included CoNS, *S. aureus*, *Citrobacter*, and *Klebsiella*, consistent with mixed pathogen profiles reported by Weldetensae *et al.* (2023) in Ethiopia and Shanhuayashe Godknows *et al.* (2024) in South Africa (58,91). Crucially, the presence of *Klebsiella* spp., a recurrent isolate across both the first and second incidences in our study, reinforces its role as a dominant Gram-negative pathogen in Ethiopian dialysis cohorts (58,62). *Citrobacter* spp., though less common here, is increasingly reported as an MDR HAIs agent with environmental persistence (91).

Enterobacter spp. and *E. coli*, though isolated once at SPHMMC, are clinically significant HAIs pathogens, as shown by Weldetensae *et al.* (2023) in CRBSIs among HD patients (58). Even low frequency detection supports the Gram-negative predominance, with 63.5% reported at University of Gondar Comprehensive Specialized Hospital (62). Their presence underscores the need for surveillance of environmental and GI reservoirs, given 84.7% ESBL colonization in HD cohorts (91). Schamroth Pravda *et al.* (2024) study's data further support this trend, with *E. coli* (14.8%) identified as a frequent Gram-negative isolate in HD-related BSIs (38).

Gram-positive isolates showed CoNS predominance, consistent with global HD data as the main catheter-related pathogen (43). The identification of *S. aureus* only once at SPHMMC during the second incidence, following a single isolation at MIICSH in the first, indicates a sporadic pattern of occurrence. Nevertheless, its presence remains clinically important, especially in tertiary centers with high patient turnover, as similar findings were reported by Weldetensae *et al.* (2023), who also identified *S. aureus* as a key pathogen in catheter-related BSIs among HD patients (58). The third incidence, though yielding no bacterial growth, involved a patient with recurrent BSI and sepsis, highlighting diagnostic challenges in late-stage infections.

As for center-specific data, our study reveals SPHMMC as the epicenter of BSI burden, accounting for 50.0% of first incidence cases and all second and third incidence cases. Sepsis progression rates varied significantly: MIICSH (50.0%), ZMH (33.3%), and SPHMMC (16.7%) in the first incidence. These disparities suggest variable IPC adherence and resource constraints across centers (16).

Our environmental sampling revealed a high contamination rate of 65.2%, with a strong dominance of Gram-negative bacteria (86.7%), especially *Klebsiella* spp. and *P. aeruginosa*. These findings are consistent with Deress *et al.* (2025), Gondar, Ethiopia, who reported that Gram-negative organisms were responsible for 63.5% of BSIs in clinical settings (62). Similarly, Janem *et al.* (2024) studied at An-Najah National University Hospital in West Bank, Palestine, Shanhuayashe Godknows *et al.*, (2024) in South Africa, and Weldetensae *et al.* (2023) in Ethiopia found that 84.7%, 65.2%, 57.6% of HD patients were colonized with ESBL-producing Gram-negative bacteria, respectively, indicating a bidirectional risk where patient colonization may contribute to and be caused by contamination in the dialysis environment (91). The presence of *P. aeruginosa*, a known waterborne pathogen, aligns with observations by Weldetensae *et al.* (2023), who highlighted its role in CRBSIs and its ability to persist in moist hospital environments (58).

Our findings demonstrate notable concordance with other studies, reinforcing the hypothesis that HAIs transmission from environmental reservoirs is a primary driver of Gram-negative BSIs in dialysis settings. The microbial overlap between environmental and clinical isolates – particularly the detection of *Klebsiella* spp., *P. aeruginosa*, and *Enterobacter* spp., in both water systems and patient blood cultures – mirrors other studies findings or patterns. For instance,

Kanamori *et al.* (2022), study affiliated with Tohoku University of Graduate School of Medicine, Senai, Japan and University of North Carolina School of Medicine, North Carolina, USA, reported that 90.9% of waterborne BSI cases in dialysis patients were caused by Gram-negative bacteria, validating our cohort's clinical Gram-negative bacteria dominance of 58.8% and environmental Gram-negative bacteria prevalence of 86.7% (92). This alignment underscores the biological plausibility of transmission from contaminated water and surfaces, especially given the high environmental positivity rate of 65.2% in our units, which is consistent with the 61.3% contamination benchmark reported by Kolek Chester *et al.* (2023) conducted at Migori County Referral Hospital in Migori, Kenya (93). Exclusive detection of *Citrobacter* spp. on a gown and in a patient's blood culture indicates surface-to-patient transmission. While our statistical association was marginal ($p \approx 0.062$), Kanamori *et al.* (2022) emphasize that in HAIs epidemiology, microbiological concordance often outweighs statistical thresholds, especially in studies with limited sample sizes (92).

These findings validate surveillance and highlight dual BSI burden: Gram-positive (CoNS, *S. aureus*) needing strict catheter care, and Gram-negative requiring strong IPC. CoNS predominance (33.3% clinical vs. 3.3% environmental) supports its role as a skin commensal and major CRBSI cause (Miller *et al.*, 2016) (43). Exclusive detection of *Acinetobacter* and *Shigella* signals IPC gaps, increasing risk from virulent Gram-negative pathogens like *Klebsiella* and *Pseudomonas*.

CoNS isolates showed 100% MDR, resistant to multiple drugs, far higher than 45.7% reported by Ashagre *et al.* (2021) in Bahir Dar, Ethiopian cohort, wherein resistance to ampicillin reached 76.1% and ciprofloxacin 45.7% (8). Globally, Gram-positive bacteria, both *S. aureus* and CoNS account for 40% to 80% of CRBSIs, and specifically CoNS were recognized as major MDR pathogens in CRBSIs, as highlighted by Miller LM *et al.* (2016), Canada (43). Environmental isolates mirrored clinical resistance, confirming the HD unit as an MDR reservoir, consistent with Shanhuayashé Godknows *et al.* (2024), South Africa, who documented environmental colonization with MDR organisms in dialysis settings (91).

In this study, two *S. aureus* isolates were recovered, comprising of one methicillin-resistant *S. aureus* (MRSA) and one methicillin-sensitive *S. aureus* (MSSA). The MRSA isolate was resistant to ceftazidime, gentamicin, and penicillin but sensitive to ciprofloxacin and clindamycin,

whereas the MSSA isolate showed resistance only to penicillin with full sensitivity to cefoxitin and gentamicin: however, interpretation of these findings requires caution given the small number of isolates, which limits direct comparison with other studies. This observed 50% oxacillin resistance among *S. aureus* isolates is significantly lower than the 61.1% oxacillin resistance (MRSA) reported by Deress T *et al.* (2025) at the University of Gondar Comprehensive Specialized Hospital, yet greater than the 25% MRSA prevalence documented by Dassalegn *et al.* (2022) at Jimma University Medical Center (62,94). Globally, MRSA has shown a dramatic rise, with attributable deaths doubling from 57,200 in 1990 to 130,000 in 2021, according to Naghavi *et al.* (2024) (95) and hence it highlights that even with few isolates, such resistance is important because MRSA is a major global cause of death according to the GBD 2021 Antimicrobial Resistance Collaborators, which performed a Global Systematic Analysis covering 204 countries and territories (95).

Our environmental *Klebsiella* spp. isolates exhibited the highest resistance burden among Gram-negative organisms, with 66.7% showing MDR and complete resistance to multiple beta-lactams, aminoglycosides, and trimethoprim-sulfamethoxazole. This high environmental MDR rate aligns with findings from Worku M *et al.* (2024), who reported 100% resistance to cefotaxime and a 57.1% MDR rate in *Klebsiella pneumoniae* in Northwest Ethiopia (63). It also corresponds with Deress T *et al.* (2025), Ethiopia, who documented an even higher MDR rate of 97.5% and 94.4% resistance to cefotaxime in clinical isolates (62). Environmental isolates showed alarming resistance, marking the unit as a reservoir for ESBL-*Klebsiella*. Clinical isolates had mixed resistance (50% in episode one, 0% in episode two), suggesting temporal shifts or interventions. Partial carbapenem resistance is concerning, as carbapenem-resistant *K. pneumoniae* ranks among the top four global AMR threats – with the highest global burden increase from 1990 to 2021 (95).

Our clinical *P. aeruginosa* isolates showed complete resistance to amikacin, ciprofloxacin, meropenem, and tobramycin, while 50% retained sensitivity to imipenem and ceftazidime. This resistance pattern mirrors the findings of Pachori *et al.* (2019) at Ganeshi Lal Agrawal University, Mathura in India, who reported over 80% resistance to aminoglycosides and carbapenems in clinical isolates (96). In our environmental samples, *P. aeruginosa* was fully

resistant to aztreonam and tobramycin, reinforcing the role of moist HD environments in selecting for MDR strains, as demonstrated by Mohd Rafee *et al.* (2016) (97).

Our clinical isolates of *E. coli* and *Citrobacter* spp. were 100% susceptible to tested antibiotics, a favorable finding that contrasts with their 100% MDR status in environmental samples. Deress T *et al.* (2025) reported high resistance in *K. pneumoniae* and *E. coli* to first-line antibiotics like cefotaxime and ampicillin, while Shanhuayashe Godknows *et al.* (2024) found 88% resistance to trimethoprim-sulfamethoxazole in ESBL-producing Gram-negative bacteria (62,91).

In nutshell for the MDR trend, our study found that environmental isolates had higher MDR rates than clinical ones, particularly among *Acinetobacter* spp., *Citrobacter* spp., and *P. aeruginosa* (all 100% MDR). This supports the findings of Mohd Rafee *et al.* (2016), who identified HD water systems as reservoirs of MDR pathogens while conducted their descriptive laboratory study at two HD centers in Bandung, Indonesia (97). Janem A *et al.* (2024) from Palestine further reported 84.7% ESBL-GNB colonization rate in HD patient stools, highlighting the environmental-to-clinical transmission pathway (84). The 100% MDR in *Acinetobacter* spp. is especially concerning, given the WHO designation as a Critical Priority pathogen and the demonstrated ability to form biofilms in water systems, as shown by Devi *et al.* (2025) conducted a observational study at the Regional Institute of Medical Sciences (RIMS), a tertiary hospital in Imphal, India (98).

The empirical antibiotic treatment patterns observed in this study reflect both adherence to traditional prescribing norms and notable misalignments with current antimicrobial stewardship principles. The inappropriate use of vancomycin for Gram-negative organisms – particularly *Klebsiella* spp. and *P. aeruginosa* – underscores a critical deviation from EUCAST guidelines, which clearly state that vancomycin lacks efficacy against Gram-negative bacteria due to their outer membrane barrier. In our findings, vancomycin was administered in 66.7% of empirically treated *Klebsiella* spp. cases, despite its ineffectiveness against these pathogens. This highlights a significant therapeutic mismatch in empirical prescribing practices within the unit, and it aligns with a systematic review study conducted by Abu-Ola *et al.* (2025) at Qatar University who synthesized data from research carried out primarily across North America, Oman, Australia and India, showing inappropriate prescribing rates in dialysis patients ranging from 20% to 65.7% (99). This misuse falls within the “inappropriate choice or spectrum of antibiotics” category,

which ranging from the 23.6% up to 69.7% of such errors (99). While vancomycin remains a globally endorsed empirical agent for suspected MRSA infections (38), its use must be carefully tailored to local epidemiology, especially as Gram-negative BSIs become increasingly dominant in HD populations (38).

The broad-spectrum approach observed – using cefepime, meropenem, and piperacillin-tazobactam – mirrors (Abu-Ola *et al.*, 2025) a review that showed piperacillin-tazobactam (2.4-44.5% prevalence) and meropenem (2.1-25.8% prevalence) trends in dialysis settings (99), and reflects a necessary response to rising MDR. The inclusion of meropenem in critical cases is consistent with its role as the preferred treatment for ESBL-producing pathogens as indicated by Tamma *et al.* (2024) having based on Infectious Disease Society of America (IDSA) Antimicrobial-resistant Enterobacterales Treatment Guidance (100), particularly in light of the global surge in carbapenem-resistant *Klebsiella pneumoniae* and *Acinetobacter baumannii* (71). The maximal empiricism employed in the third incidence, despite the absence of culture growth, highlights the clinical urgency and mortality risk associated with suspected MDR infections, as supported by Daniel Beshah *et al.* (2022), Addis Ababa, Ethiopia's findings of high resistance rates (101). These findings collectively reinforce the need for locally informed empirical protocols and antimicrobial stewardship programs to mitigate inappropriate prescribing (23.6-69.7% of errors) and improve patient outcomes, as indicated by Abul-Ola *et al.* (2025) study (99).

The logistic regression analysis in this study identified two statistically significant independent predictors of BSIs in HD patients: repeated exposure to central venous catheter and hemoglobin (Hb) levels. ReCVC demonstrated a strong association with BSI risk, with an adjusted odds ratio (AOR) of 0.048 (95% CI: 0.008-0.300, P = 0.001), indicating that patients with a history of ReCVC are substantially more vulnerable to BSIs. This finding aligns with Weldetensae *et al.* (2023), who reported an AOR of 11.9 (p < 0.001) for previous central venous catheter (CVC) infections as a predictor of CRBSIs in Ethiopian HD patients (58). Similarly, Abbasi *et al.* (2020) from Malaysia found prior BSI to be an independent risk factor with an AOR of 6.56 (p = 0.004), while Delistefani *et al.* (2019) reported an AOR of 3.86 (p < 0.03) for recurrent catheter-related infections (64,102).

Hemoglobin levels also found as a significant independent predictor, with an AOR of 0.635 (95% CI: 0.439-0.917, $p = 0.015$), suggesting that lower Hb levels (anemia) are associated with increased BSI risk. Weldetensae *et al.* (2023) similarly reported an AOR of 2.78 ($p < 0.05$) for low Hb as a risk factor for CRBSI (58). Abbasi *et al.* (2020) from Malaysia emphasized that low Hb, as part of the malnutrition-inflammation-atherosclerosis (MIA) syndrome, compromises immune function and predisposes patients to HAIs infections (64). Opoku-Asare *et al.* (2023) from Ghana also identified that anemia significantly increases the risk of CRBSIs in African HD patients, with lower Hb levels – indicated by reduced MCH – serving as a key predictor ($p < 0.05$) (44).

The observed decline in BSI incidence following the implementation of targeted environmental interventions is strongly supported by global and regional studies. In our cohort, BSI incidence declined significantly ($p < 0.001$) after December, 2024, following bleach water treatment, pipeline replacement, and stricter IPC, with follow-up sampling showing no bacterial growth. These findings align with Opoku-Asare *et al.* (2023), who reported a 54% reduction in CRBSIs after protocol implementation in Ghana (44). The focus on dialysis water treatment and infrastructure mirrors recommendations by Kanamori *et al.* (2022), the researchers who based in Japan and the USA, Devi *et al.* (2025), Imphal, India, and Mohd Hafeez bin Mohd Rafee *et al.* (2016), Bandung, Indonesia, who identified water systems lapses as critical contributors to HD-related outbreaks (92,97,98).

Mortality analysis revealed a markedly higher death rate among patients with BSIs. In this cohort, 22.7% of patients with a first BSI episode, 20.0% with a second, and 100% mortality was observed in the single patient with a third BSI episode. In contrast, only 6.2% of patients without infection died, with 93.8% surviving through the follow-up period. These findings are consistent with Eyob AB *et al.* (2023) conducted in Addis Ababa, Ethiopia, who reported a 2.98-fold increased risk of death in infected HD patients (46). Schamroth Pravda *et al.* (2024) who undertook the study in a single center retrospective observational study similarly identified bacteremia as an independent mortality predictor (AOR 2.566, $p = 0.035$), and B.M. Belay *et al.* (2025) who studied focusing on mortality predictors among HD patients in Ethiopia reported an adjusted hazard ratio of 2.89 for infection-related mortality (38,45). The escalating mortality with recurrent BSI episodes parallels recurrence patterns documented by Almenara-Tejederas *et*

al. (2023) in Spain and Weldetensae *et al.* (2023) in Ethiopia, who observed multiple infection episodes in 19.3% and 16.2% of patients, respectively (58,66). The heightened severity of recurrent infections is often linked to MDR organisms, as highlighted by Sharifa Ezat WP *et al.* (2025) in Malaysia, Cornistein *et al.* (2025) in Argentina, and Marino *et al.* (2024) conducted by Global Systematic Analysis across 204 countries and territories, underscoring the urgent need for sustained infection control and antimicrobial stewardship in HD settings (103–105).

6.2. Strengths of the Study

As for strengths, the study's integrative design – encompassing sociodemographic, clinical, microbiological, and environmental data – offers a comprehensive understanding of BSIs in HD patients. Its focus on Ethiopian dialysis centers addresses a significant gap in SSA nephrology literature, especially in resource-limited settings. Notably, the study revealed a statistically significant reduction in BSI incidence following the implementation of a comprehensive intervention strategy ($p < 0.001$), highlighting its practical impact.

By tracking BSI episodes longitudinally, the study captured infection dynamics, including recurrence (3.5%) and sepsis progression (4.7%), aligning with global trends and emphasizing clinical severity. Environmental sampling, though biannual, revealed a 65.2% contamination rate and strong concordance with patient isolates, supporting the hypothesis of HAIs transmission. The overlap of Gram-negative organisms in both domains reinforces the plausibility of environmental sources and justifies targeted infection prevention and control (IPC) interventions.

Stratifying data across three centers revealed institutional differences in bacterial prevalence and sepsis outcomes, enabling tailored IPC strategies. The identification of dominant Gram-negative bacteria – *Klebsiella* spp., *P. aeruginosa*, and *Citrobacter* spp. – and their recurrence patterns enhances clinical relevance. These findings underscore the need for robust hygiene protocols, particularly in water systems and high-touch areas. Correlations between BSI and altered hematologic markers offered a framework for early risk detection. Antimicrobial susceptibility testing informs empirical therapy and supports stewardship in settings with limited diagnostics.

6.3. Limitations of the Study

As pertain to the limitations, the study cohort was predominantly composed of CKD patients (91.1%), with limited representation of AKI cases (8.9%). This imbalance, influenced by the

chronic care focus of participating centers, may limit the generalizability of findings to AKI populations. Although recurrence and sepsis rates were identified, the small number of affected patients (3.5% and 4.7%, respectively) reduced statistical power for subgroup analysis.

Diagnostic limitations were evident in the third BSI episode, where clinical signs of sepsis were present despite negative cultures, possibly due to prior antibiotic use. While microbial concordance between environmental and clinical isolates was observed, the absence of molecular typing restricted confirmation of transmission pathways.

Environmental sampling was conducted biannually, less frequently than international standards, potentially missing short-term contamination events. This reflects resource constraints common in low-income settings. Lastly, catheter tip cultures were not obtained due to clinical and operational barriers, limiting the scope of microbiological assessment. Blood cultures remained the primary diagnostic tool, except for one TNT-CVC sample collected in the AICU. These limitations should be considered when interpreting the study's findings and applying them to broader HD populations.

7. Conclusion and Recommendations

This study offers a comprehensive lens into the clinical, microbiological, and environmental dimensions of infection risk among maintenance HD patients, revealing a notable 91.1% burden CKD, with 82.5% in stage 5. The incidence of BSI stood at 16.6%, with 4.7% progressing to sepsis and 3.5% experiencing recurrent episodes – underscoring a persistent and clinically significant threat. Gram-negative bacterial, particularly *Klebsiella* spp. and *P. aeruginosa*, emerged as dominant pathogens, followed by Gram-positive CoNS. The spatial concordance of isolates across dialysis units confirmed a critical link between environmental contamination and clinical infection, highlighting systemic lapses in hygiene protocols, though our interventions during the study period showed a decline in incidence. Despite 92.9% of patients receiving HD thrice weekly, infection recurrence persisted, pointing to procedural inadequacies. Risk factors such as reduced hemoglobin and repeated exposure to central venous catheter further compounded vulnerability. The study also documented the socio-economic impact of CKD, with many patients exiting the workforce or education, and revealed poor outcomes (66.7%) among AKI patients. Ultimately, this study underscores that infection control and comorbidity management are pivotal to improving survival and quality of life in dialysis-dependent renal patients.

In light of the above conclusions, the study suggests the following recommendations:

- Routinely fix sources of environmental contamination and apply effective cleaning measures to maintain hygienic dialysis settings.
- Strengthen water-line disinfection and implement early detection a response strategy to lower BSI rates.
- Improve procedural standards during HD and provide targeted training for nurses, who remain in close contact with HD patients throughout treatment.
- Apply strict and consistently monitored antibiotic stewardship to ensure proper antimicrobial use an effectively limit resistance.
- Conduct regular assessments of hemoglobin levels and review past infection records to identify and protect high-risk patients.
- Design targeted care strategies for patients with AKI and offer support or referrals to those who have left work or school due to kidney failure.

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9. Annexes

I. Research Participant Information Sheet

Title of the Study: Incidence of Bloodstream Infection, Bacterial etiology, Antimicrobial Susceptibility Profile and Risk Factors among patients under Hemodialysis, with Intervention Assessment in Addis Ababa, Ethiopia: A Multi-Center Prospective Cohort Study

Investigator: Moti Wodajo (D.V.M., MSc Candidate)

Organization: SPHMMC

Sponsor: Collaborative with SPHMMC

You are invited to be involved in research on hemodialysis, which is a life-saving treatment for patients with end-stage renal disease. Before deciding to participate in the research, it is better to understand the information in this form because it briefs your rights and our responsibilities to you. This information and consent or assent form consists of purpose, examinations, possible advantages, risks and inconveniences related to this study. Your right to resign from taking part in the research is also explained below. You have the right to ask any question at any time related to the research. Your participation is voluntary. You may talk to anyone you fill joyful and you may take time to decide whether to participate or not.

Purpose of the study

This study aims to investigate the incidence, causes, and risk factors for infections among patients undergoing hemodialysis treatment in Addis Ababa, Ethiopia.

Specifically, the study has the following goals:

- To determine the rate of infections, including bloodstream infections and sepsis, in hemodialysis patients at multiple dialysis centers in Addis Ababa.
- To identify the types of bacteria causing bloodstream infection and sepsis.
- To analyze the susceptibility of the bacteria to different antibiotics.
- To understand the risk factors and conditions associated with higher rates of infection in these patients.

- To compare infection rates, causal microbes, and antimicrobial resistance patterns across different dialysis centers.

The findings from this study will provide valuable insights into the burden, causes, and prevention of dialysis-related infections in Addis Ababa, Ethiopia. This evidence can help improve infection control practices, optimize antibiotic use, and enhance patient screening and care protocols.

Ultimately, the study aims to guide interventions that reduce infection rates, morbidity, and mortality among hemodialysis patients in Ethiopia. Your participation will be key in generating the data needed to accomplish this goal and shape patient care policies.

Study Procedure

If you decide to take part in this research and meet the eligibility criteria, you will be asked to participate in the following procedures:

1. Interview: You will be interviewed to collect information on your demographic background, medical history, dialysis treatment details, medication use, and other relevant factors. This interview involves answering questions and will take approximately 30-45 minutes.

2. Sample collection:

- Blood samples will be collected from you when an infection is suspected, using sterile techniques. For adults, 10-20 ml of blood will be collected into blood culture bottles. For children, 1-5 ml will be collected based on age.
- If you have a temporary dialysis catheter, the catheter tip will be collected after removal and sent for analysis.
- Environmental swabs may be taken from equipment, surfaces, and other areas in the dialysis unit to check for potential sources of infection.

You will not need to pay for any of the sample collection or testing done specifically for this research study. The blood draws and other procedures related to this research will be provided free of charge.

Please let the study staff know if you have any questions or concerns about these study procedures. Your participation is entirely voluntary.

Risks and Inconveniences

- Blood draws may cause brief discomfort, bruising, or swelling at the site. There is also a small risk of infection or fainting. Trained staff will collect blood using sterile technique to minimize risks.
- Collection of catheter tips poses no additional risk, as they are routinely removed as part of dialysis care.
- Environmental swabbing involves minimal risk, as sterile swabs are used.
- Participation will require your time for the interview and sample collection during your dialysis visits. We will coordinate with your dialysis schedule to minimize inconvenience.
- There is a small risk of loss of confidentiality of your information. We will use strict security measures to protect your data and privacy.
- Participation in this research is voluntary. You may experience discomfort in answering some of the questions. You can decline to answer any questions and withdraw at any time.
- There may be risks that are currently unknown or unforeseeable. Please contact the study team at any time if you have any concerns.

Let the study staff know about any discomfort, swelling, bruising or other issues after the blood collection. We will provide care or recommend you follow up with your physician.

Please ask the study team if you have any other questions or concerns about the potential risks or inconveniences. We are dedicated to making study participation as safe and comfortable for you as possible.

Benefits

While there may not be any direct benefits to you from participating in this study, your involvement may potentially help others in the future.

- The information learned from this study may help improve infection control and prevention practices in dialysis units in Ethiopia and beyond. This can lead to reduced rates of dangerous dialysis-related infections for other patients.

- Your participation will contribute to better understanding of the types of bacteria causing infections, improving diagnosis and treatment approaches. If there is a positive bacterial isolate you will be treated with a specific drug that can kill the causative agent.
- Identifying risk factors can allow screening of patients at high risk and targeting of infection control measures.
- Understanding antimicrobial resistance patterns can help shape better antibiotic prescription practices.
- Overall, this study aims to guide evidence-based policies to enhance the quality and safety of dialysis care in Ethiopia.

You will receive the results of any blood culture or other sample testing done as part of this study, which may aid your care. However, no other individual results will be provided.

There is no payment or reimbursement for participating in this study. However, your contributions will provide valuable data to improve patient care, infection prevention, and dialysis practices.

Please let the study team know if you have any other questions about the potential benefits or value of the study. Your willingness to participate may help protect other patients undergoing dialysis.

Compensation

All study-related examinations are free of charge to you.

Protection of your private life

We will do everything we can to protect your privacy. Information retrieved from your medical record will be treated as strictly confidential. The information will be identified by a code and not by your name. The documents where your name is mentioned will not be shared with anyone, except the study researchers, and your doctor who have to keep it confidential. By signing this informed consent or assent form, you agree with this access to your records.

The findings of the study will be published in medical journals and can be shared in an international database. Your name will not appear in any database, report or publication resulting from this study.

Ethics committee

Ethics committee of St. Paul's Hospital Millennium Medical College, Menelik II Comprehensive Specialized Hospital and Zewditu Memorial Hospital will review and approve the study before the start of it. The committee will also perform ongoing review of the study to make sure it is carried out in the safest way possible.

When clinically relevant results are discovered, the clinician will immediately be informed, who can trace back the patient identity when needed.

Research Directorate

The Research Directorate will oversee the coordination and management of the study across St. Paul's Hospital Millennium Medical College, Menelik II Comprehensive Specialized Hospital, and Zewditu Memorial Hospital, ensuring adherence to ethical standards and study protocols. They will facilitate communication among centers, review progress, and ensure compliance with data protection and confidentiality requirements. The Directorate will also handle the dissemination of findings and coordinate with clinicians for the identification and notification of patients with clinically relevant results.

Voluntary participation

Your participation in this research is totally voluntary. Your participation is dependent on your choice. Your decision to participate or not to participate in the research will not have any effect on the services you get from the hospital. You have a full right to withdraw from the research at any time, even after signing the consent or assent form. You do not have to give a reason for wanting to stop from being part of the study.

Contact person in case of questions

If you have any questions concerning your participation in this study, or if you think you have been harmed as a result of the study, you may contact the researcher, now, during, or after the study whose contact information are provided below.

Name	Phone number	Email
Moti Wodajo (D.V.M., MSc Candidate)	+251911671830	redninetos@gmail.com
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II. Consent / Assent Form

Title of the Study: Incidence of Bloodstream Infection, Bacterial etiology, Antimicrobial Susceptibility Profile and Risk Factors among patients under Hemodialysis, with Intervention Assessment in Addis Ababa, Ethiopia: A Multi-Center Prospective Cohort Study

Part which is destined only to the participant or his/her legal representative

I understood and I have been informed about the study and the participant informed consent or assent form sheet copy is given to me.

The study was explained to me in a simple and clear language with enough information. Sufficient time was given to me to realize and ask questions, to which I got satisfactory answers. I am freely willing to be part of the study and cooperate in the study activities. I am willing to give information concerning my medical history, clinical examination and participate in giving blood samples. If I want to discontinue participating, even after signing the informed consent, I know I can do so. I agree that my doctor and other healthcare professionals involved in my diagnosis are informed about my participation in this study.

☐

Yes

☐

No

To be completed by the participant

Date: Name of the participant:

Signature (or thumbprint) of participant:

Note: The fingerprint replaces the signature, ONLY for participants who can't read and write (accompanied by a witness).

To be completed by the legal guardian of the participant (For participants aged 0-18 years)

Date: Name of legal guardian:

(In case there is no 'legal' guardianship, consider asking to add the relationship of the guardian with the participant here as well)

Signature (or thumbprint) of legal guardian:

Note: the fingerprint replaces the signature, ONLY if the legal guardian can't read and write (accompanied by a witness)

To be completed by the witness (if the participant / legal guardian can't read and write)

Date: Name of witness:

Signature of witness:

Note: If the participant (or legal guardian) is unable to read and/or write, an impartial witness should be present during the informed consent discussion. After the written informed consent form is read and explained to the participant and after s/he has orally consented to participation in the study, and has provided fingerprint, the witness should complete the name of the participant, add the date of fingerprint, and sign, and personally date the consent form. By signing the consent form, the witness attests that the information in the consent form and any other written information was accurately explained to, and apparently understood by the participant (or legal guardian), and that informed consent was freely given.

To be completed by the person obtaining the informed consent

I, undersigned, ... confirm that I have informed the participant (and/or the legal guardian) about all the relevant aspects of this study. I confirm that he/she has consented voluntarily to participate in the study.

Date: Signature:

III. Amharic Version Form

የምርምር ተሳታፊ መረጃ ቅጽ

የጥናቱ ርዕስ:- የኢንፌክሽን ክስተት፣ መንስኤ ባክቴሪያዎች፣ ፀረ-ተህዋስያን ተጋላጭነት መገለጫ ሰነድ እና በደም እጥበት ታካሚዎች ላይ የሚደርሱ ሥጋቶች፣ በአዲስ አበባ፣ ኢትዮጵያ በብዙ ማዕከላት በይሆናል የሚከናወን የወደፊት የቡድን ጥናት።

ተመራማሪ፡ ሞቲ ወዳጆ (ዲቪዩም ፣ የ2ኛ ዲግሪ እጩ)

ተቋም፡- የቅዱስ ጳውሎስ ሆስፒታል ሚሴኒየም ሕክምና ኮሌጅ

ስፖንሰር፡- ከቅዱስ ጳውሎስ ሆስፒታል ሚሴኒየም ሕክምና ኮሌጅ ጋር በመተባበር

ከላሊት ደክሞ መደበኛ ስራውን ለማከናወን እክል ሲገጥመው የደም እጥበት የከላሊት ተግባር ምትክ ሆኖ የሚያገለግል ሲሆን አንተ/ቺም አሁን በምናደርገው የደም እጥበት ምርምር ላይ እንድትሳተፉ/ፊ በአክብሮት ተጋብዘሃል/ሻል። በጥናቱ ላይ ለመሳተፍ ከወሰንክ/ሽ በፊት ከዚህ በታች የተጠቀሱትን መረጃዎች መረዳት ተገቢ ነው። ምክንያቱም መብትህ/ሽንና እኛ ለአንተ/ቺ ያለንን ሀላፊነቶችን ያብራራል። ይህ የስምምነት ቅጽ ዓላማውን፣ ምርመራዎችን፣ ሊሆን የሚችሉ ጥቅሞችን፣ ሥጋቶችን እና ከዚህ ጥናት ጋር የተያያዙ ችግሮችን ያካትታል። በጥናቱ ላይ ለመሳተፍና ለመልቀቅ መብትህ/ሽ ከዚህ በታች ተብራርቷል። በማንኛውም ጊዜ ከጥናቱ ጋር የተገናኙ ጥያቄዎችን የመጠየቅ መብት አለህ/ሽ። የአንተ/ቺ ተሳትፎ በፈቃደኝነት ነው። ቅጹ ላይ ያሉትን ጥያቄ ለመመለስ ከሰው ጋር ተማክረህ/ሽ ሊሆን ይችላል። ላለመሳተፍም ጊዜ ወስደህ/ሽ መወሰን ትችላለህ/ትቺያለሽ።

የጥናቱ ዓላማ

ይህ ጥናት በአዲስ አበባ፣ ኢትዮጵያ ውስጥ የደም እጥበት በሚወስዱ ታካሚዎች ላይ የሚከሰቱትን የኢንፌክሽን መንስኤዎችንና ሥጋቶችን ለመመርመር ያለመ ነው። በተለይም ጥናቱ የሚከተለትን ግቦች በውስጡ አኳቷል፡-

- በአዲስ አበባ በሚገኙ ከበርካታ የከላሊት እጠበት ማዕከላት ውስጥ በደም እጥበት ታማሚዎች ላይ የደም ዝውውር ኢንፌክሽን እና የሴፕሲስ መጠን ለማወቅ፤
- የደም ዝውውር ኢንፌክሽንና ሴፕሲስን የሚያስከትሉ የባክቴሪያ ዓይነቶችን ለመለየት፤

- ለተለያዩ ፀረ-ተህዋሲያን የባክቴሪያውን ተጋላጭነት ለመተንተን፤
- በእነዚህ ታካሚዎች ላይ ከፍ ባለ የኢንፌክሽን ክስተት ጋር ተያይዘው የሚመጡ ሥጋቶችን ለመረዳት፤
- በተለያዩ የደም እጥበት ማዕከሎች ውስጥ የኢንፌክሽን መጠንን፣ መንስኤ የሆኑ ባክቴሪያዎችንና ፀረ-ተህዋሲያንን የመቋቋም ዘዴዎችን በማነፃፀር፣ በአዲስ አበባ፣ ኢትዮጵያ ውስጥ የሚደረገው የዚህ ጥናት ግኝቶች የደም እጥበት ኢንፌክሽኖችን ጫና፣ መንስኤና መከላከያ ነጥቦች ላይ ጠቃሚ ግንዛቤዎችን ይሰጣል። ይህ ማስረጃ ቅጽ የኢንፌክሽን ቁጥጥር ልምዶችን ለማሻሻል፣ የፀረ ተህዋሲያን አጠቃቀምን ለማመቻቸትና የታካሚን የደም እጥበት ሂደትና እንክብካቤ ፕሮቶኮሎችን ለማሻሻል ይረዳል።

በመጨረሻም ጥናቱ በኢትዮጵያ ያለውን የደም እጥበት ህመምተኞችን የኢንፌክሽን መጠን፣ በሽታና ሞትን የሚቀንሱ እርምጃዎችን ለማሳለጥ ያለመ ነው። ይህንን ግብ ለማሳካትና የታካሚ እንክብካቤ ፖሊሲዎችን ለመቅረጽ የአንተ/ቺ ተሳትፎ ወሳኝ ነው።

የጥናት ሂደት

በዚህ ጥናት ውስጥ ለመሳተፍ ከወሰኑ እና የብቁነት መስፈርቱን ካሟላህ/ሽ በሚከተሉት ሂደቶች ውስጥ እንድትሳተፍ/ፊ ትጠየቃለህ/ቂያለሽ።

1) ቃለ መጠይቅ፡- ስለ ሥነ-ህዝብ ዳራህ/ሽ፣ ስለ ህክምና ታሪክህ/ሽ፣ ስለ ደም እጥበት ህክምና ዝርዝሮች፣ የመድኃኒት አጠቃቀም እና ሌሎች ተያያዥ ጉዳዮች ላይ መረጃ ለመሰብሰብ ቃለ መጠይቅ ይደረግልሃል/ሻል። ይህ ቃለ መጠይቅ ከ30-45 ደቂቃ ይወስዳል።

2) የናሙና ስብስብ

- ኢንፌክሽን መከሰቱ ሲጠረጠር ጽዱና አግባብ ባለው የህክምና ቴክኒክ የደም ናሙና ከአንተ/ቺ ይሰበሰባል። ለአዋቂዎች ከ10-20 ሚሊ ሊትር በደም መሰብሰቢያ ጠርሙሶች ይሰበሰባል። ለህጻናት ደግሞ እንደ እድሜያቸው ከ1-5 ሚሊ ሊትር ይሰበሰባል።
- ጊዜያዊ የደም እጥበት ካቴተር ተጠቃሚ ከሆንክ/ሽ ካቴተሩ ከመወገዱ በፊት ጫፉ ተቆርጦ ለምርመራ ወደ ላብራቶሪ ይላካል።
- ተጓዳኝ የኢንፌክሽን ምንጮችን ለመፈተሽ በደም እጥበት ክፍል ውስጥ ካሉ መሳሪያዎች፣ ንጣፎች እና ከሌሎች የክፍሉ ቦታዎች ላይ በጥጥ ተጠርጎ ናሙናዎች ሊወሰዱ ይችላሉ።

ለዚህ ምርምር ሲባል ለተደረጉ የናሙና ስብስብና የላብራቶሪ ምርመራ አትክፍልም/ዩም ለዚህ ምርምር የሚወሰደው የደም ናሙና እንዲሁም ሌሎች ከላይ የተጠቀሱት ናሙናዎች በነጻ ይሰጣሉ።

ስለ እነዚህ የጥናት ሂደቶች ጥያቄዎች ወይም ስጋቶች ካለህ/ሽ እባክህን/ሽን ለጥናት ቡድኑ አሳውቅ/ቂ። የአንተ/ቺ ተሳትፎ ሙሉ በሙሉ በፈቃደኝነት ነው።

ሥጋቶችና ምችት ማጣት

- የደም ናሙና ሲወሰድ ትንሽ ምችት ሊነሳና እብጠት ሊያስከትል ይችላል። ኢንፌክሽን ሲከሰት እንዲሁም አንዳንዴ ለጊዜው ብሽፍ እንደማለት ወይም ራስን መሳት ሊኖር ይችላል። ይህን ስጋት ለመቀነስ የሰለጠኑ የጤና ባለሙያዎች ጽዳና አግባብ ባለው የህክምና ቴክኒክ የደም ናሙና ይወስዳሉ።
- ከተጠቀምክበት/ሽበት በኋላ ሊወገድ ዘንድ ከተነቀለው የደም እጥበት ካቴተር ላይ ጫፉን ቆርጦ መውሰድ ብዙ አደጋ አያስከትልም።
- የደም እጥበት ክፍል ውስጥ ካሉት አጠራጣሪ ነገሮች ወይም ቁሶች ላይ በተዘጋጀ ንጹህ ጥጥ የሚወሰዱ ናሙናዎች ብዙ አደጋ አያስከትሉም።
- ቃለ መጠይቅ ሊደረግልህ/ሽ እና ናሙና ሲወሰድ ጊዜ ይወስዳል። ይህንን ችግር ለመቀነስ ከደም እጥበት መርሃ ግብርህ/ሽ ጋር እንዲሳለጥ እናደርጋለን።
- የመረጃህን/ሽን ምስጢራዊነት ማጣት እጅግ ያነሰ ነው። የአንተን/ቺን ግላዊ መረጃ ለመጠበቅ ጥብቅ የደህንነት እርምጃዎችን እንጠቀማለን።
- በዚህ ጥናት ውስጥ መሳተፍ በፍቃደኝነት ነው። አንዳንድ ጥያቄዎችን ለመመለስ ምችት ላይሰማህ/ሽ ይችላል። ማንኛውንም ጥያቄ ስትመልስ እምቢ ማለት እና በማንኛውም ጊዜ መተው ትችላለህ/ትቺያለሽ።
- አሁን ላይ ሆነን የማናውቃቸው ወይም የማንጠብቃቸው አደጋዎች ሊኖሩ ይችላሉ። አባክህን/ሽን የሚያሳስብህ/ሽ ነገር ካለ በማንኛውም ጊዜ የጥናት ቡድኑን አናግር/ሪ።

ከደም ናሙና መሰብሰብ በኋላ ምችት ማጣት፣ እብጠት፣ ድብርት፣ ወይም ሌሎች ጉዳዮች ከተሰሙህ/ሽ ወይም ሲታዩህ/ሽ ለጥናት ቡድኑ አሳውቅ/ቂ። እንደ አስፈላጊነቱ እንክብካቤ ይደረግልሃል/ሻል። አልያም ከሐኪምህ/ሽ ጋር እንድትከታተል/ዩ እንመክራለን።

እባክህ/ሽ የጥናት ቡድኑን ሊኖሩ ስለሚችሉ ችግሮች ወይም ሥጋቶች ካለህ/ሽ ጠይቅ/ቂ። የጥናት ተሳትፎህን/ሽን በተቻለ መጠን አስተማማኝና ምቹ ለማድረግ ቆርጠን ተነስተናል።

ጥቅሞች

በዚህ ጥናት ውስጥ በመሳተፍ አንተ/ቺ ምንም አይነት ቀጥተኛ ጥቅም ላይኖርህ ይችላል። ነገር ግን የአንተ/ቺ ተሳትፎ ወደፊት ሌሎች ተመሳሳይ ተገልጋዮች ሊጠቀሙበት ይችላሉ።

- ከዚህ ጥናት የሚገኘው መረጃ በኢትዮጵያና ከዚያም ባሻገር ባሉት የኩላሊት እጥበት ህክምና ክፍሎች ላይ የኢንፌክሽን ቁጥጥር እና መከላከልን ለማሻሻል ይረዳል። ይህ ለሌሎች ታካሚዎች የክፉ እጥበት ነክ ኢንፌክሽን መጠን እንዲቀንስ ሊያደርግ ይችላል።
- የአንተ/ቺ ተሳትፎ የኢንፌክሽን መንስኤ የሆኑትን የባክቴሪያ አይነቶች በተሻለ ለመረዳት፣ የምርመራ እና የሕክምና ዘዴዎችን ለማሻሻል አስተዋጽኦ ይኖረዋል።
- አዎንታዊ የባክቴሪያ ምርመራ ውጤት ካለም መንስኤውን ሊገድል በሚችል ልዩ መድኃኒት ትታከማለህ/ትታከሚያለሽ።
- የሥጋት መንስኤዎችን ለመለየት፣ ከፍተኛ ተጋላጭነት ደረጃ ላይ ያሉ ታካሚዎችን ለመመርመር እና ኢንፌክሽን መቆጣጠሪያ እርምጃዎችን ለማሳለጥ ያስችላል።
- የፀረ-ተህዋሲያን መከላከያ ዘዴዎችን መረዳት የተሻሉ የፀረ-ተህዋሲያን ማዘዣ ልማዶችን ለመቅረጽ ይረዳል።
- በአጠቃላይ ይህ ጥናት በማስረጃ ላይ የተመሰረተ ሆኖ በኢትዮጵያ ያለውን የእጥበት ህክምና ጥራት እና ደህንነት ከፍ ለማድረግ እንዲሁም ፖሊሲዎችን ለመቅረጽ ያለመ ነው።

አንድ የዚህ ጥናት አካል የተደረገ ማንኛውም ተሳታፊ የናሙናዎቹን ምርመራ ውጤት ማግኘት ይችላል/ትችላለች። ለሚደረግለት/ላት ቀጣይ የሕክምና እንክብካቤ የሚጠቀምበት / የምትጠቀምበት ይሆናል። የሌላ ግለሰብ ውጤቶችን ማግኘት ግን ፈጽሞ የተከለከለ ነው።

በዚህ ጥናት ውስጥ ለመሳተፍ ምንም አይነት ክፍያ ወይም ማካካሻ አይሰጥም። ነገር ግን የአንተ/ቺ አስተዋጽኦ የታካሚ እንክብካቤን፣ የኢንፌክሽን መከላከልን እና የደም እጥበት ልምምዶችን ለማሻሻል ጠቃሚ መረጃን ይሰጣል።

እባክህ/ሽ ሌሎች ማንኛውም ጠቀሜታዎችን በተመለከተ ለአጥኚው ቡድን አሳውቅ/ቂ። ለመሳተፍ ፍቃደኛ መሆንህ/ሽ ሌሎች የደም እጥበት ላይ ላሉ ታካሚዎች ሊረዳ ይችላል።

ማካካሻ

ከጥናቱ ጋር የተያያዙ ምርመራዎች ሁሉ ለአንተ/ቺ ከክፍያ ነጻ ናቸው።

የግል ሕይወትዎ ምስጢራዊነት

የአንተ/ቺን ግላዊ ምስጢር ለመጠበቅ የምንችለውን ሁሉ እናደርጋለን። ከሕክምና መዝገብህ/ሽ የተወሰደ መረጃ እንደ ጥብቅ ምስጢራዊ ሰነድ ይቆጠራል። መረጃው በስምህ/ሽ ሳይሆን በኮድ ነው የሚታወቀው። ከተመራማሪዎችና ከዶክተርህ/ሽ በስተቀር ስምህ/ሽ ያለበት ሰነድ ለማንም አይጋራም። ይህን በመረጃ የተደገፈ የስምምነት ወይም የፈቃደኝነት ቅጽ በመፈረም ተስማምተዋል/ሻል።

የጥናቱ ግኝቶች በህክምና ጆርናሎች ውስጥ የሚታተሙ ሲሆን በዓለም አቀፍ መድረክ ላይ ሊቀርብ ይችላል። ከዚህ ጥናት በተገኘ ማንኛውም ሪፖርት ወይም ህትመት ውስጥ ስምህ/ሽ አይገለጽም።

የሥነ ምግባር ኮሚቴ

የቅዱስ ጳውሎስ ሆስፒታል ሚሌኒየም ሕክምና ኮሌጅ ፣ የዳግማዊ ምኒልክ ኮምፕረኬንሲቭ ስፔሻላይዝድ ሆስፒታል እና የዘውዲቱ መታሰቢያ ሆስፒታል የሥነ-ምግባር ኮሚቴ ጥናቱ ከመጀመሩ በፊት ገምግሞ ያጸድቃል። ኮሚቴው ጥናቱ በተቻለ መጠን አስተማማኝ በሆነ መንገድ መካሄዱን ለማረጋገጥ ቀጣይነት ያለው ግምገማ ያደርጋል።

ክለሲካዊ ተዛማጅነት ያላቸው ውጤቶች ሲገኙ ለህክምና ባለሙያ ወዲያውኑ ይነገራል። አስፈላጊ ሆኖ ሲገኝ ደግሞ ሀኪሙ የታካሚውን ማንነት ማወቅ ይችላል።

የምርመራ ዳይሬክቶሬት

የምርመራ ዳይሬክቶሬቱ በቅዱስ ጳውሎስ ሆስፒታል ሚሌኒየም ሕክምና ኮሌጅ ፣ በዳግማዊ ምኒልክ ኮምፕረኬንሲቭ ስፔሻላይዝድ ሆስፒታል እና በዘውዲቱ መታሰቢያ ሆስፒታሎች ውስጥ

የጥናቱን ቅንጅትና አስተዳደር ይቆጣጠራል። የሥነ-ምግባር ደረጃዎችን እና የጥናት ፕሮቶኮሎችን መተግበራቸውን ያረጋግጣል። በማዕከሎቹ መካከል ግንኙነትን ያመቻቻል፤ ሂደቱን ይገመግማል፤ እንዲሁም የመረጃዎችን ምስጢራዊነት መስፈርቶችን መከበሩን ያረጋግጣል። ዳይሬክቶሬቱ የግኝቶችን ሥርጭት እንዲከናወን ያደርጋል። ክሊኒካዊ አግባብነት ያለው ውጤት ያላቸውን ታካሚዎች ለመለየት እና ለማሳወቅ ደግሞ ከህክምና ባለሙያዎች ጋር በትብብር ይሰራል።

በፈቃደኝነት ላይ የተመሠረተ ተሳትፎ

በዚህ ጥናት ውስጥ ያለህ/ሽ ተሳትፎ ሙሉ በሙሉ በፈቃደኝነት ነው። የአንተ/ቺ ተሳትፎ በአንተ/ቺ ምርጫ ላይ የተመሰረተ ነው። በጥናቱ ላይ ለመሳተፍ ወይም ላለመሳተፍ ያደረገው/ገሽው ውሳኔ ከሆስፒታል በሚያገኙት አገልግሎት ላይ ምንም ዓይነት ተጽዕኖ አይኖረውም። የስምምነት ቅጹን ከፈረምክ/ሽ በኋላም ቢሆን በማንኛውም ጊዜ ከጥናቱ የመውጣት ሙሉ መብት አለህ/ሽ። የጥናቱ አካል ከመሆን ለማቆም የምትፈልግበትን ምክንያት መስጠት አያስፈልግም።

ጥያቄ ቢኖርህ/ሽ የምታናግረው/ሪው ግለሰብ

በዚህ ጥናት ውስጥ ያለህን/ሽን ተሳትፎ በተመለከተ ማንኛውም ዓይነት ጥያቄ ካለህ/ሽ ወይም በጥናቱ ምክንያት ጉዳት ደርሶብኛል ብለህ/ሽ የምታስብ/ቢ ከሆነ ከዚህ በታች ለቀረቡ የጥናቱ ቡድን ጥያቄህን/ሽን በማቅረብ ማነጋገር ትችላለህ/ትችያለሽ።

ስም	ስልክ ቁጥር.	የኢሜል አድራሻ
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አንተነህ መሃሪ (ፒኤች)	+251912060506	antenehmehari@gmail.com
አልጋነሽ ገ/ዮሐንስ (ቢ.ኤስሲ.፣ኤምኤስሲ.)	+215939003167	alganesh5838@gmail.com
ሊና መሐመድ (ኤምዲ ፣ ኔፋሮሎጂስት)	+251912603945	lina.mohammed@sphmmc.edu.et
ትዕግስት ፍቅሬ (ኤምዲ፣ ኔፋሮሎጂስት)	+251911315162	
ሕይወት ለገሰ (ሲኒየር ነርስ)	+251912659961	

የፍቃደኝነት ቅጽ

የጥናቱ ርዕስ፡- የኢንፌክሽን ክስተት፣ መንስኤ ባክቴሪያዎች፣ ፀረ-ተህዋስያን ተጋላጭነት መገለጫ ሰነድ እና በደም እጥበት ታካሚዎች ላይ የሚደርሱ ሥጋቶች፣ በአዲስ አበባ፣ ኢትዮጵያ በብዙ ማዕከላት በይሆናል የሚከናወን የወደፊት የቡድን ጥናት።

ለተሳታፊው ወይም ለህጋዊ ወኪሉ ብቻ የተወሰነ ክፍል

በምርምሩ ላይ ተሳታፊ ለመሆን የጥናቱን የመረጃ ቅጽና ግልባጭ ተረድቻለሁ። ይህ በመረጃ የተደገፈ የመግባባትና የፍቃደኝነት ቅጽ ቅጂ ተሰጥቶኛል።

ጥናቱ በቂ መረጃ ባለው ቀላል እና ግልጽ ቋንቋ ተብራርቶልኛል። ለመገንዘብ እና ጥያቄ ለመጠየቅ በቂ ጊዜ ተሰጥቶኛል። ለዚህም አጥጋቢ መልስ ስለአገኘሁ የጥናቱ አካል ለመሆን እና በጥናት ሂደቶች ውስጥ ለመተባበር ፈቃደኛ ነኝ። የህክምና ታሪኬን፣ ክሊኒካዊ ምርመራዬን በተመለከተ መረጃ ለመስጠት፣ የደም ናሙና በመስጠት ለመሳተፍ ፈቃደኛ ነኝ። ተሳትፎዬን ማቆም ከፈለግኩ፣ በመረጃ የተደገፈ የስምምነት ቅጽ ከፈረምኩ በኋላም ቢሆን፣ ይህን እርምጃ መውሰድ እንደምችል አውቃለሁ። በምርመራዬ ላይ የተሳተፉት ሀኪም እና ሌሎች የጤና ባለሙያዎች በዚህ ጥናት ውስጥ መካተቴን መረጃ እንደተሰጣቸው በማወቅ እስማማለሁ።

አዎ

☐

አይ

☐

በተሳታፊ የሚሞላ

ቀን _____ የተሳታፊው ስም _____

የተሳታፊው ፊርማ/ _____ የጣት አሻራ _____

ማስታወሻ፡- የጣት አሻራው ፊርማውን ይተካል። ይኸውም ማንበብና መጻፍ አለመቻሉን/ሏን ተመስክሮ ተፈጻሚ ይሆናል።

በህጋዊ ሞግዚት የሚሞላ (ከ0-18 ዓመት ለሆኑ ተሳታፊዎች)

ቀን _____ የሕጋዊ ሞግዚት ስም _____

(ህጋዊ ሞግዚትነት መረጃ ከሌለ የአሳዳጊው ቤተሰባዊ ግንኙነት ይገለጽ)

የህጋዊ ሞግዚት ፊርማ/የጣት አሻራ _____

ማሳሰቢያ፡- የጣት አሻራው ፊርማውን ይተካል። ይኸውም ማንበብና መጻፍ አለመቻሉን/ሷን ተመስክሮ ተፈፃሚ ይሆናል።

በምስክሩ የሚሞላ (ተሳታፊ) ህጋዊ አሳዳጊ ማንበብና መጻፍ የማይችል ከሆነ)

ቀን _____ የምስክር ስም _____

የምስክር ፊርማ _____

ማስታወሻ፡- ተሳታፊው/ዋ ሕጋዊ ሞግዚት/ቷ ማንበብና መጻፍ ካልቻለ/ች፣ በመረጃ ላይ የተመሰረተ የስምምነት ውይይት በሚደረግበት ጊዜ ገለልተኛ ምስክር መገኘት አለበት። በጽሁፍ የተገለጸው የስምምነት ፎርም ከተነበበ በኋላ ወይም ለተሳታፊው ከተገለጸ በኋላ እና በጥናቱ ለመሳተፍ በቃል ፍቃደኛ ሆኖ የጣት አሻራ ካቀረቡ በኋላ ምስክሩ የተሳታፊውን ስም መሙላት፣ የጣት አሻራውንና ቀን በመጨመር መፈረም ይኖርበታል። በዚህ ቅጽ የጣት አሻራ የተደረገበት ቀን ይገለጻል። የስምምነት ቅጹን በመፈረም ምስክሩ በስምምነት ቅጹ ላይ ያለው መረጃና ማንኛውም የጽሑፍ ሰነድ በትክክል የተብራራለትና በተሳታፊው ወይም በህጋዊ ሞግዚት የተብራራለት እንደሆነና በመረጃ ላይ የተመሰረተ ስምምነት በፈቃደኝነት መስጠቱን ያረጋግጣል።

የተቀበለውን ስምምነት በማግኘት ተመራማሪው የሚሞላው

እኔ _____ ለሁሉም ተሳታፊ (እና/ወይም ህጋዊ ጠባቂ/ አሳውቂ በዚህ ጥናት ውስጥ ያሉ አስፈላጊ ገጽታዎች በጥናቱ ውስጥ ለማሳተፍ ወይም ለማካተት በፈቃደኝነት እንደተሰማሙ አረጋግጣለሁ ።

ቀን _____ ፊርማ _____

IV. Afaan Oromoo Version Form

Waraqaa Odeeffannoo Hirmaattota Qorannoo

Mata duree qorannichaa: Taateewwan Infeekshinii, Baakteeriyaa Sababa Dhukkubaa, Profaayilii Saaxilamummaa Farra Maaykiroobiin tahu fi Qabxiilee dhukkubsattoota Dhiiga-dhiqaarra jiran balaaf saaxilu: Qo'annoo fuullee garee giddugala hedduu, Finfinnee, Itoophiyaa.

Qorataa: Mootii Wodaajoo (D.V.M., Kaadhimamaa Digrii Lammaffaa)

Dhaabbata: SPHMMC

Ispoonsara: Jaarmiyaa SPHMMC waliin tumsuun

Dhukkubsattoota dhukkuba kalee sadarkaa dhumaa qabaniif dhiiga-dhiqaa ykn yaala lubbuu baraaruu irratti akka hirmaattu affeeramteetta. Qorannicha irratti murteessitee hirmaachuun dura odeeffannoo bifa armaan gadii jiru hubachuun gaariidha. Sababni isaas mirga kee fi itti gaafatamummaa nuti siif qabnu eera waan ta'eef. Odeeffannoon fi unki hayyamaa kun kaayyoo, qormaata, faayidaa, balaa fi rakkoolee qorannoo kanaan walqabatani ta'uu danda'an of keessaa qaba. Qorannoo kana irratti, mirgi aangoo hirmaachuu fi gadhiisuu akka armaan gadiitti ibsameera. Qorannoo kanaan walqabatee yeroo barbaaddetti gaaffii gaafachuuf mirga qabda. Hirmaannaan kees fedhii keetiini. Yeroo unkaan guutamuus nama kamiyyuu wajjin mari'achuu ni dandeessa. Akkasumas, itti hirmaachuuf ykn dhiisuuf yeroo itti kennuu ni dandeessa.

Kaayyoo qorannichaa

Qorannoon kun as Itoophiyaatti, magaalaa Finfinneetti, dhukkubsattoota wal'aansa dhiiga-dhiqaa fudhatan irratti taatee, sababoota dhukkubaa fi balaa dhukkuba kana qabsiisan qorachuuf kan akeeke dha.

Addatti ammoo qorannichi galmoota armaan gadii qaba:

- Wiirtuuwwan dhiiga-dhiqaa sadan magaalaa Finfinneetti argaman keessatti, saffisni infekshinii dhiigaa fi seepsiisii gama warra dhukkubsattoota dhiigni isaanii dhiqamu biratti maal akka fakkaatu adda baasuuf.
- Gosoota baakteeriyaa infekshinii dhiigaa fi seepsiisii fidan adda baasuuf.

- Baakteeriyaa argame sun qoricha farra baakteeriyaa adda addaatiif saaxilamuu isaa xiinxaluuf.
- Balaa fi haalawwan infekshinii ol’aanaa dhukkubsattoota kana biratti fidan hubachuuf.
- Wiirtuuwwan dhiiga-dhiqaa sadan keessatti Sadarkaan infekshinii, gosti maaykiroobii sababa tahee fi akkaataan ittisni farra maaykiroobii maal akka fakkaatu walbira qabanii ilaaluuf.

Itoophiyaatti, Finfinnee keessatti, agannoon qorannoo kanarraa bahu ba’aa, sababoota fi ittisa infekshinii dhiiga-dhiqaa waliin dhufan irratti hubannoo gatii guddaa qabu kan kennu taha. Ragaan kun gochaalee to’annoo infekshinii fooyyessuuf, itti fayyadama dawa gaarii diriirsuuf, adeemsa sirna qorannoo fooyyeessuuf fi kunuunsa dhukkubsataa guddisuuf ni gargaara.

Dhumarratti, qorannoon kun saffisa infekshinii, dhukkubbii fi du’atii dhukkubsattoota dhiiga-dhiqaa Itoophiyaa keessa jiran hir’isuuf kan akeke dha. Hirmaannaan keessan kaayyoo yaadame galmaan ga’uuf, deetaa barbaachisu maddisiisuuf fi imaammata kunuunsa dhukkubsataaf godhamu bocuuf furtuu dha.

Adeemsa Qorannoo

Qorannoo kana irratti hirmaachuuf yoo murteessitee fi ulaagaa yoo guutte, hojimaata armaan gadii irratti akka hirmaattu si gaafanna:

1. Af-gaaffii: Odeeffannoo seenaa dimogiraafii, seenaa yaalaa, ibsa wal’aansa dhiiga-dhiqaa, itti fayyadama qorichaa fi wantoota barbaachisoo biroo walitti qabuuf af-gaaffiin ni taasifama. Af-gaaffiin kun gaaffiif deebii kan of keessaa qabu yoo ta’u, tilmaamaan daqiiqaa 30-45 kan fudhatu taha.

2. Saamuda walitti qabuu:

- Yeroo infekshiniin shakkamu, saamudni dhiigaa, adeemsa fi sirna qulqulluu fayyadamuun sirraa fudhatama. Ga’eessotaaf dhiigni mililiitrii 10-20tti gara qaruuraa dhiigaatti ni naqama. Daa’immaniif ammo, umurii irratti hundaa’uus, mililiitrii 1-5tti ni fudhatama.
- Yoo kateetira dhiiga-dhiqaa yeroof ta’u qabaatte, fiixeen kateetirichaa erga baafamee booda walitti qabamee xiinxalaaf gara laaboraatooriitti ergama.

- Kutaa dhiiga-dhiqaa keessatti, wantoota madda infekshinii ta'uu danda'an sakatta'uuf meeshaalee irraa, irra-keessa wantootaa fi naannoo isaa irraa jirbii qulqulluudhaan saamudni fudhatamuu ni danda'a.

Saamuda sassaabamuuf ykn qorannoo hojjetamu kanaaf addatti kaffaltiin ati gootu hin jiru. Dhiiga fudhachuuni fi hojimaatni biroo qorannoo kanaan walqabatan bilisaan kennamu.

Hojimaata qo'annoo kana ilaalchisee gaaffii ykn yaada yoo qabaattan hojjetoota qo'annichaa beeksisaa. Hirmaannaan keessan guutummaatti fedhii keessaniini.

Balaa fi Rakkoolee Mudatan

- Yeroo dhiigni fudhatamu, bakki qaamni irraa fudhatame sun miira hin tolle fiduu ykn madaa'uu ykn dhiita'uu danda'a. Akkasumas, carraan dhukkubaan qabamuu ykn yeroof of wallaaluu mudachuu danda'a. Hojjettoonni fayyaa leenji'an balaa kana xiqqeessuuf adeemsaa fi sirna qulqulluun dhiiga ni sassaabu.
- Fiixeen kateetiraa walitti qabamu balaa dabalataa hin fidu. Sababiin isaas, akka qaama kunuunsa dhiiga-dhiqaa tokkootti yeroo hunda waan gatamaniif.
- Sababa jirbii qulqulluun sassaabamuuf, saamudni naannoo irraa sassaabamu, balaa xiqqaa qaba.
- Yeroo dhiiga-dhiqaa keessaniitti, af-gaaffii fi saamuda sassaabuuf, hirmaannaan keessan, turtii yeroo muraasaa ni barbaada. Qisaasa xiqqeessuuf sagantaa dhiiga-dhiqaa keessan waliin qindoominaan ni hojjenna.
- Balaan iccitii odeeffannoo keessanii dhabuu xiqqaa dha. Deetaa fi iccitii keessan eeguuf tarkaanfiiwwan nageenyaa cimaa ni fayyadamna.
- Qorannoon kun hirmaannaa fedhii ofiitiin kan raawwatamu dha. Tarii gaaffiiwwan tokko tokko deebisuuf miira dhabuu si mudachuu danda'a. Gaaffii kamiyyuu deebisuu diduu fi yeroo barbaaddetti dhaabuu dandeessa.
- Balaan ammatti hin beekamne ykn tilmaamamuu hin dandeenye jiraachuu ni mala. Yaada yoo qabaattan yeroo barbaaddanitti garee qorannoo qunnamaa.

Dhiigni erga fudhatame booda miira namatti hin tolle, dhiita'uu, madaa'uu ykn dhimmoota biroo kamiyyuu yoo battalatti agartan hojjetoota qorannichaaf beeksisaa. Kunuunsa ni kennina ykn hakiima kee waliin akka hordoftu si gorsina.

Maaloo balaa ykn rakkoolee mudachuu danda'an ilaalchisee gaaffii ykn yaada biroo yoo qabaattan garee qorannoo gaafadhaa. Hirmaannaan keessan hanga danda'ametti nageenya fi mijataa akka isiniif ta'u gochuuf ni carraaqna.

Faayidaalee

Qorannoo kanaratti hirmaachuudhaan faayidaan ati kallattiin argattu hin jiru. Haa ta'u malee, hirmaannaan kee gara fuulduraatti namoota kaan gargaaruu danda'a.

- Odeeffannoon qorannoo kanarraa argamu, Itoophiyaa fi kutaalee dhiiga-dhiqa kaan keessatti to'annoo fi ittisa infekshinii fooyyessuuf gargaaruu danda'a. Kunis, dhukkubsattoota biroo infekshinii balaafamaa dhiiga-dhiqa wajjin walqabatee dhufu hir'isuu danda'a.
- Hirmaannaan keessan gosoota baakteeriyaa infekshinii fidan haala gaariin hubachuuf, mala adda baasuu fi wal'aansaa fooyyessuuf gumaacha qaba.
- Sababoota balaa adda baasuun dhukkubsattoota balaa guddaa qaban qorachuu fi tooftaawwan to'annoo infekshinii irratti akka xiyyeeffannu ni taasisa.
- Akkaataa ittisa farra maaykiroobii hubachuun gochaalee ajaja farra baakteeriyaa fooyya'oo bocuuf gargaaruu danda'a.
- Walumaagalatti, qorannoon kun imaammata ragaa irratti hundaa'ee qulqullinaa fi nageenya kunuunsa dhiiga-dhiqaa Itoophiyaa keessatti qajeelchuuf kan akeeke dha.

Akka qaama qorannoo kanaatti, bu'aa qorannoo dhiigaa kamiyyuu ykn qorannoo saamuda biroo godhame ni argatta. Kunis, kunuunsa kee gargaaruu danda'a. Haa ta'u malee, bu'aan dhuunfaa kan nama biraa hin kennamu.

Qorannoon kanaratti hirmaachuuf kaffaltiin ykn deebiin hin jiru. Haa ta'u malee, gumaachni keessan kunuunsa dhukkubsataaf, ittisa infekshiniif fi gocha dhiiga-dhiqaa fooyyessuuf deetaa faayidaa guddaa qabu taha.

Maaloo, faayidaa ykn galtee qorannichi argachuu danda'u ilaalchisee gaaffii biraa yoo qabaatte garee qo'annichaa beeksisi. Fedhiin ati hirmaachuuf qabdu dhukkubsattoota biroo dhiiga-dhiqaaf tarreeffaman gargaaruu danda'a.

Beenyaa

Adeemsaa fi sirni qorannoon walqabatu hundi kaffaltii malee siif kennama.

Eegumsa jireenya dhuunfaa keessanii

Iccitii keessan eeguuf waan dandeenyu hunda ni goona. Odeeffannoon galmee yaalaa keessan irraa argame akka iccitii cimaatti ilaalla. Odeeffannoon sun maqaa keetiin osoo hin taane koodiidhaan adda baafama. Sanadoonni maqaan kee itti caqafame qorattoota qorannichaa, doktara kee isa si hordofu fi ogeessa kee isa iccitii kee eegu malee nama kamiifuu hin qoodamu. Unka hayyamaa beekamtii qabu kana mallatteessuudhaan, galmeewwan kee argachuuf kana irratti walii galta.

Argannoon qorannichaa barruulee yaalaa irratti kan maxxanfamu yoo ta’u, kuusaawwan odeeffannoo idil-addunyaa keessatti qoodamuu danda’a. Maqaan kee garuu kuusdeetaa, gabaasa ykn maxxansa qorannoo kana irraa maddu kamiyyuu keessatti hin mul’atu.

Koree naamusaa

Koreen naamusaa Kolleejjii Meedikaalaa Hospitaala Mileniyeemii Qulqulluu Phaawuloosii, Hospitaala Ispeeshaalaayizdii Waliigalaa Minilik 2ffaa fi Hospitaala Yaadannoo Zewdituu qorannoo kana osoo hin jalqabin dura haalduree jiru gamaaggamuun ni raggaasisa. Koreen kun qorannichi karaa qajeellootiin akka raawwatamu gamaaggama itti fufiinsa qabu ni raawwata.

Bu’aan qorannoo barbaachisaa ta’e yeroo argamu, ogeessi fayyaa battalumatti ni beeksifama, yeroo barbaachisaa ta’ees eenyummaa dhukkubsataa hordofuu ni danda’a.

Daayirektoreetii Qorannoo

Daarektoreetiin Qorannoo qindoominaa fi bulchiinsa guutuu gama Kolleejjii Meedikaalaa Hospitaala Mileniyeemii Qulqulluu Phaawuloosii, Hospitaala Ispeeshaalaayizdii Waliigalaa Minilik 2ffaa fi Hospitaala Yaadannoo Zewdituu keessatti jiru ni to’ata, ulaagaa naamusaa fi adeemsi qorannichaa akka kabajamu ni taasisa. Wiirtuuwwan gidduutti qunnamtii ni mijeessa, adeemsa gamaaggamaa, akkasumas ulaagaalee eegumsa deetaa fi iccitii eeguu ni mirkaneessa. Daayirektoreetichi argannoowwan babal’isuuf ni hojjeta. Dhukkubsattoota bu’aan qorannoo isaanii barbaachisaa ta’e adda baasuu fi beeksisuudhaaf ogeeyyii fayyaa waliin qindoomee hojjata.

Hirmaannaa tola ooltummaa

Qorannoo kanaratti hirmaannaan kee guutummaatti fedhii keetiini. Hirmaannaan kee filannoo kee irratti hundaa'a. Qorannicha irratti hirmaachuu fi hirmaachuu dhiisuu kee tajaajila hospitaala irraa argattu irratti dhiibbaa tokkollee hin qabu. Unka hayyamaa erga mallatteessitee boodas yeroo barbaaddetti qorannoo irraa ba'uuf mirga guutuu qabda. Qaama qorannichaa ta'uu irraa dhaabuu akka barbaaddu sababa dhiheessuun si hin barbaachisu.

Gaaffii yoo qabaattan nama qunnamtan

Waa'ee hirmaannaa qorannoo kanaratti qabdu ilaalchisee gaaffii yoo qabaatte ykn sababa qorannichaan miidhaan sirra ga'eera jettee yoo yaadde, qorataa kan odeeffannoon quunnamtii isaa armaan gaditti kenname qunnamuu ni dandeessa.

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Hiwoot Laggasa (Narsii Olaantuu)	+251912659961	

I.Unka Hayyamaa

Mata duree qorannichaa: Taateewwan Infeekshinii, Baakteeriyaa Sababa Dhukkubaa, Profaayilii Saaxilamummaa Farra Maaykiroobiin tahu fi Qabxiilee dhukkubsattoota Dhiiga-dhiqaarra jiran balaaf saaxilu: Qo’annoo fuullee garee giddugala hedduu, Finfinnee, Itoophiyaa

Hirmaataa ykn bakka bu’aa seeraa qofaaf

Hubadheera, waa’een qorannichaas naaf eerameera. Waraabbiin waraqaa beekamti qabu kun naaf kennama.

Qorannoon kun afaan salphaa fi ifa ta’een odeeffannoo gahaa wajjiin naaf ibsameera. akkan hubadhuu fi gaaffii gaaffuuf, yeroo gahaan naaf kennameera. Kanaafis, deebii quubsaa argadheera. Qaama qorannichaa ta’ee hojiiwwan qorannichaa irratti tumsuuf fedhii qaba. Seenaa yaalaa koo, qorannoo fayyaa ilaalchisee odeeffannoo jiru kennuu fi saamuda dhiigaa kennuu irratti hirmaachuuf fedhii qaba. Erga hayyama beekumsa qabu kana mallattessee boodas, yoon hirmaachuu koo addaan kutuu barbaade, kana gochuu akkan danda’u nan beeka. Doktorri koo fi ogeeyyiin fayyaa biroo qorannoo kana keessatti hirmaatan waa’ee hirmaannaa koo baruusaanii walii gala.

☐

Eeyyee

☐

Lakki

Hirmaataan kan xumuramu

Guyyaa:

Maqaa hirmaataa:

Mallattoo (ykn qubbee harkaa) hirmaataa:

Hubachiisa: Ashaaraan qubaa mallattoo bakka bu'a, hirmaattoota dubbisuu fi barreessuu hin dandeenyeef (ragaa wajjin) qofa.

Guddiftuu seera-qabeessa hirmaataatiin kan guutamu (Umurii waggaa 0-18 kan ta’eef)

Guyyaa:

Maqaa guddiftuu seeraa:

(Yoo guddiftuu 'seera qabeessaa' hin jirre, hariiroo guddiftuun hirmaataa wajjin qabdu asittillee gaafachuuf yaaluu)

Mallattoo (ykn qubbee harkaa) guddiftuu seeraa:

Hubachiisa: ashaaraan qubaa mallattoo bakka bu'a, yoo guddiftuun seeraa dubbisuu fi barreessuu hin dandeenye qofa (ragaa wajjin)

Ragaan kan guutamu (yoo hirmaataan / guddiftuun seeraa dubbisuu fi barreessuu hin dandeenye)

Guyyaa:

Maqaa ragaa: Mallattoo ragaa:

Hubachiisa: Hirmaataan (ykn guddiftuun seeraa) dubbisuu fi/ykn barreessuu yoo dadhabe, yeroo marii hayyama beekumsa qabu irratti ragaan loogii hin qabne argamu qaba. Unkaan hayyama odeeffannoo barreeffamaan qophaa'e erga dubbifamee hirmaataaf ibsamee fi erga qo'annicha irratti hirmaachuuf afaaniin hayyama erga kennee booda, akkasumas ashaaraa qubaa erga kennee booda, ragaan maqaa hirmaataa guutuu, guyyaa ashaaraa qubaa itti dabaluu, fi mallatteessuu, fi dhuunfaan unka hayyamaa guyyaa itti murteessuu. Unka hayyamaa mallatteessuudhaan, ragaan odeeffannoon unka hayyamaa keessa jiruu fi odeeffannoon barreeffamaa biroo kamiyyuu sirritti akka ibsame, fi hirmaataa (ykn guddiftuu seeraatiin hubatame), akkasumas hayyamni odeeffannoo qabu bilisaan akka kenname mirkaneessa.

Nama hayyama beekumti qabu argateen kan guutamu

Ani, kan armaan gaditti mallatteesse, qorannoo kana irratti hirmaataa hirmaachisisuuf ibsa ga'aa barbaachisoo ta'an eeruu koo nan mirkaneessa. Qorannicha irratti hirmaataan fedhii isaatiin hirmaachuuf hayyamamuu isaas nan mirkaneessa.

Guyyaa: Mallattoo:

V. A Structured, an Interviewer Administered Questionnaires

In this study, we employ questionnaires tailored for hemodialysis patients, utilizing the Kobo Toolbox for efficient digital dissemination and collection. This approach ensures the gathering of comprehensive, structured data through a detailed interview process, designed to capture personalized and accurate information from participants. This methodology underscores our commitment to precision in data collection, specifically catering to the unique needs of the hemodialysis patient population.

Socio-Demographics of Participants

Study center: _____ Date of interview: _____

Name of interviewer: _____ Name of Data Collector: _____.

Study ID: _____ MRN: _____ Accession Code: _____

Inpatient: _____ Outpatient: _____ Current ward: _____

Address: _____ Cellphone number: _____

Region: _____ Zone: _____ Woreda: _____

Age in years: _____ Sex: Male _____ Female _____

Education level: _____ Employment status: _____

Annual household income: _____ Marital status: _____ Occupation: _____

Does the patient meet the criteria of inclusion? Yes _____ No _____

Kidney Disease History

1. What was the primary cause of your kidney failure? (Glomerulonephritis, Diabetes, other)
2. Do you have any other Co-morbid conditions (chronic illnesses)? (Diabetes, HTN, other)
3. How long have you been on dialysis? (< 6 months, 6-12 months, 1-2 years, 3-5 years, > 5years)
4. What type of dialysis are you currently receiving? (In-center/ Home HD, Peritoneal Dialysis)
5. How often do you receive dialysis treatments? (2x, 3x, 4x, 5x per week)
6. What is your blood flow rate for treatments? (<300, 300-400, >400 mL/min)

7. How long are your dialysis sessions? (1.5, 3, 4, 5+ hours)
8. What symptoms led to starting dialysis? (Body swelling, low urine production, other)
9. What diagnostic tests were done? (Blood, Urine, Imaging, Biopsy)
10. Are you on a fluid restriction? (Yes/No) Amount?
11. How many days a week do you stay within your fluid restriction? (0, 1-2, 3-4, 5-6, everyday)
12. Are you on a renal diet? (Yes/No)
13. How is your appetite? (Poor, Fair, Good, Very Good)
14. Do you have dialysis care assistance? (Yes/No) Type?
15. What kind of help do they provide? (Transportation, meals, medication management)

Acute Kidney Injury Status

1. Are you recovering kidney function? (Yes/No)
2. What diagnostic tests were done? (Blood, Urine, Imaging, Biopsy)
3. What was your initial AKI treatment? (Dialysis/No dialysis)
4. What additional AKI treatments did you receive? (Medications, lifestyle changes)

Chronic Kidney Disease Transplant Status

1. Have you been assessed for transplant? (Yes/No)
2. What was the transplant assessment result? (Eligible, Ineligible, Not yet assessed)
3. If transplanted, when did you receive transplant? (Date)

Family History

1. Family history of kidney disease? (Yes/No)
2. If yes, what is your relation? (Spouses, Parent, Siblings, Grandparents, other)

Dialysis Adequacy

Pre-Dialysis		Post-Dialysis	
Blood pressure in mmHg		Blood pressure in mmHg	
Pulse rate in bpm		Pulse rate in bpm	
Temperature in °C		Temperature in °C	
Respiratory rate in bpm		Respiratory rate in bpm	
Weight in kg		Weight in kg	

Additional values			
Height in m?		What is your recent hematocrit level?	
What is your recent hemoglobin level?		What is your recent Kt/V value?	

Laboratory Findings

a. Diagnostic Testing

1. Have you had kidney function lab tests? (Yes/No)
2. If yes, check all that apply (GFR, BUN, Creatinine, Albuminuria)
3. Have you had a kidney biopsy? (Yes/No)
4. When was your most recent biopsy? (Past (3, 3-6, 6-12) months, (1-2, >2) years ago)
5. What was the reason for biopsy? (Unexplained failure, Proteinuria, Monitor status)
6. What was determined from the biopsy? (Severity/stage of kidney disease, other)
7. What disease stage was indicated? (Stages 1-5)
8. Did your treatment change base on biopsy results? (Yes/No)
9. Do you regularly check lab values? (Yes/No)

b. Infection History and Microbiological Tests

1. Diagnosed with infection on dialysis? (Yes/No)
2. Types of infection experienced? (Bloodstream, Access site, Peritonitis)
3. What type of vascular access do you use for hemodialysis treatments? (AVF, AVG, CVC)
4. Has blood sample been taken to check for infection since starting hemodialysis (Yes/No)
5. If yes, could you tell us from which site they were drawn? (Access site, Peripheral vein)
6. How many culture bottle sets collected? (1, 2, 3+)
7. Was an organism identified in culture? (Yes/No)
8. Days for culture to become positive? (<24, 24-48, >48 hours)
9. What organisms were identified? (*Staph*, *Strep*, Gram-negative)
10. Other microbiology tests done? (Urine, Sputum, Tissue, Wound cultures)
11. Was an antibiotic sensitivity panel done? (Yes/No)
12. Was organism (sensitive, intermediate, resistant to antibiotics, not reported)?
13. Did treatment include antimicrobials? (Yes/No)
14. Were infection control measures enhanced? (Yes/No)

VI. Amharic Version Questionnaire

የጥናት ቃለ-መጠይቅ ቅጽ

ይህ የጥናት ቃለ-መጠይቅ ለደም እጥበት ታካሚዎች የተዘጋጀ ሲሆን ለተቀላጠፈ የመረጃ ስብስብና ስርጭት “ኮቡቱልቦክስ” የተሰኘን የዲጂታል መተግበሪያ የምንጠቀም ይሆናል። ይህ አካሄድ ከጥናቱ ተሳታፊዎች ዝርዝር ባለ መጠይቆች ትክክለኛ ግላዊ መረጃና የተዋቀረ አጠቃላይ ሰነድን ለመያዝ የተነደፈ መሆኑን ያመለክታል። ጥናታዊ መረጃን ለመሰብሰብ በእንዲህ አይነት መልኩ መሥራታችን ለጥናቱ ያለንን ተነሳሽነት የሚያሳይ ሲሆን በተለይም ለደም እጥበት ታካሚዎች ልዩ ፍላጎታቸውን ለማሟላት ዘንድ ያለንን ቁርጠኝነት ያጎላል።

የማህበራዊና ተፈጥሮአዊ መስተጋብር መረጃዎች

የጥናቱ ማዕከል _____ የቃለ-መጠይቁ ቀን _____

የጠያቂው ስም _____ የናሙና ሰብሳቢ ስም _____

የተሳታፊው ልዩ መታወቂያ _____ የህክምና መዝገብ ቁጥር _____ የላብራቶሪ ኮድ _____

ታካሚ _____ ተመላላሽ ታካሚ _____

አሁን ያለበት የህክምና ክፍል _____ ቀደም ሲል የነበሩበት የህክምና ክፍል ካለ _____

አድራሻ _____ የሞባይል ስልክ ቁጥር _____ ክልል _____ ዞን _____ ወረዳ _____

ዕድሜ (በዓመት ስሌት) _____ ፆታ፣ ወንድ _____ ሴት _____

የትምህርት ደረጃ _____ የቅጥር ሁኔታ _____

ዓመታዊ የቤተሰብ ገቢ _____ የጋብቻ ሁኔታ _____ ሥራ _____

ታካሚው በጥናቱ ውስጥ ለማካተት መስፈርቱን ያሟላል ? (አዎ/አይ)

የኩላሊት በሽታ ታሪክ

1. ከባድ የኩላሊት ህመምህ/ሽ መንስኤ ምን ነበር? (ግሎሜሩሎኔፍራይቲስ፣ የስኳር በሽታ፣ ሌሎች)
2. ሥር የሰደዱ ሌሎች በሽታዎች ካሉህ/ሽ ይጠቀስ (የስኳር በሽታ፣ የደም ግፊት፣ ሌሎች)
3. ለምን ያህል ጊዜ ደምህ/ሽ ሲታጠብ ነበር? (ከ6ወር በታች፣ ከ6-10 ወር፣ ከ1-2 ዓመት፣ ከ3-5 ዓመት፣ ከ5 ዓመት በላይ)
4. በአሁኑ ጊዜ ምን ዓይነት የእጥበት ዘዴ እያገኘህ/ሽ ነው? (በማዕከል/በቤት ውስጥ የሚሰጥ የደም እጥበት፣ ፔሪቶኒያል እጥበት)
5. በሳምንት ምን ያህል ጊዜ የደም እጥበት ህክምናዎችን ታገኛለህ/ሽ? (2፣3፣4፣5 ጊዜ)
6. ለህክምናው የደም ፍሰትህ/ሽ መጠን በደቂቃ ስንት ነው? (ከ300 ሚሊ ሊትር በላይ፣ ከ300-400፣400 ሚሊ ሊትር በላይ)
7. የአንተ/አንቺ የደም እጥበት ክፍለ ጊዜዎች ለምን ያህል ሰዓት ነው? (1 ከግማሽ፣ 3፣4፣5+)
8. የኩላሊት (የደም) እጥበት እንድትጀምር/ሪ ያደረጉህ/ሽ ምልክቶች ምንድን ናቸው? (የሰውነት እብጠት፣ የሽንት መጠን መቀነስ፣ ሌሎች)
9. ምን አይነት የህክምና ምርመራዎች ተደርጓል? (የደም፣ የሽንት፣ የራጅ፣ ባዮፕሲ)
10. ፈሳሽ ከመውሰድ ተቆጥበዋል? (አዎ/አይ)። አዎ ከሆነ መጠኑ ይገለጽ።_____
11. ፈሳሽ ሳትወስድ/ጂ በሳምንት ለምን ያህል ቀን ትቆያለህ/ያለሽ? (0,1,2,3,4,5,6 በየቀኑ)
12. ለኩላሊትህ/ሽ ተስማሚ የሆኑ ምግቦችን እየተመገብክ/ሽ ነው? (አዎ/አይ)
13. የምግብ ፍላጎትህ/ሽ እንዴት ነው? (የለኝም፣ መጠነኛ፣ ጥሩ፣ በጣም ጥሩ)
14. በደም እጥበት ወቅት እርዳታና እንክብካቤ የሚያደርግልህ/ሽ አለ/ች (አዎ/አይ)። ካለ ይተይቡ_____
15. ምን አይነት እርዳታና እንክብካቤ ታገኛለህ/ኚያለሽ? (ትራንስፖርት፣ ምግብ፣ መድኃኒት)

አጣዳፊ የኩላሊት ጉዳት ሁኔታ

1. ከአጣዳፊ የኩላሊት ጉዳት እያገገምክ/ሽ ነው? (አዎ/አይ)
2. ምን ዓይነት የምርመራ ዓይነት ተደርጎልሃል/ሻል? (የደም፣ የሽንት፣ የራጅ፣ ባዮፕሲ)
3. ለአጣዳፊ የኩላሊት ጉዳት የተደረገልህ/ሽ ህክምና ምን ነበር (የደም እጥበት ተደርጎልኛል/አልተደረገልኝም)
4. ያገኘህ/ሽ ተጨማሪ ህክምናዎች ጥቀስ (መድኃኒት፣ የአኗኗር ዘዴ ለውጦች)

ሥር ለሰደደ የኩላሊት በሽታ የንቀለ ተከላ ሁኔታ

1. የኩላሊት ንቀለ ተከላ እንዲደረግ ዘንድ ተገምግመሃል/ሻል? (አዎ/አይ)
2. የንቀለ ተከላ ግምገማ ውጤቱ ምን ነበር? (ብቁ፣ ብቁ ያልሆነ፣ ገና ያልተገመገመ)
3. ንቀለ ተከላ ተደርጎልህ/ሽ ከሆነ መቼ ነበር የሆነው? (ቀንና ዓ/ም)

የቤተሰብ ታሪክ

1. በቤተሰብህ/ሽ ውስጥ የኩላሊት በሽታ ያለበት/ያለባት አለ? (አዎ/አይ)
2. አዎ ከሆነ ዝምድናህ /ሽ ምንድን ነው ? (ባል/ሚስት፣ ወላጆች፣ እህት፣ ወንድም፣ አያት፣ ሌሎች)

ብቁ የህክምና እጥበት ሁኔታ

ቅድመ ደም እጥበት		ድህረ ደም እጥበት	
የደም ግፊት መጠን በ 'mmHg'		የደም ግፊት መጠን በ 'mmHg'	
የልብ ምት መጠን በ'bpm'		የልብ ምት መጠን በ'bpm'	
የሰውነት ሙቀት መጠን በ °C		የሰውነት ሙቀት መጠን በ °C	
የትንፋሽ መጠን በ'bpm'		የትንፋሽ መጠን በ'bpm'	
ተጨማሪ ልኬቶች			
ቁመት በሜትር		የቅርብ ጊዜ የሄሞጥክሪት መጠን	
የቅርብ ጊዜ የሄሞግሎቢን መጠን		የቅርብ ጊዜ ኬቲ/ቪ መጠን	

የላብራቶሪ ግኝቶች

ሀ. የምርመራ ውጤቶች

1. የኩላሊት ተግባር መገምገሚያ የላብራቶሪ ምርመራዎች አድርገሃል/ሻል? (አዎ/አይ)
2. አዎ ከሆነ የትኞቹ ናቸው? (ጂኤፍአር፣ ቢዩኤን፣ ኪሬቲኒን፣ አልቡሚኑሪያ)
3. የኩላሊት ባዮፕሲ ተደርጎልሃል/ሻል? (አዎ/አይ)
4. የቅርብ ጊዜ ባዮፕሲህ/ሽ መች ነበር? (ያለፉት 3 ወራት፣ ከ3-6 ወራት፣ ከ6-12 ወራት፣ 1-2 ዓመት፣ ከ2 ዓመት በፊት)
5. ባዮፕሲው የተደረገበት ምክንያት ምን ነበር? (ያልታወቀ ከባድ የኩላሊት ህመም፣ ፕሮቲኑሪያ፣ የክትትል ሁኔታ)
6. ከባዮፕሲው ውጤት ምን ተወሰነ? (የኩላሊት ሕመም ደረጃዎች፣ ሌላ)

7. የኩላሊት ህመም ደረጃው ስንት ነው? (1-5)
8. የህክምና አሰጣጥ ሁኔታ ከባዮፕሲው ውጤት በኋላ ተቀይሯል? (አ/አይ)
9. የላብራቶሪ ምርመራዎችን ውጤት ለማወቅ በየጊዜው ትመረመራለህ/ትመረመሪያለሽ (አ/አይ)

ለ. ኢንፌክሽን ታሪክ እና የማይክሮባሎጂ ምርመራዎች

1. በደም እጥበት ወቅት ኢንፌክሽን ተከስቶብህ/ሽ ያውቃል? (አ/አይ)
2. ምን አይነት ኢንፌክሽን ነበር? (የደም ዝውውር፣ የደም እጥበት ቱቦ ጫፍ፣ ፔሪቶናይቲስ)
3. ለደም እጥበት ምን አይነት የደም ቧንቧ ተደራሽ ተደርጓል? (የተገናኘ የደም ሥር ፊስቱላ/ግራፍት፣ ካቴተር)
4. የደም እጥበቱ ከተጀመረ አንስቶ ከተከሰተ ኢንፌክሽን የደም ናሙና ተወስዷል? (አ/አይ)
5. አዎ ከሆነ፣ ከየትኛው የአካል ክፍል/ቦታ ላይ ነው የተወሰደው? (ከአክሰስ፣ ከደም መላሽ ደም ስር ጫፍ)
6. ናሙናው በስንት የደም ብርጭቆ ተሰበሰበ? (1,2,3+)
7. በደም ናሙናው በሽታ አምጪ ህዋስ ተገንቷል? (አ/አይ)
8. የደሙን ናሙና በሽታ ውጤት ለማየት ስንት ሰዓታት ፈጀ? (ከ24 ሰዓት በታች፣ ከ24-48፣ ከ48 ሰዓታት በላይ)
9. ምን አይነት በሽታ አምጪ ህዋስ ተለየ? (ስትሬፕቶኮክስ፣ ስታፍሎኮክስ፣ ግራም ኔጌቲቭ)
10. ሌሎች የማይክሮባሎጂ ምርመራዎች በየትኛው ዓይነት ተደርጉ? (በሽንት፣ በአክታ፣ በቲሹ፣ በቁስል ናሙና)
11. የተለየው ህዋስ ለመድኃኒት ያለው የተጋላጭነት ዝንባሌ ተሰርቷል? (አ/አይ)
12. የተለየው ህዋስ ለመድኃኒት ያለው ዝንባሌ? (ተጋላጭ፣ መካከለኛ፣ የተለመደ)
13. የወሰድከው/ሽው የኩላሊት ፀረ-ጀርም መድኃኒቶችን ያጠቃልላል? (አ/አይ)
14. የኢንፌክሽን ቁጥጥር ስርዓቱ የተሻሻለ ነገር አለው? (አ/አይ)

VII. Afaan Oromoo Version Questionnaire

Gaaffii Caasaa Dhukkubsattoota Dhiiga-dhiqaa

Qorannoon kun, gaaffilee dhukkubsattoota dhiiga-dhiqaa irratti kan xiyyeeffatu yagguu tahu, adeemsa turtii gaaffiif deebii mijeessuuf aplikeeshinii “Koobootuulbooks” jedhamu fayyadamna. Malli kun adeemsa af-gaaffii bal’aa, odeeffannoo dhuunfaa fi sirrii ta’e hirmaattoota irraa sassaabuuf kan qophaa’ee dha. Odeeffannoo sassaabuuf haala akkasiin sirriitti hojjachuun keenyas, kutannoo qabnu kan hubachiisu yoo tahu, addatti immoo fedhii dhukkubsattoota dhiiga-dhiqaa kan guutu dha.

Hawaas-Dimoogiraafii Hirmaattotaa

Giddugala qorannoo: _____ Guyyaa af-gaaffii: _____

Maqaa gaafataa: _____ Maqaa sassaabaa saamudaa: _____.

Koodii Qorannoo: _____ MRN: _____ Koodii Miseensummaa: _____ .

Dhukkubsataa mana yaalaa keessa jiru: _____ Dhukkubsataa

mana yaalaa ala jiru: _____ Kutaa amma jiru: _____ .

Teessoo: _____ Lakkoofsa bilbila harkaa: _____

Naannoo: _____ Zoonii: _____ Aanaa: _____ .

Umurii waggaadhaan: _____ Saala: Dhiira _____ Dubartii _____ .

Sadarkaa barnootaa: _____ Haala hojii: _____

Galii maatii waggaa: _____ Haala gaa’elaa: _____ Hojii: _____ .

Wal’aanamaan ulaagaa hammatamuu ni guutaa? Eeyyee _____ Lakki _____ .

Seenaa Dhukkuba Kalee

1. Sababni guddaan kalee kee dadhabsiise maali? (Glomerulonephritis, Sukkaara, kan biraa)
2. Dhukkuboota biroo bubbule qabdaa? (Sukkaara, Dhiibbaa dhiigaa, kan biraa)
3. Hangamiif dhiiga-dhiqaa fudhattee? (< ji'a 6 , ji'a 6-12 , waggaa 1-2 , waggaa 3-5 , > waggaa 5)
4. Ammaan kana gosa dhiiga-dhiqaa akkamii fudhatta? (HD-Giddugaleessatti / manatti, PD)
5. Torbanitti yeroo meeqa wal'aansa dhiiga-dhiqaa argatta? (2x, 3x, 4x, 5x)
6. Wal'aansaaf saffisni dhiiga keetii meeqa? (mL <300, 300-400, >400 /daqiiqaan)
7. Yeroon dhiiga-dhiqaa keetii hangam dheerata? (sa'aatii 1.5, 3, 4, 5+)
8. Mallattoo dhukkuba dhiiga-dhiqaaf sababa tahu? (Dhiitoo qaamaa, fincaan xiqqaachuu)
9. Qorannoon adda-baasuu godhame? (Dhiiga, Fincaan, Raajii, Baayoopsii)
10. Lagannaa dhangala'aa irra jirtaa? (Eeyyee/Lakki). Eeyyeen yoo tahe, hangami?
11. Torbanitti guyyoota meeqaaf dhangala'aa lagattaa? (0, 1-2, 3-4, 5-6, guyyaa guyyaan)
12. Nyaata Kaleef tahu fudhachaa jirtaa? (Eeyyee/Lakki)
13. Fedhiin nyaataa keetii akkami? (Yaraa, Fooyyee, Gaarii, Baay'ee Gaarii)
14. Yeroo dhiiga-dhiqaa, qaama si gargaaru fi kunuunsu qabdaa? (Eeyyee/Lakki) Gosa isaa ibsi?
15. Gargaarsa akkamii siif godhu? (Geejjiba, nyaata, kanniinsa qorichaa) .

Haala Miidhaa Cimaa Kalee

1. Kaleen kee dandamachaa jiraa? (Eeyyee/Lakki)
2. Qorannoon adda-baasuu godhame kami? (Dhiiga, Fincaan, Raajii, Baayoopsii)
3. Wal'aansi miidhaa cimaa kalee jalqabaa maal ture? (Dhiiga-dhiqaa/Dhiiga-dhiqaa hin qabu) .
4. Wal'aansa dabalataa AKI akkamii argatte? (Qoricha, jijjiirama akkaataa jireenyaa) .

Haala Jijjiirraa Dhukkuba Kalee Yeroo Dheeraa

1. Qaama jijjiirrachuudhaaf madaalamteettaa? (Eeyyee/Lakki)
2. Bu'aan madaallii qaama jijjiirrachuu maal ture? (Ulaagaa kan qabu/kan hin qabne, kan biraa)
3. Yoo kalee jijjiirratte, yoom ture? (Gyyaa isaa ibsi)

Ga'umsa dhiiga-dhiqaa

Dhiiga-dhiqa Dura		Dhiiga-dhiqa Booda	
Dhiibbaa dhiigaa, mmHg		Dhiibbaa dhiigaa, mmHg	
Saffisa dhahannaa onnee, bpm		Saffisa dhahannaa onnee, bpm	
Ho'a qaamaa, °C		Ho'a qaamaa, °C	
Saffisa sirna hargansuu, bpm		Saffisa sirna hargansuu, bpm	
Ulfaatina qaamaa, kg		Ulfaatina qaamaa, kg	
Gatii safartuu dabalataa			
Hojjaa / dheerina, m		Sadarkaan hematocrit dhihoo	
Sadarkaan himoogilobiinii dhihoo		Gatiin Kt/V dhiheenya kanaa maali?	

Seenaa Maatii

1. Maatii keessaa, namni seenaa dhukkuba kalee qabu jiraa? (Eeyyee/Lakki)
2. Yoo eeyyee ta'e hariiroon keessan? (Haadha warraa, Warra, Obbolaa, Akaakayyuu, kan biraa)

Argannoo Laaboraatoorii

a. Qorannoo

1. Dalagaa kalee hubachuuf, qorannoo mana yaalaa argateettaa? (Eeyyee/Lakki)
2. Yoo eeyyee ta'e, kanneen ilaallatu hunda fili. (GFR, BUN, Creatinine, Albuminuria) .
3. Baayoopsiin kalee keetiif raawwatameeraa? (Eeyyee/Lakki)
4. Baayoopsichi dhiheenya kana yoom godhame? (Waggaa 3, 3-6, 6-12, 1-2, >2 dura darbe)
5. Sababni baayoopsii maal ture? (Kufaatii hin ibsamne, prootini fincaan keessaa, kan biroo)
6. Argama baayoopsii irraa maaltu murtaa'e? (Sadarkaa dhukkuba kalee, kan biroo)
7. Sadarkaan dhukkubichaa meeqaffaa ture? (Sadarkaa 1-5) .
8. Bu'aa baayoopsii irratti hundaa'uun wal'aansi kee jijjiiramee? (Eeyyee/Lakki)
9. Yeroo hunda gatiiwwan qorannoo keetii mana yaalaatti ni sakatta'aamaa? (Eeyyee/Lakki)

b. Seenaa Infeekshinii fi Qorannoo Maaykiroobaayoloojii

1. Dhiiga-dhiqaa irratti infekshiniin qabamuu kee adda bahee turee? (Eeyyee/Lakki)
2. Gosoota infekshinii mudate? (Dhiiga, Bakka Dhaqqabummaa, kan biroo)
3. Wal'aansa dhiiga-dhiqaatiif gosa isa kam fayyadaman? (AVF, AVG, CVC)

4. Erga dhiiga-dhiqaa as infekshinii qorachuuf saamudni dhiigaa fudhatamee? (Eeyyee/Lakki) .
5. Yoo eeyyee ta'e, marsariitii kamirraa fudhatame? (Argamarraa, Ujummoo fiixeerraa) .
6. Tuuta qaruuraa meeqatu walitti qabame? (1, 2, 3+) .
7. Orgaanizimiin adda baafamee turee? (Eeyyee/Lakki)
8. Sa'aatiin kaalcharii hangamiif tura? (<24, 24-48, >sa'aatii 48)
9. Orgaanizimoota kamtu adda bahe? (Staph, *Strep*, Graam-negaatiivii)
10. Qormaata maaykiroobaayoloojii biroo hojjetame? (Fincaan, Tishuu, Madaa) .
11. Paaneliin miira antibaayootikii hojjetamee turee? (Eeyyee/Lakki)
12. Orgaanizimiin; (miira qabeessa, giddugaleessa, antibaayootikii dandamatu, hin gabaafamne)?
13. Wal'aansi kee qoricha farra maaykiroobii of keessaa qabaa? (Eeyyee/Lakki)
14. Tooftaawwan to'annoo infekshinii fooyyaa'aaniiruu? (Eeyyee/Lakki)

VIII. Data Collection and Microbiology Procedures

Data Collection Tools

To ensure a comprehensive data collection process, two primary instruments were employed: a structured questionnaire administered through KoBo Toolbox and a dedicated microbiological analysis form.

The questionnaire, which underwent pretesting at the SPHMMC facility to ensure its accuracy and uniformity, was designed to gather a wide range of data. This included socio-demographic information such as age, sex, marital status, educational level, occupation, and place of residence. Additionally, detailed clinical data were collected, encompassing the primary etiology of kidney failure, existing comorbidities, the frequency of dialysis treatments, the type of vascular access used, and the patient's medication history. Key parameters for assessing dialysis adequacy, including pre- and post-dialysis blood pressure, weight, pulse rate, and Kt/V values, were systematically recorded. The questionnaire also captured variables relevant to BSI, such as the presence of fever, sepsis, previous exposure to antibiotics, and any history of vascular access replacements.

Sample Collection

Clinical Specimen Procurement: The collection of clinical specimens was guided by established best practices for the diagnosis of BSIs. Upon clinical suspicion of infection or sepsis, blood

samples were procured for culture using aseptic techniques. The site of collection depended on the patient's vascular access, which included an arteriovenous fistula (AVF), an arteriovenous graft (AVG), a permanently tunneled central venous catheter (PT-CVC), or a temporary non-tunneled central venous catheter (TNT-CVC). For patients with a CVC, blood was typically drawn directly from the catheter and concurrently from a peripheral venipuncture site, such as a right arm peripheral vein (RAPV) or left arm peripheral vein (LAPV), to investigate BSIs. For patients with an AVF or AVG, blood samples were aseptically collected via direct venipuncture of the arterial needle insertion site immediately before the HD session began, a critical step to ensure the specimen represented the patient's systemic state and was not drawn from, or potentially contaminated by, the extracorporeal dialysis circuit. The standard procedure for adult and adolescent patients involved the collection of 16-20 mL of whole blood, which was then distributed equally between two aerobic culture bottles. As the youngest patient encountered and recruited for the study in the ward was 12 years old, there was no pediatric case below this age, and hence there was no data available for the demographic group. A specialized protocol was implemented for suspected infective endocarditis, requiring three separate blood draws to maximize the probability of pathogen recovery: two blood culture bottles were collected simultaneously from distinct anatomical sites, and a third was drawn one hour thereafter.

A primary objective of the research proposal was the concurrent collection of catheter tips and blood cultures to identify potential BSIs. However, the practical execution of this objective was severely constrained by the clinical realities of the study environment. The routine removal of indwelling catheters for surveillance purposes was not feasible. Clinicians typically opted to preserve existing vascular access until an AVF became functional or until blood culture results could guide intervention. This clinical judgement was further influenced by systematic factors, including staffing limitations, the desire to minimize patient discomfort, and the scarcity of alternative vascular access points. As a result of these deferrals, only a single catheter tip specimen was obtained during the study period. This specimen, consisting of an approximately 5 cm distal segment, was aseptically excised from an ICU patient and transported to the laboratory in a sterile Falcon tube for subsequent culture. This significant deviation from the initial research plan has been documented and is acknowledged as a limitation imposed by the operational dynamics within high-acuity dialysis units in a resource limited setting.

Environmental and Water Samples Collection: A biannual environment surveillance program was implemented to identify potential microbial reservoirs within the clinical environment. Sampling was conducted on two separate dates: May 21, 2024, and November 1, 2024. The surveillance targeted both high-contact surfaces and critical water sources.

Surface samples were obtained from patient beds, dialysis chairs, and healthcare worker gowns using sterile cotton swabs pre-moistened with normal saline to maximize microbial recovery. To evaluate the microbiological quality of the water used for dialysis, 100 mL samples were collected from two key points: the terminal water lines supplying the dialysis machines and the hospital's central water treatment unit. At the SPHMMC center, the sampling protocol was augmented to include the water system of the transplant ward, with samples taken from both its treatment unit and distribution line. For transport, swabs were secured in Amies transport medium, while water samples remained in their sterile collection bottles. All specimens were transferred to the microbiology laboratory without delay to ensure the preservation and viability of the microorganisms.

Transportation and Laboratory Accessioning

To guarantee both personnel safety and specimen viability during transit, a standardized transport protocol based on the Triple Packaging System was strictly followed. Each sample was enclosed within a sealed primary container, which was then placed inside a secondary container lined with absorbent material to contain any potential leakage. This was secured within a durable, rigid outer casing for physical protection.

Upon arrival to the laboratory, specimens were formally accessioned, which included logging receipt, applying unique laboratory labels, and prioritizing for immediate processing. Blood culture bottles were entered into an incubation phase at 37°C, where they were continuously monitored for a maximum of 7-days. And bottle demonstrating macroscopic evidence of microbial proliferation, such as visible turbidity or gas production, was flagged as presumptively positive and sub-cultured onto appropriate media. Bottles that showed no signs of growth by the conclusion of the 7-day incubation period were officially reported as negative and decontaminated prior to disposal in accordance with established biosafety protocols.

Microbiological Culture, Isolation, and Interpretation

Presumptively positive blood cultures were sub-cultured onto a panel of solid media, including Blood Agar (BAP), Chocolate Agar (CAP), and MacConkey Agar (MAP). BAP was utilized for the isolation of non-fastidious organisms and to assess hemolytic patterns, categorized as α -hemolysis (partial lysis, greenish zone), β -hemolysis (complete lysis, clear zone), or γ -hemolysis (no lysis). CAP, containing lysed red blood cells that provide hemin (X factor) and NAD (V factor), was included to facilitate the recovery of fastidious organisms. MAP was used for the selective isolation and differentiation of Gram-negative bacteria based on their ability to ferment lactose, indicated by pink or red colonies resulting from a pH drop below 6.8. BAP and CAP plates were incubated aerobically at 37°C in a 5% CO₂ candle jar for 24-48 hours, while MAP plates were incubated for 18-24 hours. While plates showing no growth were discarded after 24 hours, the original blood culture bottles were retained and monitored for up to seven days to capture slow-growing pathogens.

The distal segment of the catheter tip was rolled directly across the surfaces of BAP, CAP, and MAP, which were then incubated under the same conditions. Similarly, environmental swabs were streaked onto this same trio of media. Water samples underwent a concentration step, wherein 100 mL was passed through a 0.45 μ m sterile membrane filter. The filter was then enriched in Tryptic Soy Broth (TSB) for two hours before being cultured on MacConkey Agar and incubated at 37°C for 18-24 hours. The use of MAP for water analysis, rather than the FSSAI's standard recommendation of using Chromogenic Coliform Agar (CCA) and Violet Red Bile Lactose (VRBL), was a methodologically justified on its validation as a cost-effective alternative suitable for low-resource laboratory settings.

Following incubation, all plates were visually inspected for colony morphology, pigmentation, and the aforementioned differential characteristics. Representative colonies were selected for Gram staining, which classified bacteria as Gram-positive (purple) or Gram-negative (red), prior to subsequent identification procedures.

Identification of Bacterial Isolates

Following preliminary characterization by Gram staining, bacterial isolates were subjected to a panel of biochemical tests for species-level identification. Gram-positive cocci were first tested

for catalase production. Catalase-positive isolates were then subjected to a coagulase test tube to differentiate *S. aureus*, confirmed by the formation of a fibrin clot, from coagulase-negative staphylococci.

Gram-negative rods characterization was performed using a suite of biochemical assays to confirm their identity as members of the Enterobacteriaceae family. This included Triple Sugar Iron (TSI) agar to assess carbohydrate fermentation, observed as a color change to yellow, and hydrogen sulfide (H₂S) production, seen as a black precipitate. Additional tests included urease activity, which turned the medium pink; citrate utilization, indicated by a color change from green to blue; Sulfur-Indole-Motility (SIM) medium, where motility was evidenced by diffuse growth away from the stab line; lysine metabolism on Lysine Iron Agar (LIA), which was interpreted through characteristic color changes in the slant and butt of the medium; a positive oxidase reaction was identified by the rapid development of a deep purple color, while indole production was indicated by the formation of a red ring after the addition of Kovac's reagent. The collective results of these assays were interpreted to achieve species-level identification in accordance with the guidelines stipulated by the EUCAST Clinical Breakpoint v13.0 guideline and the ISO 9308-1:2014 standard.

Antimicrobial Susceptibility Testing (AST)

The antimicrobial susceptibility profile of each bacterial isolate was determined using the standardized Kirby-Bauer disk diffusion method on Mueller-Hinton Agar (MHA). To ensure reproducibility, a bacterial suspension of each isolate was prepared and its density was adjusted to match a 0.5 McFarland turbidity standard before being uniformly swabbed onto the MHA plate.

In accordance with EUCAST Clinical Breakpoint v13.0 guideline, appropriate antimicrobial panels were selected for each isolate based on its Gram stain reaction and organism type (Gram-positive cocci vs. Gram-negative rods). The complete range of antimicrobial agents tested across the study included: Amikacin (AK), Amoxicillin-Clavulanic acid (AMC), Ampicillin (AMP), Aztreonam (ATM), Cefepime (FEP), Cefotaxime (CTX), Ceftriaxone (CRO), Ceftazidime (CAZ), Cefixime (CFM), Cefoxitin (FOX), Chloramphenicol (C), Ciprofloxacin (CIP), Clindamycin (DA), Doxycycline (DOX), Erythromycin (E), Gentamicin (CN), Imipenem (IPM), Meropenem (MEM), Oxacillin (OXA), Penicillin (P), Piperacillin–Tazobactam (TZP),

Tetracycline (TE), Tobramycin (TOB), Trimethoprim–Sulfamethoxazole (SXT), and Vancomycin (VA).

Plates were then incubated aerobically at 37°C for 16-18 hours. Following incubation, the zones of inhibition were measured in millimeters. These quantitative measurements were translated into the qualitative categories of Sensitive (S), Intermediate (I), or Resistant (R) according to the most current interpretive standards published by EUCAST Clinical Breakpoint v13.0 guideline. A consistent data handling workflow was implemented, beginning with manual recording in a microbiology logbook. The results were then digitized into Excel spreadsheets and subsequently merged with the corresponding patient data from KoBo Toolbox to create a final master file for statistical analysis using IBM SPSS Version 27.

Media and Test Principles

Staining method:

Gram Stain: Differentiates bacteria based on their cell wall structure. Gram-positive bacteria, with a thick peptidoglycan layer, retain the primary crystal violet stain and appear purple. Gram-negative bacteria, with a thin peptidoglycan layer and an outer membrane, are decolorized and subsequently take up the safranin counterstain, appearing red or pink.

Culture media:

Blood Agar (BAP): An enriched medium containing mammalian blood that supports the growth of a wide range of bacteria, including fastidious organisms. It is also a differential medium, allowing for the classification of bacteria based on their hemolytic patterns (α -hemolysis, β -hemolysis, or γ -hemolysis).

Chocolate Agar (CAP): A highly enriched medium containing red blood cells that have been lysed by gentle heating. This process releases intracellular growth factors, specifically hemin (Factor X) and NAD (Factor V), which are essential for the cultivation of fastidious pathogens.

MacConkey Agar (MAP): A selective and differential medium. Bile salts and crystal violet inhibit the growth of most Gram-positive bacteria, selecting for Gram-negative organisms. It differentiates bacteria based on their ability to ferment lactose: fermenters produce acid, turning

the neutral red pH indicator and their colonies pink or red, while non-fermenters remain colorless.

Key Biochemical Tests:

Catalase Test: Detects the presence of the enzyme catalase, which breaks down hydrogen peroxide into water and oxygen. A positive result is indicated by the rapid formation of bubbles when the bacterial inoculum is mixed with hydrogen peroxide.

Coagulase Test: Identifies the enzyme coagulase, which converts fibrinogen in plasma to fibrin, causing a clot. This test is a key marker for differentiating *S. aureus* (positive) from coagulase-negative staphylococci.

Oxidase Test: Detects the presence of the enzyme cytochrome c oxidase, a component of the electron transport chain. A positive test, indicated by a rapid change to a deep purple color on the reagent disk, is characteristic of many aerobic and facultative anaerobic bacteria.

Motility Test: Assesses the ability of bacteria to move, typically performed in a semi-solid agar medium (SIM). Motile organisms migrate away from the initial stab line, causing the medium to appear turbid or cloudy, while non-motile organisms grow only along the stab line.

IX. Ethical Approval and Support Letters

St. Paul's Hospital Millennium
Medical College
Research Directorate



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Ref. No. Pm23/1207
Date: 13/05/2024

Institutional Review Board (IRB) of St. Paul's Hospital Millennium Medical College (SPHMMC)
Ethical Clearance

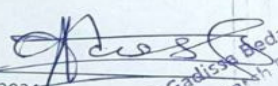
Research Title: Incidence of infection or sepsis, bacterial etiology, antimicrobial susceptibility profile and risk factors among patients under Hemodialysis in Addis Ababa A multi-Center prospective cohort study

Principal Investigator: Dr Moti Wodajo

The IRB of SPHMMC has reviewed the above mentioned research proposal and made the following decision:

- Approved:- X
- Approved with recommendation:- _____
- Approved on condition :- _____
- Disapproved:- _____

The decision is valid for 12 months and the research should be conducted in compliance with the protocol/proposal approved by the IRB of SPHMMC. Any subsequent revision/amendment of the protocol/proposal needs approval before conduct of the research. The researcher should also submit written summaries of the research status to the IRB every 03 months. Upon the conclusion of the study, manuscripts and thesis work to the final/completed research project needs to be submitted to the IRB.

IRB Chair:  **Gadesa Bedada (PHD)**
Signature: _____
Date: May 14, 2024
Research Directorate



Cc:

- Vice Provost for Academic and Research
- IRB
- Dr Moti Wodajo

Tel: +251112732639 P.O. Box: 1271 E-mail: irb@sphmmc.edu.et



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City Government of Addis Ababa Health Bureau

REF.N.O. A/A/H/17475/227

DATE 29/07/2016

TO:

- ZEWUDITU MEMORIAL HOSPITAL
- MENILIK II REFERRAL HOSPITAL

Subject: Request to access Facilities to conduct approved research

This letter is to support MOTI WODAJO DERESSA to conduct research which is entitled as "INCIDENCE OF INFECTION OR SEPSIS, BACTERIAL ETIOLOGY, ANTIMICROBIAL SUSCEPTIBILITY PROFILE AND RISK FACTORS AMONG PATIENTS UNDER HEMODIALYSIS IN ADDIS ABABA, ETHIOPIA: A MULTI-CENTER PROSPECTIVE COHORT STUDY." The study proposal was duly reviewed and approved by the Addis Ababa Health Bureau procedures, and submit an activity progress report to the Ethical Committee as required. Therefore, we request the facility and staffs to provide support to the principal investigator.



With Regards

Ethical Clearance Committee

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Cc

6383/69/284
29-09-2016

MOTI WODAJO DERESSA
ETHICAL CLEARANCE COMMITTEE

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የተመረጠ/ች ተቃ	ጠ. ቁ. 4221/1/821/2475
የተረጋገጠ/ች ተቃ	



Date 29/09/16 E.C

Menelik II Comprehensive Specialized Hospital



MIICSH Training & Research Dep't

To Niguss

Departments of

Menelik II comprehensive specialized hospital

Subject: Requests to conduct ethically approved research

This letter is to support Mr./Ms./Dr./Nr Moti Deressa

On the research topic of Incidence of infection or Sepsis, Bacteri
Etology, Antimicrobial Seseptability profile &
Risk factors among patients under Hemodialysis
in Addis Ababa, Ethiopia: 2024. Amulti Center prospective
cohort study.

The study proposal is duly reviewed and approved by Addis Ababa Health
bureau IRB and the approval letter is left to our department.

Therefor we request your department and staffs to provide and support for the
data collector or principal investigator.

With regards

Research officer

Fissewtsion E

☎251-123 42 72/23 70 15 - 19

☎433/4 h n 011237022 AddisAbaba, Ethiopia

Replying Please quote our Ref.No

To: - Dialysis..... dep't

Zewditu memorial hospital

Subject: -Request to access departments to conduct approved research

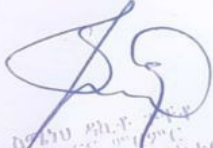
The letter is to support Mr/Ms/Dr...M.D.T.I. Wedajo

On the research topic of

Incidence of infection for sepsis, bacterial etiology,
Antimicrobial Susceptibility profile & risk factors,
among patient under Hemodialysis at ZMH
the study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB and the approval letter was left to our department (Training and research directorate).

Therefore we request the department and staffs to provide support to the principal investigator.

With regard


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በጽሑፍ ላይ ፊርማ
Simenach G. Gucheto
Training & Research Directorate
Director