PREDICTORS OF HOSPITAL LENGTH OF STAY AMONG HEMODIALYSIS PATIENTS WITH CATHETER-RELATED BLOODSTREAM INFECTIONS: A SINGLE-CENTER RETROSPECTIVE STUDY IN DIVINE WORD HOSPITAL

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Chapter 1
Introduction

A. Background of the Study

Bacteremia remains a major cause of morbidity and mortality among patients with end-stage renal disease (ESRD), particularly those undergoing hemodialysis. Among this group, the risk of infection is especially high in patients utilizing catheters for vascular access (Lata, 2016). Catheters account for nearly half of all infections in hemodialysis patients, with catheter-related bloodstream infections (CRBSIs) representing the second leading cause of death in this population (Yousif, 2021). The estimated incidence of CRBSIs ranges from 1.1 to 5.5 episodes per 1,000 patient-days (Pasilan, 2024). These infections not only contribute to significant morbidity but also impose considerable clinical and economic burdens. The development of CRBSI is frequently associated with prolonged hospitalization due to the need for intravenous antibiotic therapy, catheter removal or replacement, and close monitoring for complications such as sepsis. (Bhojaraja, 2023).

The 2019 National Kidney Foundation Kidney Disease Outcomes Quality Initiative(NKF KDOQI) guidelines define CRBSI based on four key criteria: the presence of clinical manifestations of infection, at least one positive blood culture (BC) from a peripheral source such as a vein or dialysis circuit, no other identifiable source of infection, and isolation of the same organism from both the catheter segment(hub or tip) and the peripheral blood sample. Additional supportive evidence includes simultaneous quantitative blood cultures with a catheter-to-peripheral blood ratio of $\geq$3:1or a differential time to positivity (DTP) of $\geq$ 2hours between catheter and peripheral blood cultures when available Central vascular catheters(CVCs) are normally recommended for temporary usage after starting hemodialysis, typically inserted into the internal jugular or femoral vein and the recommended duration is up to two weeks (Yousif et al, 2021). However, these catheters are associated with a higher risk of infection, thrombosis, and hospitalization compared to arteriovenous fistulas (AVFs), which are the preferred vascular access for hemodialysis(Santoro, 2014). Despite these risks, the use of central venous catheters are still commonly used in low- to middle-income countries due to

socioeconomic constraints. Factors such as patients refusing dialysis, inability to afford timely vascular access procedures, delays in AVF creation, and failure of AVF maturation all contribute to reliance on catheter and an increased risk of complications (Pasilan, 2024).

While previous studies have identified some risk factors for CRBSI, most have focused on general populations or regions with established healthcare systems. There is limited local data on the factors that determine the length of stay among hemodialysis patients who develop CRBSI in the Philippine setting, where healthcare resources are limited, delayed access to care, and different catheter management practices may influence outcomes. This study aimed to identify clinical, microbiologic, and treatment-related predictors of hospital length of stay (LOS) and to describe the demographic and clinical characteristics of Filipino patients with ESRD undergoing maintenance hemodialysis who developed CRBSI.

B. General Objective:

To identify the factors associated with prolonged hospital length of stay among adult hemodialysis patients with CRBSIs admitted at Divine Word Hospital from January 1, 2019 to December 31, 2024.

Specifically this study aims study to:

1. Describe the demographic and clinical characteristics of hemodialysis patients diagnosed with CRBSI in terms of:
    - 1.1 Age
    - 1.2 Sex
    - 1.3 Pre-existing Comorbidities
        - 1.3.1 Hypertension
        - 1.3.2 Diabetes Mellitus
        - 1.3.3 Cardiac Disease
        - 1.3.4 Neurologic Disease
        - 1.3.5 Malignancy
        - 1.3.6 Autoimmune
    - 1.4 Etiology of Kidney
        - 1.4.1 Diabetic Kidney Disease
        - 1.4.2 Hypertensive Kidney Disease
        - 1.4.3 Glomerulonephritis
        - 1.4.4 Obstructive Uropathy
        - 1.4.5 Gout Nephropathy
        - 1.4.6 Sepsis
2. To determine infection-related and hemodynamic variables among patients with CRBSI in terms of
    - 2.1. Co-existing infection
    - 2.2. MAP $\leq$ 70mmHg
    - 2.3. Use of Vasopressor

3. To characterize microbiologic profile and laboratory parameters among patients with CRBSI in terms of
   3.1. Type and specific organism isolated
   3.2. Serum creatinine
   3.3. Fasting blood sugar
4. To determine the vascular access and treatment-related characteristics among patients with CRBSI in terms of
   4.1. Catheter site
   4.2. Catheter duration (≤29 days vs. ≥30 days),
   4.3. History of prior central venous catheterization,
   4.4. Time from admission to empiric antibiotic initiation (in hours)
   4.5. Time from admission to catheter intervention
   4.6. Catheter removal or replacement (yes/no) and time to intervention (in days),
   4.7. ICU admission (yes/no)

5. To compare hospital length of stay across key subgroups (number of pre-existing comorbidities, presence of co-existing infection, hemodynamic status, organism type, treatment timeliness, catheter duration, history or prior CVC, catheter removal, time of catheter intervention, time of admission to empiric antibiotic initiation, and ICU admission) using non-parametric statistical tests.

C. Scope and Limitation of the study

This retrospective observational study analyzes data from medical records and patient charts at Divine Word Hospital, covering the period from January 1, 2019, to December 31, 2024. This aims to identify the clinical predictors associated with the length of hospital stay among hemodialysis patients with CRBSI in a tertiary hospital setting. The study includes all admitted patients aged 19 and above undergoing hemodialysis and have confirmed CRBSIs based on the KDQOI 2019 guidelines.

This study has several limitations. Being a retrospective analysis, it relies on the accuracy and completeness of medical records, which could lead to biases or result in missing data. Additionally, since the study was conducted at a single tertiary hospital, the

findings may not be fully applicable to other healthcare settings or populations. Furthermore, it also does not assess long-term outcomes beyond hospitalization or evaluate the cost-effectiveness of specific interventions.

D. Significance of the study

This study identifies key predictors of prolonged hospital stay(≥ 14days) in 147 hemodialysis patients with CRBSI at Divine Word Hospital (2019-2024). Clinically, it shows that hypotension, vasopressor use, delayed antibiotic(>3ours), catheter removal/replacement and catheter intervention significantly extend LOS, guiding faster interventions to reduce complication and mortality(14.3%). Institutionally, findings support local protocols for early catheter removal and infection bundles to improve outcomes and bed turnover. Nationally, it adds Philippine data on CRBSI patterns (52.4% Gram-negative), informing DOH and nephrology guidelines to promote AVF use and reduce catheter reliance. As a resident, it highlights practical, evidence-based solutions to a common dialysis complication in resource-limited settings.

E. Definition of Terms

1. **Catheter intervention days:** Defined as the interval (in days) from the time of diagnosis or clinical suspicion of a catheter-related infection to the removal, replacement, or exchange of the implicated catheter
2. **Catheter-Related Bloodstream Infection (CRBSI)**: A bloodstream infection that meets the criteria outlined by the 2019 KDOQI guidelines, characterized by clinical signs of infection, isolation of the same organism from both the catheter and peripheral blood cultures, and no other identifiable source of infection.
3. **Central Venous Catheter (CVC)**: A vascular access device inserted into large veins, such as the internal jugular or femoral vein, used for hemodialysis.
4. **Comorbidities**: Co-existing medical conditions or diseases in a patient, such as diabetes mellitus, hypertension, or cardiovascular disease, which can influence outcomes in patients with CRBSIs.

5. **Empiric antibiotic:** Refers to the initial administration of broad-spectrum antimicrobial therapy initiated upon clinical suspicion of infection, prior to the availability of culture and sensitivity results.
6. **End-Stage Renal Disease (ESRD)**: The final stage of chronic kidney disease, where the kidneys no longer function adequately to sustain life without renal replacement therapy, such as hemodialysis or kidney transplantation.
7. **Gram-Positive and Gram-Negative Organisms**: Bacteria classified based on their cell wall composition and staining properties under the Gram stain method.
8. **Hemodialysis (HD)**: A renal replacement therapy that filters waste, toxins, and excess fluid from the blood of patients with kidney failure using a dialysis machine and a vascular access device.
9. **Hospital Discharge**: the formal release of a patient from inpatient care once clinically stable, with plans for continued management and follow-up in the outpatient or home setting.
10. **Hospital Length of stay:** the total number of calendar days from the date of hospital admission (recorded as the admission timestamp in the electronic medical record) to the date of hospital discharge (recorded as the discharge order timestamp or actual discharge date), inclusive of both days. For patients who expired during admission, LOS was calculated from the admission date to the date of in-hospital death.
11. **Infection Control Practices**: Measures and protocols implemented in healthcare settings to prevent and manage infections, such as hand hygiene, catheter care, and timely removal of unnecessary catheters.
12. **Socioeconomic Constraints**: Limitations related to financial, educational, or resource availability that may influence healthcare delivery, including the use of central venous catheters for prolonged durations due to delays in creating arteriovenous fistulas.

F. CONCEPTUAL FRAMEWORK

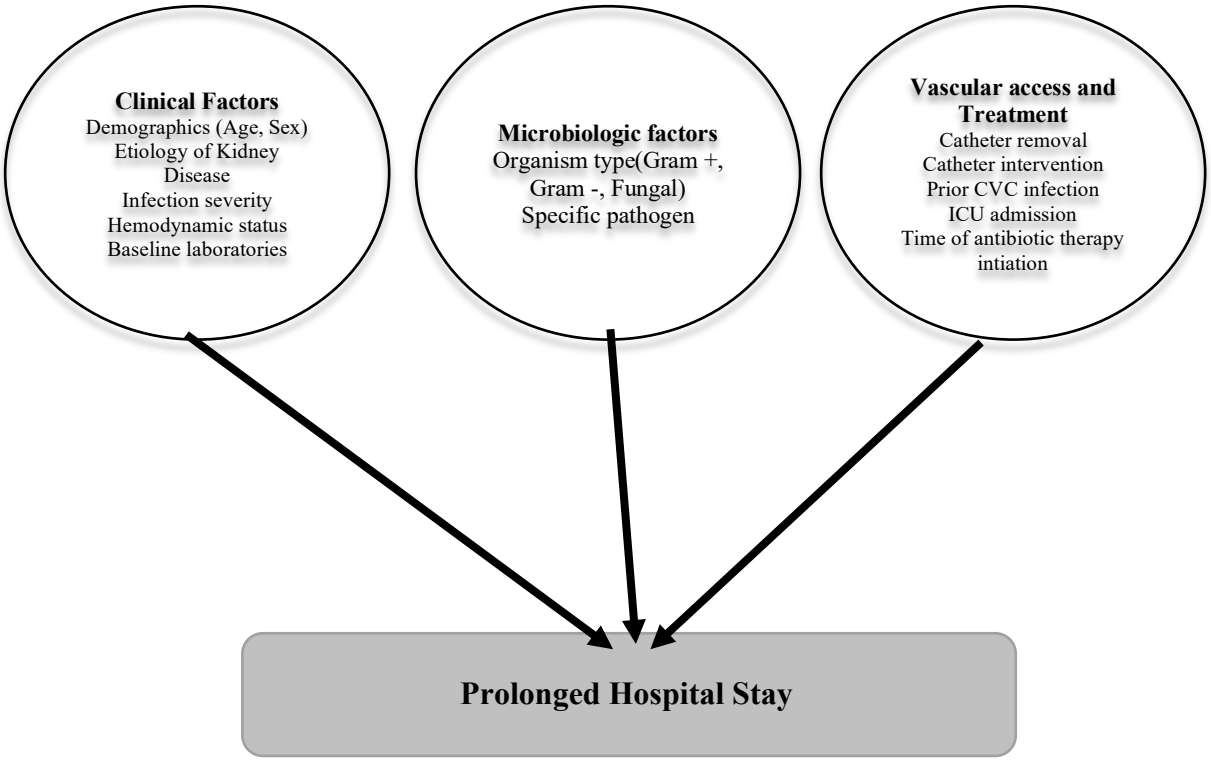


Figure 1. Conceptual Framework of the Study

Chapter 2
Review of Related Literature

Catheter-related bloodstream infections represent a major clinical and public health concern, particularly among patients with ESRD receiving maintenance hemodialysis. The incidence of infection among hemodialysis patients is markedly higher—up to 26 times greater than that of the general population—making infections the second leading cause of death and morbidity in this group (Weldetensae, 2023; Mohamed, 2019). Central venous catheters account for approximately half of all infections in hemodialysis patients, with CRBSIs recognized as one of the most serious complications. These infections contribute to prolonged hospital stays, increased healthcare costs, and higher mortality rates (Pasilan, 2024).

Risk Factors for CRBSI

Identifying risk factors for CRBSI is crucial for developing effective preventive and therapeutic strategies aimed at reducing infection rates and improving outcomes. Prior studies have identified several significant contributors to CRBSI development, including the catheter insertion site, the use of multi-lumen catheters, prolonged catheterization, poor hand hygiene, and advanced patient age (Futamara, 2024). These factors can be broadly categorized as exogenous—such as bacterial contamination from the external environment—and endogenous, including concurrent infections, weakened immune defenses, and bacterial translocation secondary to prolonged antibiotic use (Opilia, 2008).

Patient-related clinical parameters also play a vital role. Hemoglobin, white blood cell count, and previous catheter-related infections have been identified as independent predictors of CRBSI (Weldetensae, 2023). Futamara et al. (2024) reported that urban residence, extended catheter duration, and prior catheter infections significantly increased the likelihood of developing CRBSI, with a previous infection raising the risk by twelvefold. These findings emphasize the importance of minimizing catheter dwell time and preventing reinfection through vigilant surveillance and aseptic technique.

Furthermore, these established risk factors for CRBSI have also been shown to significantly contribute to an increased length of hospital stay among hemodialysis patients. Prolonged catheter dwell time, recurrent catheter manipulation, and prior episodes of CRBSI predispose patients to more persistent and severe infections that require extended antimicrobial treatment, repeated blood cultures, and longer periods of clinical monitoring, thereby extending hospitalization (Futamura et al., 2024). Patients with recurrent CRBSIs frequently develop more complex infectious profiles—including sustained bacteremia, multidrug-resistant organisms, and catheter-related complications—that further delay source control and recovery, increasing overall LOS (Weldetensae et al., 2023). In addition, the presence of immunocompromising conditions such as diabetes, malnutrition, or chronic inflammation—commonly observed among populations at risk for CRBSI—exacerbates infection severity by impairing neutrophil activity, endothelial integrity, and host defenses, which prolongs the clinical course and necessitates more intensive supportive management (Garnacho-Montero et al., 2008). These observations across multiple studies demonstrate that the same risk factors predisposing patients to CRBSI also play a critical role in prolonging hospitalization, not merely by initiating infection but by influencing its complexity, duration, and response to treatment.

Prognostic Indicators and Mortality Predictors

Mortality among patients with CRBSI is influenced by multiple clinical and biochemical factors. Several studies have identified that the use of non–peripherally inserted central catheters (non-PICC), isolation of *Candida* species from blood cultures and early infection onset within 30 days of catheter placement are associated with worse outcomes (Futamara, 2024). Concurrent infections and poor nutritional status further increase mortality risk. Weakened immune function also facilitates colonization by opportunistic pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) and *Candida* species, predisposing patients to secondary infections including sepsis and pneumonia (Futamara et al., 2024). In this context, nutritional and inflammatory biomarkers have been important prognostic tools. Serum creatinine, although widely used as a measure of kidney function in the general population, has limited utility for this

purpose in patients with end-stage renal disease receiving maintenance hemodialysis. In this population, creatinine levels reflect muscle mass, protein intake, and overall nutritional reserve, rather than residual renal clearance. Lower predialysis creatinine values frequently indicate protein–energy wasting (PEW), sarcopenia, and diminished physiologic reserve—factors consistently linked to frailty, prolonged hospitalization, and mortality in hemodialysis cohorts (Kalantar-Zadeh et al., 2013, Fouque et al., 2008, Kang et al., 2019). These nutritional and metabolic abnormalities impair immune function through mechanisms such as reduced complement production, impaired neutrophil activity, and chronic inflammation, predisposing ESRD patients to more severe and persistent infections. Importantly, serum creatinine is a poor marker of infection severity because it does not rise in response to inflammatory or septic processes; instead, fluctuations largely reflect muscle mass, hydration status, or dialysis timing rather than infection burden (Carrero et al., 2014, Kalantar-Zadeh et al., 2013)

Economic and Clinical Burden

Recent investigations have consistently demonstrated the substantial clinical and economic burden imposed by CRBSIs. Dimick et al. (2024) reported that CRBSI in critically ill surgical patients increased total hospital costs, extended hospital stay by 22 days, and raised ICU mortality from 21% to 56%. Similarly, Blot et al. (2023) identified longer ICU (28 vs. 20 days) and total hospital stays (53 vs. 41 days). Tarricone et al. (2023) likewise showed that catheter-related infections nearly doubled hospital costs and length of stay in Italian ICUs. However, these studies lacked long-term follow-up data on post-discharge morbidity and survival, emphasizing a critical gap in understanding the broader consequences of CRBSI.

Guideline-Based Management and Prevention

The Kidney Disease Outcomes Quality Initiative provides comprehensive, evidence-based recommendations for the prevention and management of CRBSI in hemodialysis patients. Initial management involves obtaining blood cultures prior to antibiotic initiation to ensure pathogen-directed therapy. Empiric coverage should include both Gram-positive and Gram-negative organisms, with special consideration for MRSA

due to its high prevalence. Once the pathogen is identified, antibiotic therapy should be tailored accordingly. Recommended treatment duration varies—four to six weeks for *S. aureus*, seven to fourteen days for Gram-negative or *Enterococcus* species, and at least fourteen days for *Candida* infections.

For infection prevention, KDOQI emphasizes measures aligned with the Centers for Disease Control and Prevention (CDC), including proper hand hygiene, regular infection surveillance, standardized catheter care protocols, staff and patient education, minimizing CVC use, and using chlorhexidine for skin antisepsis. Additional measures include disinfecting catheter hubs, applying antimicrobial ointments at insertion sites, and ensuring timely catheter removal when feasible. Management of infected catheters must be individualized based on the patient's clinical status, vascular access options, and dialysis requirements, with a focus on patient-centered care.

Determinants of Hospital Discharge and Clinical Recovery

Beyond infection control and mortality, hospital discharge outcomes are an important yet limitedly studied aspect of CRBSI management. Early catheter removal has been associated with shorter hospital stays and lower in-hospital mortality among affected patients (De Capitani et al., 2025). Prompt initiation of appropriate empirical antibiotic therapy is equally vital; delays of more than 48 hours, particularly in gram-negative infections such as *Acinetobacter baumannii* bacteremia, have been linked to increased mortality and prolonged hospitalization (Erbay et al., 2009). Furthermore, patient-related factors—including nutritional and functional status, as well as the presence of multiple comorbidities—play a pivotal role in determining readiness for discharge. Despite extensive literature on CRBSI-related morbidity and mortality, few studies have focused on factors associated with favorable outcomes such as early or successful hospital discharge, particularly in low- and middle-income countries (LMICs).

Global and Socioeconomic Context

CRBSIs remain a significant challenge for hemodialysis populations worldwide, particularly in resource-limited settings such as the Philippines, where hemodialysis is the

predominant modality of renal replacement therapy. Infection rates vary markedly across socioeconomic contexts, with lower CRBSI rates in high-income countries (HICs) compared to LMICs (Bello, 2022). This disparity is largely attributed to differences in healthcare infrastructure, infection surveillance systems, and access to trained healthcare personnel. In HICs, well-established infection control protocols—including standardized catheter insertion and maintenance procedures, timely catheter removal, and robust antimicrobial stewardship—contribute to improved outcomes (Maki, 2021; Soi, 2016; Daniels, 2013).

In contrast, public hospitals in developing regions often face constraints in resources, staffing, and equipment. A study by Pasilan et al. (2024) conducted in a Philippine tertiary government hospital reported a CRBSI incidence rate of 6.72 episodes per 1,000 catheter-days—significantly higher than rates observed in HICs. Addressing these gaps necessitates targeted interventions, including investments in healthcare infrastructure, workforce training, and the implementation of evidence-based infection prevention and control programs tailored to local settings.

Chapter 3
Methodology

A. Research Design

This retrospective cohort study analyzed 147 adult hemodialysis patients with confirmed catheter-related bloodstream infections, defined per 2019 KDOQI guidelines, admitted to Divine Word Hospital, Tacloban City, from January 1, 2019, to December 31, 2024. Data on demographics, comorbidities, infection severity, microbiologic isolates, vascular access characteristics, and treatment variables were extracted from medical records.

B. Study Locale

The study was conducted at Divine Word Hospital, a 160-bed capacity, private, tertiary-level training institution located at Barangay 49, Real Street, Tacloban City, Leyte, Philippines.

This facility serves as a major referral center for the Eastern Visayas region, providing comprehensive medical and surgical services, including a fully equipped Hemodialysis Unit with 13 dialysis machines and an average of 1,200 dialysis sessions per month. The hospital is accredited by the Department of Health (DOH) standards for quality and patient safety.

C. The Study Population and Sample

The study included 147 adult hemodialysis patients with confirmed CRBSIs admitted to Divine Word Hospital from January 1, 2019, to December 31, 2024. Patients were identified through the hospital's microbiology laboratory database using matched blood and catheter tip cultures, followed by chart review to confirm hemodialysis status and KDOQI-defined CRBSI diagnosis. Inclusion and exclusion criteria were applied as outlined below.

Inclusion Criteria:

1. Adult patients aged ≥19 years who were receiving hemodialysis.
2. Patients diagnosed with CRBSI based on the 2019 KDOQI clinical practice guidelines.
3. Patients who had undergone central venous catheter placement for hemodialysis access.

Exclusion Criteria:

1. Patients under 19 years of age.
2. Non-hemodialysis patients with CRBSIs (e.g., those with peripherally inserted central catheter lines for other indications).

D. Data Gathering Procedure

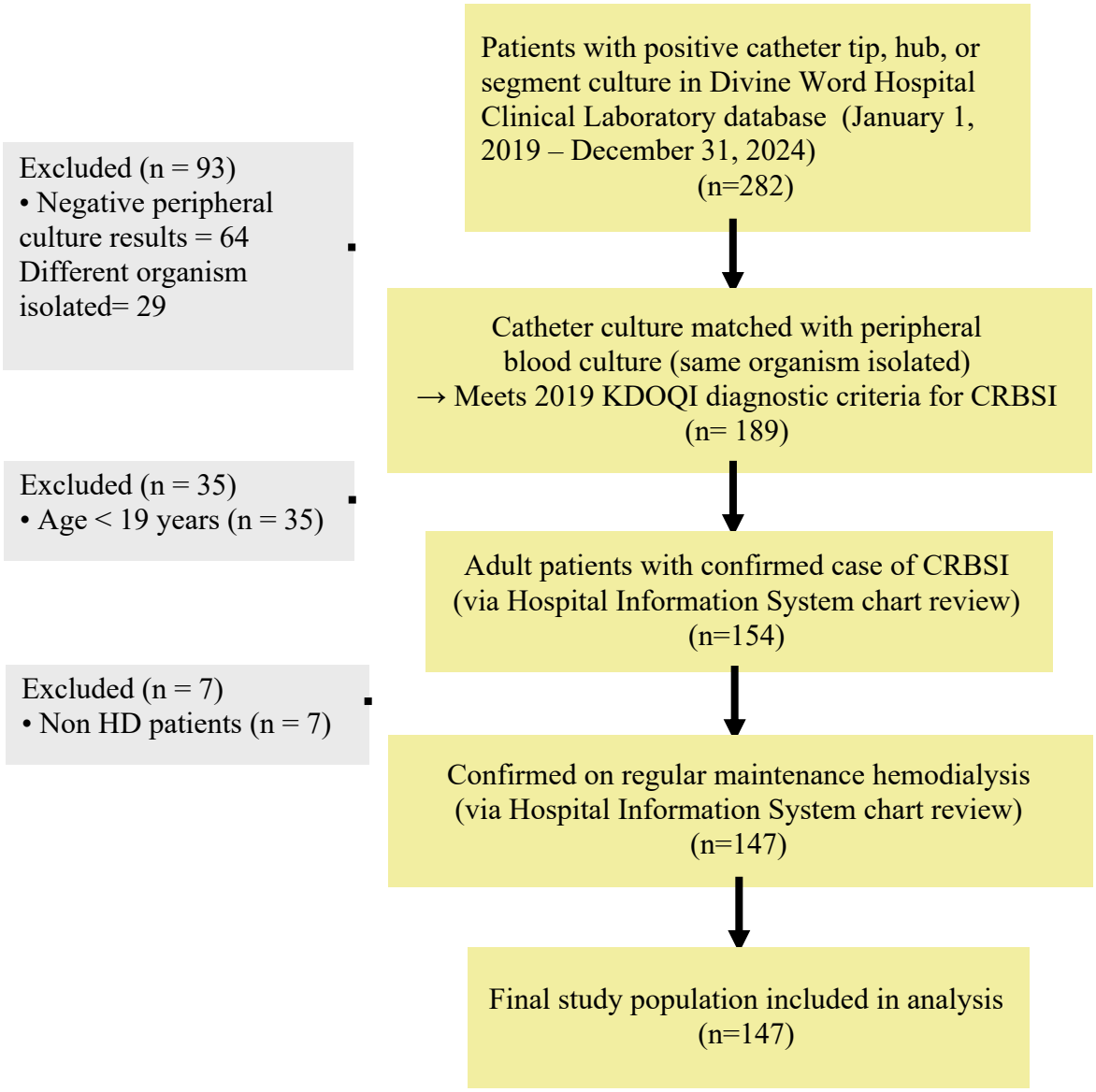
The study received ethical approval. A request for permission to conduct the research, along with the research protocol, was submitted to the Hospital Administration, the Medical Director, and the Chairperson of the Department of Internal Medicine.

Data collection commenced with the identification of all patients who had positive catheter tip, hub, or segment cultures recorded in the Divine Word Hospital Clinical Laboratory database from January 1, 2019, to December 31, 2024 (n = 282). Medical records were then reviewed to confirm that the identical microorganism was isolated from both the catheter culture and at least one peripheral blood culture, in accordance with the diagnostic criteria for definite CRBSI outlined in the 2019 KDOQI Clinical Practice Guideline for Vascular Access(n=189).

From this cohort, only adult patients (age ≥19 years) were retained (n = 154 after excluding 35 patients aged <19 years). Further chart review using the hospital's Hospital Information System (HIS) was performed to verify that patients were on regular maintenance hemodialysis. Seven patients who were not on chronic hemodialysis were excluded, yielding a final analytic cohort of 147 adult hemodialysis patients with confirmed CRBSI (Figure 2).

Relevant variables—including demographic profile, comorbidities, infection-related and hemodynamic parameters, microbiologic and laboratory results, vascular access characteristics, treatment timelines, and clinical outcomes (hospital length of stay and in-hospital mortality)—were extracted using a pre-designed data collection form.

Figure 2. Flow Diagram of Patient Selection Process



E. Data Analysis

All statistical analyses were conducted to identify demographic, clinical, microbiologic, vascular access and treatment-related factors associated with hospital length of stay among adult hemodialysis patients with confirmed catheter-related bloodstream infection. Data were coded and analyzed using IBM SPSS Statistics

Descriptive statistics were used to summarize all baseline characteristics. Categorical variables—such as sex, comorbidities, organism type, hemodynamic instability (MAP <70 mmHg), vasopressor use, co-existing infection, catheter characteristics, treatment delays, and ICU admission—were presented as frequencies and percentages. Continuous variables, including serum creatinine, fasting blood sugar, and treatment timing (hours or days), were expressed as medians with interquartile ranges (IQR) due to non-normal distributions confirmed through visual inspection of histograms and the Shapiro–Wilk test.

To determine the association between patient characteristics and LOS, comparisons of LOS across subgroups were performed using Mann–Whitney U tests for dichotomous predictors and Kruskal–Wallis tests for variables with ≥3 categories, consistent with the non-parametric distribution of LOS. Effect sizes were expressed as mean ranks.

Associations between categorical predictors and the proportion of patients with prolonged LOS (≥14 days) were examined using Chi-square tests or Fisher's exact tests when cell counts were <5. Serum creatinine and fasting blood sugar were correlated with LOS using Spearman's rank correlation coefficients.

All statistical tests were two-tailed, with $p < 0.05$ considered statistically significant.

F. Ethical Considerations

The study underwent an ethical review process to ensure patient safety and data confidentiality. Only the information specified in the data collection plan was obtained. Both the lead investigator and co-investigator ensured that all collected data were kept

confidential for record-keeping purposes. To maintain anonymity, patient identifiers were replaced with numerical codes during data collection and analysis.

G. Conflict of Interest/Financial Disclosure

Because this study is largely conducted for academic purposes under the auspices of Divine Word Hospital, the investigators have no potential conflicts of interest.

CHAPTER 4

RESULTS AND DISCUSSION

Table 1. Demographic and Clinical Characteristics of Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024 (n = 147)

Demographic and Clinical Characteristics	Categories	F (n = 147)	% (100.0)
Age	Early Senior (61-75 y.o.)	64	43.5
	Late Middle Age (46-60 y.o.)	41	27.9
	Late Senior (76-87 y.o.)	17	11.6
	Middle Age (31-45 y.o.)	14	9.5
	Young Adulat (19-30 y.o.)	11	7.5
Sex	Male	76	51.7
	Female	71	48.3
Pre-existing Comorbidities	Hypertension, Diabetes Mellitus	53	36.1
	Hypertension	31	21.1
	Hypertension, Diabetes Mellitus, Cardiac Disease	22	15.0
	Hypertension, Autoimmune Disease	9	6.1
	Hypertension, Cardiac Disease	6	4.1
		6	4.1
	Autoimmune Disease	5	3.4
	Diabetes Mellitus	4	2.7
	Hypertension, Diabetes Mellitus, Neurologic Disease	4	2.7
	Malignancy	1	0.7
	Hypertension, Diabetes Mellitus, Cardiac Disease, Neurologic Disease	1	0.7
	Hypertension, Diabetes Mellitus, Malignancy	1	0.7
	Hypertension, Diabetes Mellitus, Autoimmune Disease	1	0.7
	Diabetes Mellitus, Autoimmune Disease	1	0.7
	Diabetes Mellitus, Cardiac Disease	1	0.7
	Diabetes Mellitus, Malignancy	1	0.7
	Neurologic Disease	1	0.7

Etiology of Kidney	Diabetic Kidney Disease	70	47.6
	Hypertensive Kidney Disease	50	34.0
	Glomerulonephritis	17	11.6
	Obstructive Uropathy	7	4.8
	Gout Nephropathy	2	1.4
	Sepsis	1	0.7

A total of 147 hemodialysis patients with confirmed catheter-related bloodstream infection were analyzed.

Demographics: Age and Sex Distribution

The majority of patients in this cohort belonged to older age groups, with early seniors aged 61–75 years comprising 43.5% of cases and late middle-aged adults (46–60 years) accounting for 27.9%. This concentration of CRBSI among older adults parallels global hemodialysis trends, where aging ESRD populations exhibit heightened susceptibility to infection due to immunosenescence, chronic inflammation, and greater exposure to vascular access procedures (Futamura et al., 2024; Weldetensae et al., 2023). Similar demographic patterns have been reported in Philippine hemodialysis cohorts, which likewise reflect the increasing burden of kidney disease among older adults driven by long-standing metabolic conditions (Pasilan et al., 2024).

The near-equal sex distribution in this study (51.7% male vs. 48.3% female) aligns with international data indicating minimal sex-based differences in CRBSI incidence among hemodialysis patients (Mohamed et al., 2019). This suggests that biological sex does not substantially influence infection risk; rather, the dominant determinants are vascular access characteristics, comorbidity burden, and dialysis-related exposures. These demographic patterns collectively imply that CRBSI in the study setting predominantly affects older adults with multiple chronic conditions, a group particularly vulnerable to infectious complications and prolonged hospitalization.

Pre-Existing Comorbidities

Hypertension (21.1%) and combined hypertension with diabetes mellitus (36.1%) were the most prevalent comorbidity profiles, consistent with well-established global and local patterns in ESRD populations where these metabolic conditions comprise the leading causes of kidney failure (Taylor et al., 2004; Pasilan et al., 2024). Diabetes mellitus is a particularly important contributor to infection susceptibility, as hyperglycemia impairs neutrophil migration, phagocytosis, and bactericidal activity, predisposing patients to more severe bloodstream infections (Bhojaraja et al., 2023). The presence of multiple comorbidities—including cardiac, neurologic, autoimmune, or malignant conditions—further reflects the complex clinical profile typical of chronic hemodialysis patients and may contribute to impaired physiological reserve and slower recovery following CRBSI.

The high proportion of patients with dual or multiple metabolic comorbidities in this cohort demonstrates their increased vulnerability to infectious complications and aligns with international observations that comorbidity burden is an important modifier of CRBSI severity and outcomes (Weldetensae et al., 2023). These findings reinforce the need for intensive risk-factor control and multidisciplinary management in hemodialysis units to limit infection risk and improve clinical outcomes.

Etiology of Kidney Disease

Diabetic kidney disease emerged as the leading etiology of ESRD (47.6%), followed by hypertensive kidney disease (34.0%), mirroring epidemiologic shifts reported both globally and in the Philippines, where metabolic diseases now account for the majority of chronic kidney disease progression (Pasilan et al., 2024; Bello et al., 2022). This distribution is consistent with the rising prevalence of diabetes and hypertension in the region and aligns with prior research showing similar etiologic patterns among hemodialysis patients with CRBSI (Futamura et al., 2024).

From a clinical standpoint, diabetic nephropathy contributes to CRBSI risk through mechanisms such as microvascular dysfunction, impaired immune response, and greater need for prolonged catheter use—factors that facilitate bacterial colonization and biofilm formation. Hypertensive nephrosclerosis, the second leading cause, frequently coexists

with cardiovascular disease and fluid overload, which may further complicate infection management. Less common etiologies such as glomerulonephritis, obstructive uropathy, and gout nephropathy reflect a smaller proportion of ESRD causes but still represent relevant subgroups within the local patient population.

Table 2. Infection-Related and Hemodynamic Variables Among Hemodialysis CRBSI at Divine Word Hospital, 2019–2024 (n = 147)

Infection Related Variables	Categories	F (n = 147)	% (100.0)
Presence of co-existing infection	No	55	37.4
	Yes	92	62.6
MAP <70mmHg	No	97	66.0
	Yes	50	34.0
Vasopressor use	No	97	66.0
	Yes	50	34.0

Presence of co-existing infection

A considerable proportion of patients (62.6%) had a co-existing infection at the time of CRBSI diagnosis, indicating a high burden of multisource infectious processes within the cohort. This finding aligns with prior studies demonstrating that hemodialysis patients frequently present with concomitant infections due to impaired cellular immunity, repeated healthcare exposure, and chronic inflammation associated with ESRD (Weldetensae et al., 2023).

Hemodynamic Instability: MAP <70 mmHg

Mean arterial pressure (MAP) <70 mmHg was observed in 34.0% of patients, indicating early hemodynamic compromise in approximately one-third of the cohort. Hypotension in the setting of CRBSI is widely regarded as a marker of severe infection and impending septic shock, particularly among hemodialysis patients who often have limited cardiovascular reserve and autonomic dysfunction (Futamura et al., 2024). The presence of hypotension in this study is clinically significant, as it was later shown to have a strong association with prolonged length of hospital stay. This aligns with established

evidence that hypotension in CRBSI reflects a more aggressive inflammatory response and is associated with a higher likelihood of requiring escalated treatment.

Vasopressor Requirement

Similarly, 34.0% of the cohort required vasopressor support, further indicating that over one-third of patients presented with severe sepsis or septic shock. Vasopressor use in CRBSI has been consistently associated with increased morbidity, ICU utilization, and mortality due to advanced circulatory failure and systemic inflammation (Zhong et al., 2021; Bitunguramye et al., 2024). In this study, vasopressor requirement showed a statistically significant association with prolonged hospitalization, emphasizing its role as a marker of infection severity. The proportion of patients requiring vasopressors is noteworthy given the already elevated baseline risk in the ESRD population, which has been reported to have exaggerated vulnerability to sepsis due to chronic immunosuppression and repeated intravascular exposure (Bhojaraja et al., 2023).

Table 3.1. Microbiologic Profile Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024 (n = 147)

Microbiologic Profile	Categories	F (n=147)	% (100.0)
Organism Type	Gram Negative	77	52.4
	Gram Positive	62	42.2
	Fungal	8	5.4
Specific Organism	Staphylococcus aureus	27	18.4
	Enterobacter cloacae	23	15.6
	Burkholderia cepacia	17	11.6
	Staphylococcus conhi	1	0.7
	Staphylococcus haemolyticus	8	5.4
	Klebsiella pneumonia	9	6.1
	Candida spp	8	5.4
	Klebsiella aerogenes	6	4.1
	Staphylococcus epidermidis	14	9.5
	Escherichia coli	6	4.1
	Acinetobacter baumannii	7	4.8
	Pseudomonas aeruginosa	5	3.4
	Stenotrophomonas maltophilia	5	3.4
	Staphylococcus warneri	2	1.4
	Enterococcus faecalis	2	1.4
	Staphylococcus hominis	2	1.4

	Staphylococcus chromogenes	1	0.7
	Elizabethkingia meningoseptica	1	0.7
	Staphylococcus pseudintermedius	1	0.7
	Acinetobacter haemolyticus	1	0.7
	Enterobacter cloacae, Enterococcus faecalis	1	0.7

The microbiologic profile of the 147 hemodialysis patients with confirmed catheter-related bloodstream infections (CRBSI) demonstrated a predominance of Gram-negative organisms (52.4%), followed by Gram-positive organisms (42.2%) and a smaller proportion of fungal pathogens (5.4%). This distribution contrasts with patterns described in high-income countries, where Gram-positive cocci—particularly coagulase-negative staphylococci and Staphylococcus aureus—traditionally account for the majority of CRBSI cases (Marr et al., 1998; Mohamed et al., 2019). Instead, the higher proportion of Gram-negative organisms in this study mirrors more recent findings from low- and middle-income settings, including the Philippines, where environmental contamination, catheter manipulation, and resource limitations contribute to increased Gram-negative bacteremia (Pasilan et al., 2024; Bitunguramye et al., 2024). The Gram-negative predominance therefore highlights the need to consider local epidemiology when selecting empiric antimicrobial regimens in dialysis units.

Among the specific pathogens identified, Staphylococcus aureus (18.4%) remained the most frequently isolated organism, demonstrating its continued clinical relevance as a major cause of catheter-associated infection in hemodialysis patients. This finding aligns with classical literature demonstrating the virulence of S. aureus in vascular access infections due to its strong biofilm-forming capacity, ability to adhere to intraluminal surfaces, and high risk of metastatic complications (Marr et al., 1998). The persistence of S. aureus in this cohort suggests a combination of host factors (e.g., diabetes-related immune dysfunction), catheter-related factors (e.g., prolonged dwell time), and procedural factors (e.g., hub contamination or dressing lapses).

Following S. aureus, the most prevalent Gram-negative organisms were Enterobacter cloacae (15.6%) and Burkholderia cepacia (11.6%), both of which are recognized for their association with healthcare-acquired infections and intrinsic

antimicrobial resistance. Their isolation in considerable frequency suggests possible environmental reservoirs within healthcare settings, particularly in moisture-containing areas or equipment frequently manipulated during dialysis. These pathogens have been reported in local and regional studies of catheter-related infections and are often associated with prolonged bacteremia and higher rates of treatment failure (Pasilan et al., 2024). Other notable Gram-negative isolates included Klebsiella pneumoniae (6.1%), Klebsiella aerogenes (4.1%), Escherichia coli (4.1%), Acinetobacter baumannii (4.8%), and Pseudomonas aeruginosa (3.4%), organisms frequently implicated in nosocomial bloodstream infections and known for their multidrug-resistant potential.

A substantial subset of Gram-positive isolates consisted of coagulase-negative staphylococci (CoNS) such as *Staphylococcus haemolyticus*, *S. epidermidis*, *S. conhi*, and *S. hominis*, collectively accounting for approximately 15–20% of all isolates. While often considered contaminants, the 2019 KDOQI definition for CRBSI requires matching peripheral and catheter-tip cultures, confirming these isolates as true pathogens in this cohort. CoNS are well-established as major contributors to catheter colonization due to their strong biofilm production, especially in long-term catheters (Rodríguez-Aranda et al., 2011).

Fungal isolates, predominantly Candida spp. (5.4%), were less common but clinically significant. Prior studies have shown that Candida-related CRBSI carries higher risk of septic complications and requires longer antimicrobial therapy and mandatory catheter removal (Futamura et al., 2024). The presence of fungal infections in this cohort may reflect repeated catheter exposure, broad-spectrum antibiotic use, and underlying immunosuppression among hemodialysis patients.

Table 3.2 Laboratory Parameters Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024 (n = 147)

Laboratory Parameters	Min	Max	Median [IQR]
Serum creatinine (µmol/L or mg/dL) (n=147)	112.90	1681.90	659.53 [461.95, 885.70]
Fasting Blood Sugar (mmol/L) (n=82)	2.14	21.69	6.09 [5.06, 8.47]

Table 3.2 summarizes two key laboratory parameters—serum creatinine and fasting blood sugar (FBS)—which provide important insight into the metabolic and nutritional status of hemodialysis patients presenting with CRBSI. Among the 147 patients, the serum creatinine values ranged widely from 112.90 to 1681.90 µmol/L, with a median of 659.53 µmol/L [461.95–885.70]. This broad range reflects the heterogeneous predialysis metabolic state typical of ESRD patients, largely influenced by differences in residual renal function, muscle mass, nutritional status, and the timing of the most recent hemodialysis session. In dialysis populations, serum creatinine is *not* primarily a marker of renal function but instead correlates strongly with protein intake, muscle mass, and overall nutritional reserve (Kalantar-Zadeh et al., 2013; Fouque et al., 2008). Lower creatinine levels in ESRD have been consistently associated with protein–energy wasting, sarcopenia, and frailty (Kang et al., 2019)—conditions that significantly impair immune competence, wound healing, and physiologic resilience during acute infections.

The pathophysiologic mechanisms linking lower creatinine to poorer outcomes in CRBSI patients stem from impaired host defense processes characteristic of malnutrition in dialysis. Reduced muscle mass reflects diminished hepatic production of complement, poor substrate availability for immunologic proteins, and overall weakened systemic response to infection. Consequently, patients with low predialysis creatinine often manifest slower bacterial clearance, greater hemodynamic vulnerability, and prolonged metabolic instability, which collectively contribute to extended recovery times. This aligns with the study's later finding that serum creatinine demonstrated a significant inverse correlation with length of stay, suggesting that patients with lower creatinine were more likely to experience prolonged hospitalization secondary to reduced physiologic reserve.

Fasting blood sugar values were available for 82 patients, ranging from 2.14 to 21.69 mmol/L, with a median of 6.09 mmol/L [5.06–8.47]. The elevated and highly variable glycemic distribution reflects the high prevalence of diabetes mellitus among ESRD patients, many of whom present with chronic hyperglycemia or stress-related dysregulation during acute illness. Hyperglycemia is well established as a contributor to impaired immune function, particularly through mechanisms that reduce neutrophil chemotaxis, phagocytosis, and intracellular killing (Bhojaraja et al., 2023). In the context

of CRBSI, poor glycemic control may potentiate bacterial proliferation, delay clearance of bloodstream infection, and increase susceptibility to complications. Although FBS was not significantly associated with length of stay in the present analysis, the variability observed in Table 3.2 suggests important heterogeneity in metabolic stability that may modulate clinical trajectory, particularly among diabetic ESRD patients who are inherently predisposed to more severe infections due to microvascular dysfunction and chronic inflammation.

Taken together, the laboratory profile in Table 3.2 demonstrates that hemodialysis patients with CRBSI often present with substantial metabolic derangements, in which both nutritional status, as reflected by creatinine and glycemic control play key roles in determining susceptibility to infection and physiologic response.

Table 4.1 Vascular Access Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024 (n = 147)

Vascular Access Details	Categories	F (n = 147)	% (100.0)
Catheter Site	Internal Jugular Vein	120	81.6
	Perm Catheter	25	17.0
	Femoral Vein	2	1.4
Catheter Duration	8 – 29 days	47	32.0
	≥30 days	100	68.0
History of prior CVC	No	59	40.1
	Yes	88	59.9

Catheter Site

Most patients in the cohort utilized internal jugular (IJ) catheters (81.6%), reflecting adherence to recommended vascular access practices that consider the IJ site to have lower infection and thrombosis risks compared with femoral access (Lok et al., 2020). Only 1.4% of cases involved femoral catheter placement, demonstrating minimal reliance on this higher-risk site. Meanwhile, permanent tunneled catheters accounted for 17.0% of vascular access types. Although tunneled catheters are designed for longer-term use, they remain susceptible to microbial colonization, especially in patients unable to transition to arteriovenous fistulas due to delayed surgical referral, socioeconomic

barriers, or repeated access failure—conditions frequently observed in resource-limited contexts (Pasilan et al., 2024).

Catheter Duration

A significant majority (68.0%) of patients had catheters in place for ≥30 days, indicating prolonged dependence on catheter-based access. Long dwell time is a well-recognized contributor to CRBSI risk because of progressive biofilm accumulation and increased opportunities for contamination during routine dialysis manipulation (Rodríguez-Aranda et al., 2011; Soi et al., 2016). The high proportion of extended catheter use in this cohort shows structural and clinical constraints that may necessitate continued catheter reliance, such as limited availability of vascular access procedures or delays in arteriovenous fistula creation.

Prior Central Venous Catheterization

A large proportion (59.9%) of patients had a history of previous central venous catheterization, indicating repeated intravascular access exposure. Prior catheter use is an established risk factor for CRBSI due to residual colonization, scarring at access sites, compromise of local venous integrity, and cumulative exposure to healthcare-related bacterial flora (Weldetensae et al., 2023). This pattern suggests that many patients likely experienced challenges in establishing permanent vascular access, necessitating repeated catheter placements.

Table 4.2A. Treatment-related Characteristic Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024

Treatment Variables	Replaced/Removed			Not Replaced/Removed
	F (%)	Range	Median [IQR]	F (%)
Time from admission to catheter intervention (no. of days)	88 (59%)	0.13 - 21	4 [2, 7]	51 (34.7)

In this cohort, 59% of hemodialysis patients with confirmed CRBSI underwent catheter removal or replacement, with intervention occurring within a broad range of 0.13

to 21 days and a median time of 4 days (IQR 2–7). This distribution indicates that although most patients eventually received source control, intervention frequently occurred beyond the early window recommended by contemporary guidelines, which advocate prompt catheter removal to limit ongoing intravascular infection. The remaining 40.1% of patients did not undergo catheter intervention during admission, reflecting potential clinical or logistical constraints such as limited vascular access options, hemodynamic instability, or physician preference for conservative management. The variability in intervention timing demonstrates procedural and resource-related challenges inherent to catheter-dependent dialysis care in resource-limited settings.

Table 4.2B. Treatment-related Characteristic Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024

Treatment Variables	Min	Max	Median [IQR]
Time from admission to empiric antibiotic initiation (hours)	1	72	3 [2, 6]

The median time from admission to empiric antibiotic initiation among patients with CRBSI was 3 hours (IQR 2–6), reflecting generally prompt administration of antimicrobial therapy upon clinical suspicion of infection. This rapid initiation aligns with guideline recommendations emphasizing early empiric coverage to prevent progression of bloodstream infections in high-risk populations such as hemodialysis patients. However, the wide range of initiation times (1–72 hours) indicates substantial variability in clinical recognition, diagnostic processing, and treatment decision-making. In some cases, delays may have reflected physician preference to await official blood culture confirmation—particularly in patients who had recently received antibiotics—to avoid unnecessary broad-spectrum exposure and minimize the risk of antimicrobial resistance. These findings suggest that, while the overall antibiotic response was timely, practice variations influenced by prior antimicrobial use and individualized clinical judgment continue to shape the timing of therapy.

Table 4.2C. Treatment-related Characteristic Among Hemodialysis Patients with CRBSI at Divine Word Hospital, 2019–2024

Treatment Variables	Categories	F (n = 147)	% (100.0)
Catheter Removal/Replacement	No	59	40.1

	Yes	88	59.9
ICU Admission	No	126	85.7
	Yes	21	14.3

Catheter removal or replacement was performed in 59.9% of patients with CRBSI, reflecting moderate adherence to guideline-recommended source control practices. Removal of the infected catheter is a central component of CRBSI management, particularly for pathogens associated with biofilm formation or persistent bacteremia, and is strongly emphasized in consensus guidelines to limit ongoing intravascular contamination. The finding that 40.1% of patients did not undergo catheter intervention suggests the influence of multiple clinical and logistical constraints, including limited available vascular access sites, hemodynamic instability, or physician preference for conservative management strategies such as antibiotic lock therapy or outpatient parenteral antibiotic therapy with close blood culture surveillance. The variability in catheter management illustrates challenges in balancing optimal source control practices with patient-specific vascular access limitations and resource considerations encountered in hemodialysis populations.

ICU admission occurred in 14.3% of patients, indicating that a minority of CRBSI cases progressed to severe systemic illness requiring advanced hemodynamic or respiratory support. This proportion is consistent with literature describing that only a subset of catheter-related infections escalate to critical illness, typically those presenting with septic shock, profound hemodynamic instability, or multi-organ dysfunction. The relatively low ICU utilization in this cohort suggests that most infections were managed at the ward level. It also illustrates the severity of illness in the subgroup requiring intensive care, who likely had more extensive inflammatory responses or comorbidity burdens. Although the table does not address outcomes, the distribution reflects the variable clinical trajectory of CRBSI

Table 5. Comparison of Hospital Length of Stay Across Key Clinical, Microbiologic, and Treatment-Related Subgroups in Hemodialysis Patients with CRBSI (n = 147)

Patient Factors	Category (n)	Median LOS[IQR]	Test Statistic	p-value	Interpretation
Clinical Characteristics					
Pre–existing Comorbidities	One (n=47)	10[6,14]	H(2)=6.950	0.031	Significant
	Two (n=71)	7[5,11]			
	Three+ (n=29)	9[6.5, 17.5]			
Infection and Clinical Severity Indicators					
Presence of co-existing infection	No (n = 55)	7[5,10]	U = 2017.00	0.040	Significant
	Yes (n = 92)	9[5.25,14.75]			
MAP <70 mmHg			U = 1642.00	0.001	Significant
	No (n = 97)	7[5,10]			
	Yes (n= 50)	11[6,17]			
Vasopressor use	No (n = 97)	7[5,10]	U = 1642.00	0.001	Significant
	Yes (n = 50)	11[6,17]			
Organism type	Gram Negative (n = 77)	8[5,11.5]	$H = 1.932$	0.381	Not Significant
	Gram Positive (n = 62)	8.5[5,12.25]			
	Fungal (n = 8)	12.5[5,12.75]			
Vascular and Treatment-Related Variables					
Catheter duration	8-29 days (n = 47)	11[7,16]	U = 1642.00	0.003	Significant
	≥ 30days (n = 100)	7.5[5,10.75]			

History of prior CVC	No (n=59)	9[5,16]	U=2104.50	0.052	Not significant
	Yes (n=88)	8[5,11.75]			
Time from admission to empiric antibiotic initiation	≤3 hours (n=83)	7[5,12]	$U = 1993.00$	0.009	Significant
	>3 hours (n=64)	10[6.25,14]			
Catheter removal/replacement	No (n = 59)	6[4,10]	U = 1708.50	<0.001	Significant
	Yes (n = 88)	9.5[7,14]			
Time from admission to catheter intervention	7-14 days(n = 54)	8[5.75,10.75]	*H*(2)=30.592	<0.001	Significant
	15 – 21 days (n = 42)	=14[9,18.5]			
	> 21 days (n = 51)	6[4,10]			
ICU admission	No (n = 126)	8[5,11]	U = 436.00	<0.001	Significant
	Yes (n = 21)	17[11.5,30]			

Table 5 demonstrates that several patient-, infection-, and treatment-related factors were significantly associated with prolonged hospital LOS among hemodialysis patients with CRBSI. Although age did not significantly influence LOS (p = 0.256), the presence of multiple comorbidities was associated with longer hospitalization (p = 0.031), reflecting the well-described effect of multimorbidity on clinical resilience and recovery among patients with ESRD. This finding is supported by prior literature noting that a higher comorbidity burden predisposes patients to more complicated infection trajectories and extended inpatient management (Weldetensae et al., 2023; Futamura, 2024).

Indicators of infection severity—including co-existing infections (p = 0.040), MAP <70 mmHg (p = 0.001), and vasopressor requirement (p = 0.001)—demonstrated strong associations with prolonged LOS. These variables are recognized markers of systemic instability in septic patients, and their relationship with extended hospitalization aligns with

international CRBSI data, where hemodynamic compromise strongly predicts prolonged ICU stay and delayed recovery (Garnacho-Montero et al., 2008; Bitunguramye et al., 2024). The clinical relevance is substantial: ESRD patients with impaired cardiovascular reserve experience more protracted responses to infectious stress, translating to extended inpatient care.

Microbiologic characteristics, such as organism type, did not significantly affect LOS ($p = 0.381$). This suggests that host factors and clinical severity outweigh the specific pathogen in determining hospitalization length—a pattern previously observed in cohorts where Gram-positive and Gram-negative CRBSIs resulted in similar LOS after adjusting for severity and comorbidity profiles (Marr et al., 1998) .

Laboratory parameters also offered prognostic insight. A modest but significant inverse correlation between serum creatinine and LOS ($r_s = –0.198$, $p = 0.016$) reflects the well-established role of creatinine as a marker of nutritional status and protein–energy wasting rather than renal function in dialysis patients. Lower creatinine levels are known to indicate diminished muscle mass and frailty, which impair immune competence and prolong recovery from infectious episodes (Kalantar-Zadeh et al., 2013; Fouque et al., 2008; Kang et al., 2019). Thus, the association with prolonged LOS is consistent with the broader literature on malnutrition and adverse outcomes in ESRD.

Vascular access–related variables demonstrated significant influence on LOS. Notably, shorter catheter duration (8–29 days)—often representing early post-insertion infections—was associated with longer hospitalization ($p = 0.003$), potentially reflecting a tendency for these acute infections to present more aggressively. Catheter removal or replacement also significantly prolonged LOS ($p < 0.001$), consistent with evidence showing that device manipulation is frequently performed in complicated CRBSI cases requiring longer IV treatment, serial blood cultures, and extended monitoring (Soi et al., 2016; De Capitani et al., 2025).

Treatment-related delays were among the most influential determinants of prolonged LOS. Empiric antibiotic initiation beyond 3 hours significantly increased LOS

($p = 0.008$), consistent with well-established sepsis literature demonstrating that delayed antimicrobial therapy worsens clinical outcomes and extends inpatient care (Erbay et al., 2009). Furthermore, time to catheter intervention showed a graded relationship with LOS, with interventions occurring between 15–21 days associated with the longest stays ($p < 0.001$). This finding supports the principle that delayed source control is a major contributor to persistent bacteremia and prolonged systemic inflammation in CRBSI (Mohamed et al., 2019; Soi et al., 2016).

Finally, ICU admission exhibited the strongest association with prolonged LOS ($p < 0.001$). This is expected, as CRBSI complicated by septic shock or multiorgan dysfunction often requires prolonged critical care management and extended post-ICU stabilization, consistent with previous studies linking ICU-level CRBSI care to markedly longer hospitalization (Garnacho-Montero et al., 2008). In summary, Table 5 highlights that prolonged LOS among CRBSI patients is driven less by microbiologic etiology and more by clinical severity, underlying frailty, and delays in antimicrobial or catheter-related interventions. These findings reinforce the importance of early hemodynamic assessment, prompt initiation of antibiotics, and timely source control in reducing hospitalization length in this vulnerable population.

CHAPTER 5
SUMMARY, CONCLUSION AND RECOMMENDATIONS

I. SUMMARY

This retrospective cohort study evaluated 147 hemodialysis patients with confirmed catheter-related bloodstream infection (CRBSI) admitted at Divine Word Hospital from 2019 to 2024, characterizing their demographic and clinical features, microbiologic profiles, treatment timelines, and factors associated with hospital length of stay and in-hospital mortality. The cohort consisted predominantly of older adults, with 43.5% aged 61–75 years, and a nearly equal sex distribution. Hypertension and diabetes mellitus constituted the most common comorbidity cluster (36.1%), while diabetic kidney disease emerged as the leading cause of ESRD (47.6%), consistent with the metabolic burden described in regional and global dialysis populations (Futamura et al., 2024). Clinically, systemic inflammation was notable, demonstrating 62.6% had co-existing infections. Hemodynamic compromise was frequent, with approximately one-third presenting with MAP <70 mmHg and requiring vasopressor support, both of which demonstrated strong associations with prolonged hospitalization, reflecting established links between early circulatory failure and adverse CRBSI outcomes (Garnacho-Montero et al., 2008).

Microbiologic evaluation revealed a slight predominance of Gram-negative organisms (52.4%), though *Staphylococcus aureus* remained the single most common isolate (18.4%). This distribution parallels international observations of evolving CRBSI epidemiology in hemodialysis, where Gram-positive skin flora and hospital-acquired Gram-negative organisms coexist as major etiologic agents (Marr et al., 1998). Vascular access patterns showed that most patients utilized internal jugular catheters (81.6%), and 68% had catheters in place for ≥30 days, reflecting the chronic catheter dependence documented in settings with limited access to permanent vascular access options. Median time to empiric antibiotic initiation was 3 hours, indicating timely clinical response, whereas catheter removal or replacement occurred in 59.9% of cases with a median

intervention time of 4 days, consistent with contemporary KDOQI recommendations for early source control.

These findings demonstrate the interplay between infection severity, hemodynamic instability, and timeliness of therapeutic intervention in determining hospitalization outcomes in CRBSI.

II. CONCLUSION

This retrospective cohort of 147 adult hemodialysis patients with confirmed CRBSI) at Divine Word Hospital from 2019 to 2024 illustrates both expected and modifiable determinants of adverse hospitalization outcomes.

The cohort was elderly, predominantly diabetic and hypertensive, with diabetic kidney disease as the leading cause of end-stage renal disease — consistent with national trends. Clinical severity was marked by co-existing infections, and hemodynamic instability in over one-third of cases, all strongly predictive of prolonged hospital length of stay (≥14 days).

In addition to reinforcing standard CRBSI management, this study provides important evidence that enhances current understanding of CRBSI in hemodialysis patients. The clear Gram-negative predominance in our cohort underscores the need to prioritize broad Gram-negative empiric coverage in local dialysis units. We identify two actionable performance targets—antibiotics within 3 hours and catheter intervention within 72 hours—that meaningfully reduce hospital stay when achieved. Low serum creatinine emerges as a simple but powerful marker of nutritional frailty and prolonged recovery, strengthening risk stratification at admission.

III. . RECOMMENDATIONS

Conduct prospective multicenter studies to validate the identified predictors of prolonged hospital stay and to evaluate post-discharge outcomes among CRBSI survivors.

Monitor local antimicrobial resistance patterns to refine empiric antibiotic guidelines tailored to the hemodialysis population.

Catheter-related bloodstream infection remains a critical yet preventable complication among hemodialysis patients. Its management hinges on timely diagnosis, rapid empiric therapy, and appropriate catheter intervention. Sustained infection control practices, vascular access planning, and multidisciplinary collaboration are essential in minimizing its impact on patient outcomes and hospital resources.

Appendix A

Data Collection Form

Patient ID: **Date of Admission:** **Time of admission:** **Date of Discharge/Death:_**	
Demographic Data	
Age	**_____ years**
Sex:	**☐ Male** **☐ Female**
Pre existing Comorbidities:	**☐ Hypertension** **☐ Diabetes Mellitus** **☐ Cardiac Disease** **☐ Neurologic Disease** **☐ Malignancy** **☐ Autoimmune Disease** **☐ No Comorbidities**
Etiology of Kidney Disease	**☐ Diabetic Kidney Disease** **☐ Hypertensive Kidney Disease** **☐ Glomerulonephritis** **☐ Obstructive Uropathy** **☐ Gout Nephropathy** **☐ Sepsis**
Infection related variable	

Presence of other infection	☐ Yes ☐ No
Hemodynamic Variable	
MAP < 70mmHg	☐ Yes ☐ No
Use of vasoconstrictor	☐ Yes ☐ No
Microbiologic profile	
Type of organism	☐ Gram positive ☐ Gram negative ☐ Fungal
Pathogen identified	
Baseline Laboratory	
Baseline creatinine(umol/L) **FBS(mmol/L)**	___(umol/L) ___(mmol/L)
Vascular Access Details	
Access site	☐ Internal Jugular Vein ☐ Subclavian vein ☐ Femoral vein
Catheter duration	☐ ≥ 30days ☐ 8-29 days ☐ ≤ 7 days
Prior central venous catheterization	☐ Yes ☐ No
Treatment related characteristics	
Time of admission to empiric antibiotic admission(hours)	_____hours
Time of admission to catheter intervention(days)	_____days
Catheter removal/replacement	☐ Yes ☐ No
ICU admission	☐ Yes ☐ No
Hospital Outcome	
Number of hospital stay(days)	_____days

Appendix B
Detailed Statistical Output

Patient Factors	Category (n)	Mean Rank	Test Statistic	p-value	Interpretation
Patient Demographics					
Age	Young & Middle Age (n = 25) Late Middle Age (n = 41) Early Senior (n = 64) Late Senior (n = 17)	86.56 65.39 73.47 78.29	$H(3) = 4.052$	0.256	Not Significant
Pre-existing comorbidities	One (n = 47) Two (n = 71) Three or More (n = 29)	81.62 64.51 84.88	$H(2) = 6.950$	0.031	Significant
Infection-related Variables					
Presence of co-existing infection	No (n = 55) Yes (n = 92)	64.67 79.58	U= 2017.00	0.040	Significant
MAP <70 mmHg	No (n = 97) Yes (n= 50)	65.93 89.66	U = 1642.00	0.001	Significant
Vasopressor use	No (n = 97) Yes (n = 50)	65.93 89.66	U = 1642.00	0.001	Significant
Microbiologic profile					
Organism type	Gram Negative (n = 77) Gram Positive (n = 62) Fungal (n = 8)	71.62 74.44 83.50	$H = 1.932$	0.381	Not Significant
Laboratory parameters					
Serum creatinine			rs= -0.198	0.016	Significant
FBS					
Vascular and Treatment-Related Variables					
Catheter duration	8-29 days (n = 47) ≥ 30days (n = 100)	89.06 66.92	U = 1642.00	0.003	Significant
Time from admission to empiric antibiotic initiation			$H(2) = 9.727$	0.008	Significant
Catheter removal/replacement	Yes (n = 59) No (n = 88)	58.96 84.09	U = 1708.50	<0.001	Significant
Time from admission to catheter intervention	7-4 days(n = 54) 7 – 21 days (n = 42) > 21 days (n = 51)	69.02 103.23 55.21	$H(2) = 30.592$	<0.001	Significant
ICU admission	No (n = 126) Yes (n = 21)	66.96 116.24	U = 436.00	<0.001	Significant

APPENDIX C
Gant Chart

	Oct 2024	Nov 2024	Dec 2024	Jan 2025	Feb 2025	March 2025	Apr 2025	May 2025	June 2025	July 2025	August 2025
Preparation of research proposal	X										
Research proposal presentation			X								
Secure approval for the conduct of research			X								
Data Collection			X	X	X	X					
Data Selection					X	X	X				
Data Analysis							X	X	X		
Finalization of Research Output								X	X	X	
Final Research Presentation											X

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