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Determining the Root Causes of Complications in Hemodialysis Maintenance Therapy

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Abstract

As with peritoneal dialysis and kidney transplantation, hemodialysis has been considered one of the most effective therapies for the replacement of kidney function. While this helps to save patients with the disease by decreasing morbidity /mortality/ rates, this medication has some side effects. These may manifest during the dialysis process alongside the ongoing treatment. Avoiding these barriers becomes crucial for improving the patients' prognosis in this context. We are going to mention some short-term complications temporarily observable during session such as muscle cramps or hypotension, or more related to the middle-long term, for instance, vascular access issues or electrolyte disorders. Hypotesnion, muscle cramps, hypoglycemia, electrolyte disturbances, disequilibrium syndrome, hypocalcemia, etc. are common complications occur during dialysis. In the extended course of dialysis treatment, patients oftencontend with complications such as bone disease, disruptions in endocrine function, infections, and cardiovascular issues. These challenges underscore the significance of ongoing vigilance and tailored care to manage the diverse health needs of individuals undergoing chronic hemodialysis. Hemodialysis is a crucial renal replacement therapy, alongside peritoneal dialysis and renal transplantation, utilized to manage end-stage renal disease (ESRD) by filtering waste products and excess fluids from the blood. Despite its efficacy in improving morbidity and mortality rates among renal patients, hemodialysis is associated with a variety of complications that can arise both during the dialysis sessions and with long-term use. Acute complications during dialysis sessions include hypotension, which is the most common and often results from rapid fluid removal. Muscle cramps can occur due to shifts in fluid and electrolyte balances. Hypoglycemia is another potential issue, particularly in diabetic patients, due to the glucose-free dialysate used during treatment. Electrolyte imbalances, such as hyperkalemia or hypokalemia, can also develop, requiring vigilant monitoring of serum levels to ensure proper management. Additionally, dialysis disequilibrium syndrome, characterized by neurological symptoms due to rapid changes in blood solute levels, and hypocalcemia, resulting from calcium removal during dialysis, are notable acute complications. Long-term hemodialysis use can lead to more chronic complications, significantly impacting patient quality of life. Bone disease, or renal osteodystrophy, is prevalent due to disrupted calcium and phosphate metabolism. Endocrine disturbances, such as altered thyroid function and sexual dysfunction, are also common. Sepsis could arise from infection, especially at the site of the vascular access line, where it poses a great risk. In addition, longer-term dialysis patients are also predisposed to hypertension, left ventricular hypertrophy, and other cardiovascular complications, which are the leading causes of death for chronic dialysis patients. These complications make it evident that there exist significant gaps where integrated approaches need to be implemented to address all the risks that patients undergoing hemodialysis face.

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INTRODUCTION

Hemodialysis, or the use of a machine to filter

blood and expel waste and extra water out of thebloodstream, is sort of like a surrogate kidney, mainly when there is kidney failure. It cannot replace the function of the kidney fully because the two principles that operate the unit are diffusion and ultrafiltration [1]. It is commonly associated with chronic renal failure (CRF), a condition that involves a slow, gradual decline in renal function over many months or years where the GFR is less than or equal to 15ml/min. One of the routine procedures to diagnose the functioning of the kidneys is determining serum creatinine, which represents the glomerular filtration rate (GFR). Abnormal creatinine levels in the CRF state reflect a lesser GFR in the kidneys. In CRF patients, the kidneys have lost their ability to cleanse the blood, and therefore dialysis is performed to remove waste from the blood [2].

The most common complications associated with hemodialysis are:

- *Muscle Cramps:* The exact cause of the development of the condition for some reason remains unknown. During dialysis, cramps are more common, while with the use of low sodium concentrations in the dialysing solutions, fast ulfire rates, hypovolvamic and hypotension form part of the likely side effects. These factors lead to vasoconstriction and reduced blood flow to the muscular system, an effect that results in detrimental effects to muscular relaxation.

Treatment

1. Stop or reduce ultrafiltration.
2. Treatment with 0.9% saline is effective.
3. Forced stretching of the muscle involved could provide relief.
4. L-carnitine and vitamin E administration may reduce the incidence of cramping [3].
    - *Dialyzer Reactions:* Typically, reactions associated with the hemodialyzer are categorized intotwo main types:
    - *Type A-Anaphylactic Reaction:* These are the possible symptoms of type A reactions: dyspnea, fever, hives, nasal discharge, itching eyes, abdominal cramps, diarrhea, and increased armpit and specific fistula localization temperature. These symptoms may occur within the first thirty minutes after the hemodialysis and can be attributed to ethylene oxide, which is used for thesterilization of dialyzers.

Treatment and prevention strategies include:

1. Administering intravenous antihistamines, steroids, and epinephrine.
2. Ensure thorough rinsing of dialyzers before use to remove residual allergens and minimize the risk of reactions [4].
    - *Type B-Nonspecific Reactions:* It may lead to chest or back pain within 20 to 40 minutes after starting hemodialysis, caused by complement activation. This pain is characterized by its rapidonset and severity.

Treatment/Prevention

1. Experimenting with an alternative dialyzer membrane could potentially aid in prevention.
    - *Hemolysis:* In the course of hemolysis, there are some evident features that may be observed in the patient during the process of dialysis: The venous blood line gives a port-wine look. The patient's looking pale and listless. The hemocrit values have dropped significantly, and the plasma, when spun in a centrifugal, has taken on a pink color. Hemolysis in the course of HD is considered an indication for stopping HD immediately, an urgent medical condition. It should be noted that patients should be followed up in cases of delayed hemolysis and should undergo a more comprehensive hematological tests. The reason for the significant correspondence, therefore, must be inferred from the analysis of a sample of the dialysate as well.

Treatment/Prevention

1. Before usage, test the machine to verify the effective functioning of the air detector alarm system.
2. Avoid chemical contaminants that can damage RBC's, oxidants such as chloramines, copper, and zinc, reducing agents such as formaldehyde, hypo- or hypertonic dialysate, overheated dialysate,small needles, and highly negative arterial pressure alarms.
3. Ensure the correct positioning of tubing in the roller pumps [5].
    - *Cardiac Arrhythmias:* Mortality rates rise following an extended intra-dialytic interval, typically within 6 hours after the conclusion of a hemodialysis session. The hemodialysis procedure initiates various mechanisms that may heighten the risk of cardiac arrhythmias. Risk factors for cardiac arrhythmias are left ventricular hypertrophy, heart failure, and ischemic heart disease; other factors are age, respiratory failure, and rapid reduction of extracellular volume etc.

Treatment/Prevention

1. Supervise serum electrolytes, bicarbonate, glucose levels, a cardiac rhythm strip via ECG, oxygen saturation, and infusion as IV fluids maybe required.
2. It can therefore be recommended that, if such circumstances arise, it may be appropriate to stop treatment modalities such as hemodialysis.
3. General Therapy: Use flexibly digoxin in case of necessity that concern ventricular rate control.
4. When dialysate analysis is performed, alter to 3-3. A potassium level of 5 mEq/L is advised for patients on digoxin to avoid low potassium levels [6].
5. *Hemorrhage:* Hemodialysis patients are commonly perceived to face an increased risk of bleeding. This susceptibility is attributed to a dysfunction in primary hemostasis, which arises from platelet dysfunction and alterations in platelet-vessel wall interaction, both of which are induced by uremia.

Treatment/Prevention

1. Warfarin and antiplatelet medications like aspirin elevate the incidence of major bleeding events.
2. Screen for bleeding, activated clotting time, and prolonged bleeding time.
3. Should never keep access covered, review heparin dose, strategy based on risk assessment, low-risk regional anticoagulation with heparin and protamine, heparin-free dialysis, regional citrate anticoagulation, and alternative methods to convectional heparin for high-risk patients [7].
    - *Febrile Reactions:* A temperature increase of at least 0 is called the minimum threshold, which means that it is impossible to record a temperature lower than the initial level. 5°C, but either axillary or rectal temperature should rise to a level of at least 37°C during hemodialysis as a sign of febrile reaction. 5°C or 38. 0°C, respectively. These may be due to exposure to components of dialysate solution and equipment used during the hemodialysis process, or they could represent localized infections at the vascular access site or catheters and grafts [8].

Treatment/Prevention

1. Obtain blood cultures.
2. Begin largely supportive and empirical.
3. Reduce the use of catheters for hemodialysis.
4. Provide adequate hemodialysis.
5. Prevent or treat malnutrition.6. Avoid iron overload.
7. Use a biocompatible dialysis membrane.
    - *Metabolic Acidosis:* It can occur accidently as a consequence of dialysate fluid containing

an improper ratio of acid and base concentrates in the form of acetate, or it can develop as a result of the accidental use of an acidic concentrate instead of acetate or bicarbonate and due to the computer software malfunction of the machine. Severe metabolic acidosis has been reported during during the first 2 hours of hemodialysis using sorbent regenerative hemodialysis in mechanicallyventilated patients.

Treatment/Prevention

1. It consists of the intravenous administration of bicarbonate at the correct concentration (38–40 mEq/L).
2. The main goal of prevention is to fit all hemodialysis machines with a pH meter and alarms that will prevent the extreme acid load that may be caused by an inappropriately prepared bicarbonate dialysate.
3. Conductivity checks are vital [9].
    - *Metabolic Alkalosis:* The most common cause is the loss of hypochloric acid as a result ofvomiting or nasogastric suction.
      Less Common Causes: Technical errors during HD; malfunction of the hemodialysis machine'spH monitor and proportioning system.
      Severe metabolic alkalosis may cause tissue hypoxia, arrhythmia, seizure, etc.

Treatment/Prevention

1. Applying hemodialysis therapy with specially formulated low-bicarbonate, low-acetate, or acid dialysis is a safe and effective intervention for severe metabolic alkalosis.
2. Severe metabolic alkalosis can be corrected rapidly and safely with bicarbonate concentrate dialysate between 25 and 28 mEq/L [10].
    - *Hyperkalemia:* It is very common in ESRD (end stage renal disease). Around 10% of HD patients contribute to 3–5% of deaths.

Etiology

- Excessive dietary potassium intake.
- Metabolic acidosis.
- Acute infection with marked catabolism.
- Medications.
- High Dialysis potassium concentrations.

AIMS AND OBJEVTIVES

1. The aim of the present study was to determine the spectrum of causes of complications in patients undergoing maintenance hemodialysis, patients with post-renal transplant failure, and patients who are planned for renal transplant at Nephro Plus Dialysis Unit Healthsure Hospital Gharuan, Punjab.
2. To evaluate the various complications of patients undergoing hemodialysis.
3. To examine the correlation between kidney disease and its complications concerning age and gender distribution.

MATERIALS AND METHODS

The prospective descriptive study was conducted in the Department of Nephrology at Nephro Plus Dialysis Unit Healthsue Hospital Gharuan, Punjab, during the period of 6 months. A total of 124 patients attending the nephrology clinic or being admitted to the nephrology ward were taken during this period, regardless of age, sex, race, or cause of renal failure. These patients were divided into three groups:

1. The first group is comprised of patients diagnosed with renal failure attending a hemodialysis unit with the following perspective:

Patients needing maintenance emergency hemodialysis for the following indications

- AKI with hyperkalemia.
- Severe azotemia.
- CKD with hyperkalemia.
- CKD with metabolic acidosis.
- CKD with fluid overload.
- Drug-induced renal failure.
- CKD with ureamia

2. The second group also includes patients with post-renal transplant failure who receive hemodialysis for maintenance and emergencies as well.
3. The third group is comprised of patients being admitted to the nephrology ward or kidney transplantunit (KTU) for a kidney transplant. These patients receive maintenance hemodialysis until they get transplanted.
4. Informed and written consent was obtained from all patients in two languages (English and Hindi)receiving maintenance emergency hemodialysis and post-renal transplant failure, as well as from patients planned for renal transplant [11–13].

Inclusion Criteria

Patients diagnosed with renal failure and attending maintenance hemodialysis with emergency indications.

- Patients with post-renal transplant failure.
- Patients who are planned for renal transplantation.
- Patients with chronic kidney disease (CKD). Patients with acute kidney injury (AKI) [14].

Exclusion Criteria

Kidney failure patients with a positive COVID-19 status were excluded from the study, as these patients receive hemodialysis in a separate infectious disease block (IBD). However, three positive COVID-19 patients were dialyzed in the dialysis unit as they needed emergency dialysis; however, strict SOPs were followed to prevent COVID-19 transmission. Patients who weren't willing to share their data [15–16].

The diagnosis of CRF and its etiology was made on the basis of a detailed medical history, underlying comorbidities, a physical examination, and the following investigations as per the prescribedprotocol. The following details and investigations were taken from each patient: The socio-demographic characteristics include:

Name:
MRD NO:
Age/Sex:
Residence:
Medical diagnosis:
Site of access for hemodialysis:
Indication of hemodialysis:
Site of access for hemodialysis:
Indication of hemodialysis:
COVID 19 Status:
Blood investigations: CBC/LFT/KFT/Coagulogram/ABG/VBG.
Triple serology status: HIV/HBsAg/HCV

The hemodialysis unit has a regular capacity of 13 dialysis machines, all Fresenius volume

controlled with the model 4008s. 8 machines for negative patients (patients with negative triple serology status HBsAG, HCV, HIV) in the hemodialysis unit; 2 machines in the infectious disease block for COVID-19 patients; 1 machine in the neonatal intensive care unit for pediatric patients; and 2 mechines for positive patients, including HCV and HBV patients, in the hemodialysis unit. The dialyser used was hollow fiber SF 8 with a surface area of $1.3m^2$. Bicarbonate-based dialysate was used in all hemodialysis sessions. The study was conducted during the period of the COVID-19 pandemic. Every patient was investigated with a COVID-19 test as per patient status and symptoms. Both rapid antigen test (RAT) and reverse transcription polymerase chain reaction (RT-PCR) were advised to patients before dialysis; however, patients were dialyzed irrespective of their COVID-19 status, as CKD patients with positive COVID-19 status were dialyzed in a separate infectious disease block (IBD), and strict SOPS were followed to prevent COVID-19 transmission. Before commencing the dialysis, I rounded the ward to record every patient's weight, blood pressure, respiratory rate, temperature, oxygen saturation, and pulse before beginning the dialysis session, then every half hourly throughout the duration of the HD-session time. Triple serology status is revealed by the card method, ELISA, and genotype and viral load are assessed by quantitative analysis [17, 18]. The patients's access to hemodialysis was evaluated, and dialysis was started with a blood flow of 200–300 ml and a dialysate flow of 500–800 ml/minute. Anticoagulation was achieved by unfractioned heparin with a dosage of 100 IU/kg of body weight. In cases where the patient is contraindicated to heparin, a saline infusion of 100–150 ml is given every 15–30 minutes to prevent coagulation of the extracorporeal blood circuit [19].

Hemodialysis adequacy was assessed through urea kinetic modeling, utilizing Kt/V. Blood glucose levels were monitored for hypoglycemia as deemed clinically necessary. Electrocardiograms (ECGs) were conducted for patients reporting new-onset chest discomfort during hemodialysis. During the procedure, the patient is completely monitored for vital parameters and clinical, technical, and vascular access-related complications, which are described as follows:

Clinical complications include hypotension, nausea and vomiting, fever and chill, headache, chest pain and back pain, hypoglycemia, cardiac arrhythmias, pruritis, hypertension, DDS, muscle cramps, restless leg syndrome, seizures, hypoxia, hemorrhage, and sudden death [20].

OBSERVATIONS AND RESULTS

Gender Distribution

- Table 1 presents the gender distribution of the participants, while Figure 1 provides a pie diagram illustrating this distribution.

Table 1. Gender distribution of the participants.

Gender	Frequency	Percent
Male	69	55.6
Female	55	44.3
Total	124	100

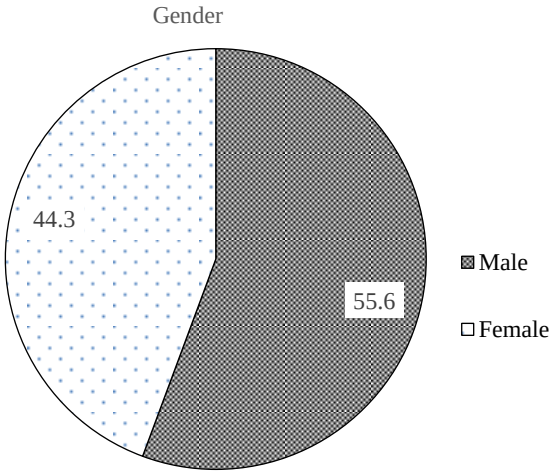

Figure 1. The pie diagram represents the gender distribution of patients.

Age Distribution

- *Table 2* details the age distribution of the patients in the study. This information is also visually represented through a graphical depiction of different age groups in Figure 2.

Table 2. Age distribution of patients in the study.

Age	Frequency	Percent
0–18	5	4
19–35	30	24.1
36–60	62	50
Above 60	27	21.7
Total	124	100

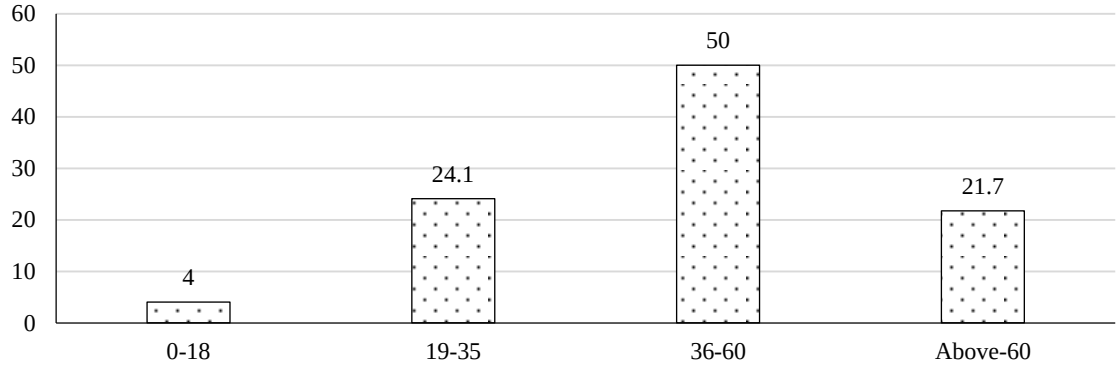

Figure 2. Graphical representation of different age groups of patients.

Patient Demographics

- Table 3 outlines the demographics of the patients, and Figure 3 visually represents the distribution of patients from rural versus urban areas.

Table 3. Patient Demographics.

Residence	Frequency	Percent
Rural	72	58
Urban	52	41.9
Total	124	100

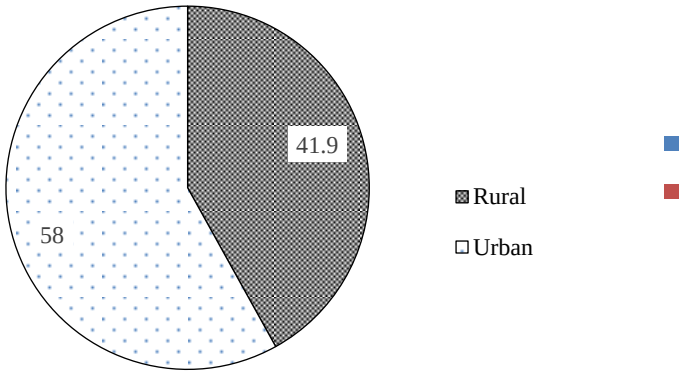

Figure 3. Represents rural vs. urban distribution.

Socioeconomic Status

- Table 4 shows the socioeconomic status of the patients, indicating that the majority belong to the middle class (86.2%), followed by the low class (8.8%), and the high class (4.8%), and Figure 4 represents the socioeconomic status of patients.

Table 4. Socioeconomic status of patients

SocioeconomicStatus	Frequency	Percent
Low		8.8
Middle	107	86.2
High	6	4.8
Total	124	100

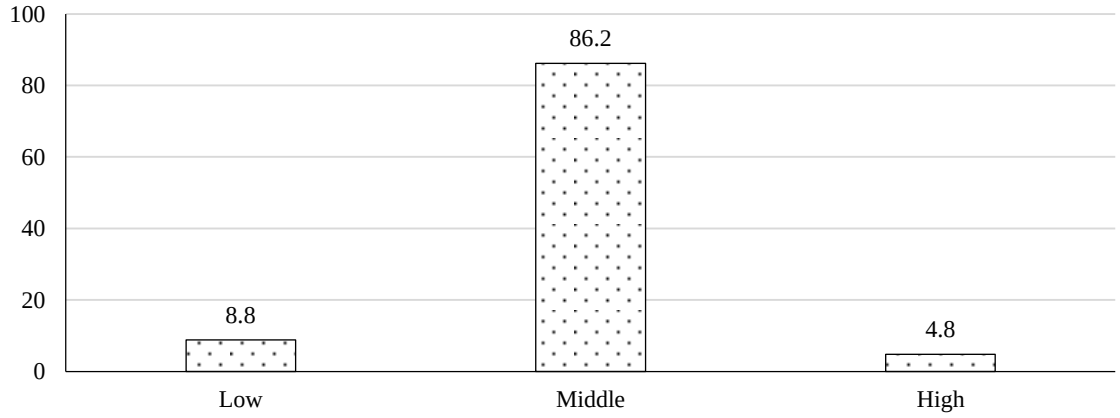

Figure 4. Represents the socioeconomic status of patients.

Vascular Access

- Table 5 lists the types of vascular access used among patients, with femoral access being the most common (54.8%), followed by arteriovenous fistula (AVF) (33.8%), jugular (9.6%), and permacath (1.6%). This distribution is also depicted in Figure 5.

Table 5. Vascular access of patients.

Access	Frequency	Percent
Femoral	68	54.8
Jugular	12	9.6
Permacath	2	1.6
Av graft	0	0

Av fistula	42	33.8
Total	124	100

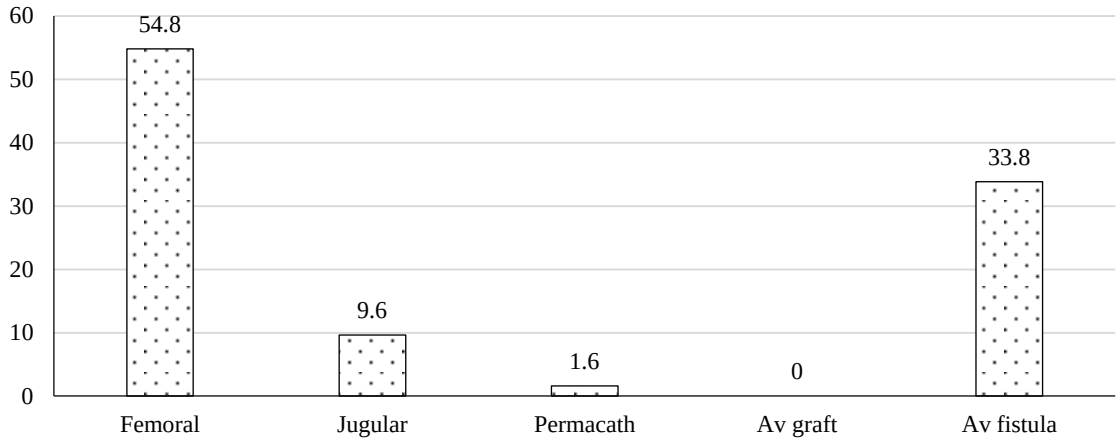

Figure 5. Represents vascular access for patients.

COVID-19 Status

- Table 6 indicates the COVID-19 status of the patients, showing that only 2.4% were COVID-19 positive, while the majority (97.5%) were negative. A pie diagram representing this data is shown in (Figure 6).

Table 6. Present COVID-19 status of hemodialysis patients.

Covid19 status	Frequency	Percent
Positive	3	2.4
Negative	121	97.5
Total	124	100

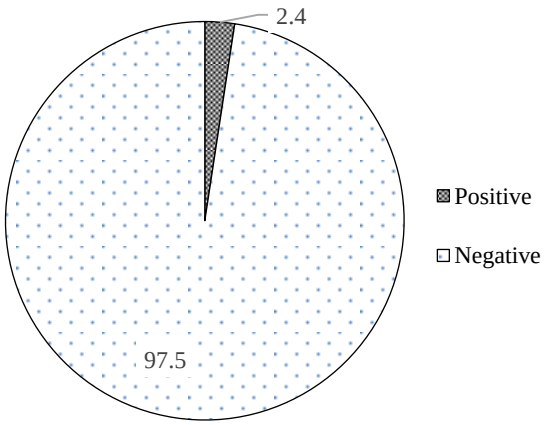

Figure 6. The pie diagram represents COVID-19 status.

Past COVID-19 Historyh

- Table 7 reveals that a majority (85.4%) of patients were COVID-19 negative naive, 2.4% were COVID-19 negative recovered, and 12% had not been tested in the past. This information is visually represented in (Figure 7).

Table 7. Past COVID-19 status of hemodialysis patients.

Covid-19 Status	Frequency	Percent

COVID negative (recovered)	3	2.4
COVID negative (Naive)	106	85.4
Not tested	15	12
Total	124	100

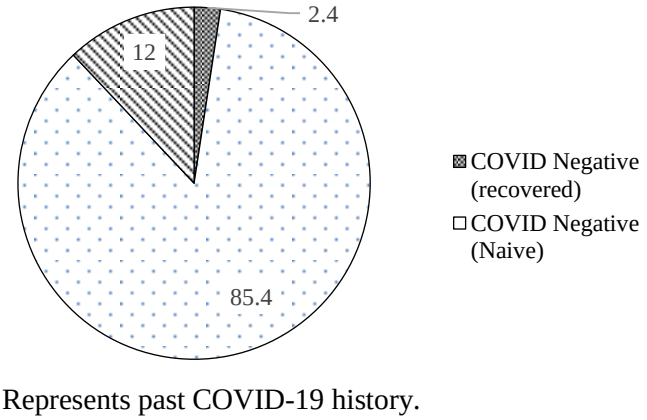

Figure 7. Represents past COVID-19 history.

HIV Status

- Table 8 shows that 100% of the hemodialysis patients were HIV-negative. This data isvisually represented in (Figure 8).

Table 8. HIV status of hemodialysis patients.

HIV status	Frequency	Percent
Negative	124	100
Total	124	100

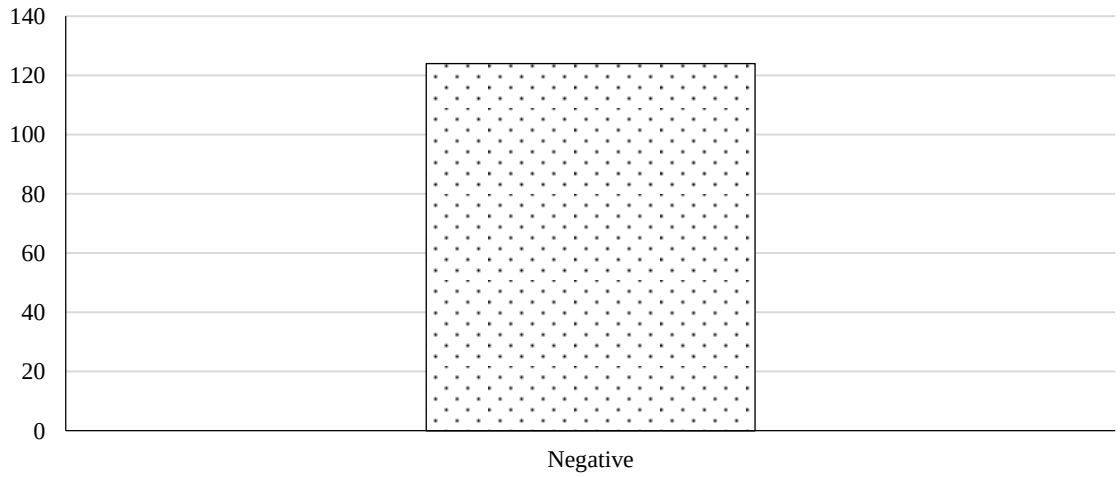

Figure 8. Represents HIV status.

HCV Status

- Table 9 indicates that only 4.8% of patients tested positive for HCV, while the majority (95.1%) were negative. This distribution is illustrated in Figure 9.

Table 9. HCV status of hemodialysis patients

HCV status	Frequency	Percent

Positive	6	4.8
Negative	118	95.1
Total	124	100

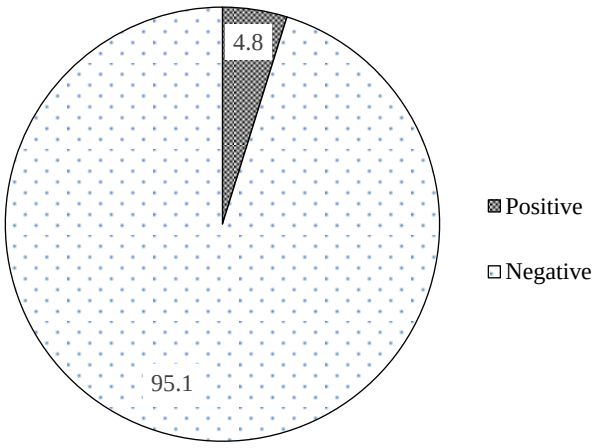

Figure 9. Represents HCV status of patients.

HBsAg Status

- Table 10 reveals that the majority of patients (98.3%) were negative for HBsAg, with only 1.6% testing positive. This data is depicted in a pie diagram in (Figure 10).

Table 10. HBsAg status of hemodialysis patients.

HBSAG status	Frequency	Percent
Positive	2	1.6
Negative	122	98.3
Total	124	100

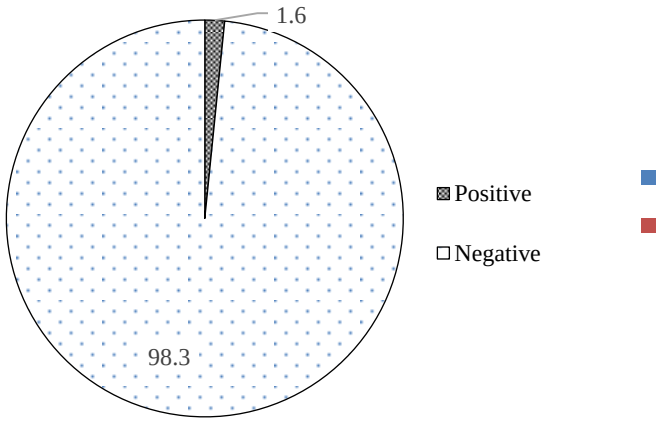

Figure 10. The pie diagram represents HBsAg status of patients.

Etiology of CKD

- Table 11 outlines the etiology of CKD patients, which is also presented in a pie chartin (Figure 11)

Table 11. Etiology of CKD patients.

Etiology	Frequency	Percent

HTN CKD ESRD	46	37
T2 DM, HTN CKD ESRD	30	24.1
CKD ESRD (Unknown etiology)	18	0.8
ADPKD	4	3.2
T1 DM CKD ESRD	4	3.2
Post renal transplant failure	4	1.6
IgA neohropathy CKD ESRD	2	1.6
Drug intoxication AKI	2	3.2
HTN AKI	2	3.2
AKI/azotemia	2	3.2
Septic shocl AKI	2	3.2
Drug induced CKD	1	0.8
Solitary kidney CKD ESRD	1	0.8
CANCA vasculitis CKD ESRD	1	0.
Obstructive uropathy AKI		
Enterocolitis AKI	1	0.8
Heavy chain deposit disease	1	0.
CKD ESRD	1	0.8
Anti GBM CKD ESRD		
PPH AKI	1	0.8
Total	124	100

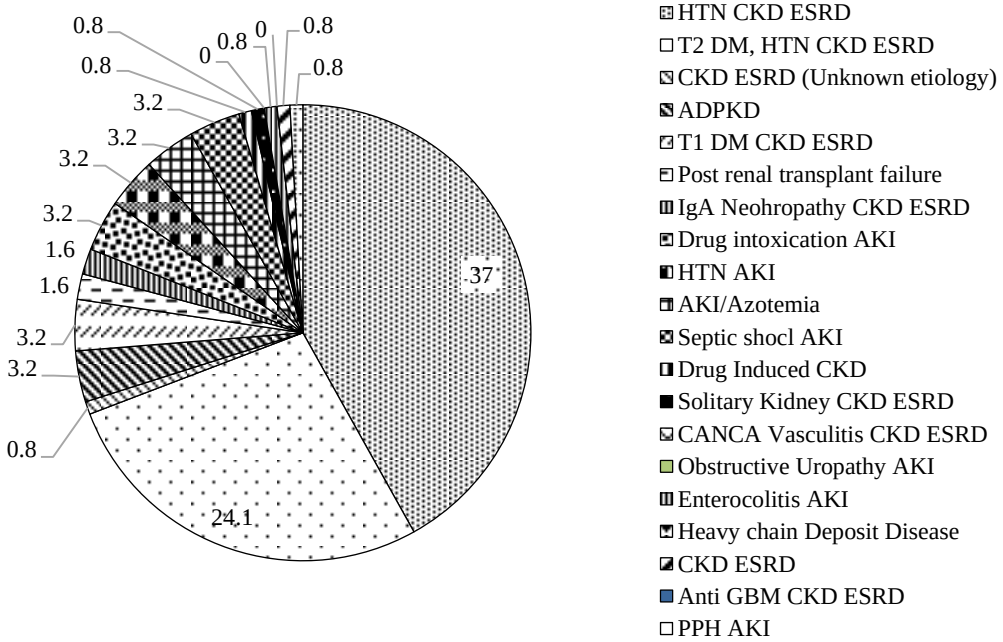

Figure 11. Pie chart etiology of CKD patients and indications for hemodialysis.

- Table 12 shows that the most common indication for hemodialysis was CKD maintenance (47.5%), followed by CKD with uraemia (20.9%), CKD with fluid overload (12.9%), severe azotemia (7.2%), CKD with metabolic acidosis (3.2%), CKD with hyperkalemia (3.2%), AKI with hyperkalemia (2.4%), and drug-induced AKI (2.4%). This information is graphically represented in (Figure 12).

Table 12. Indications of hemodialysis patient.

Indications	**Frequency**	**Percent**
CKD maintainence	59	47.5

CKD with uremia	26	20.9
CKD with fluidoverload	16	12.9
Severe azotemia	9	7.2
CKD with metabolicacidosis	4	3.2
CKD with hyperkalemia	4	3.2
AKI with hyperkalemia	3	2.4
Drug induced AKI	3	2.4
Total	124	100

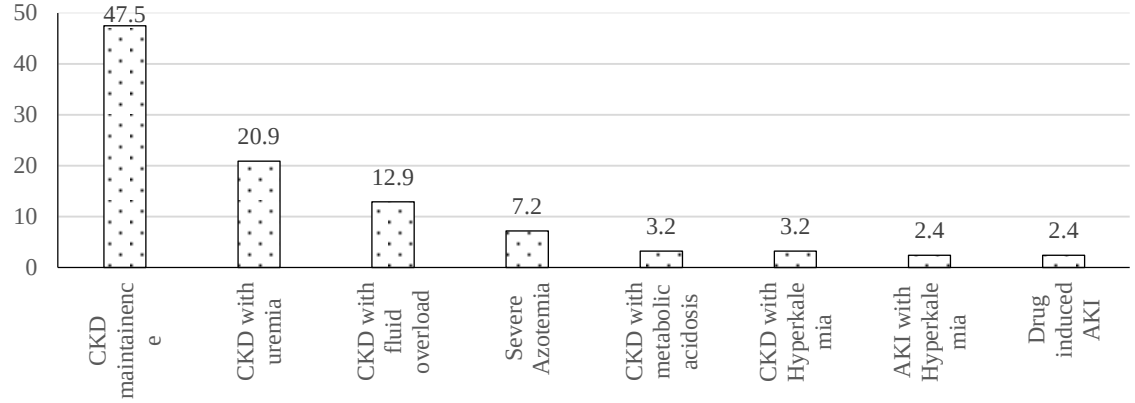

Figure 12. Shows a graphical representation of indications for hemodialysis.

Laboratory Parameters

- Table 13 provides the mean values of various lab parameters for patients, which are also represented in (Figure 13).

Table 13. Values of various lab parameters of patients.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
HB	249	12.7	2.1	14.8	7.858	2.0498
TLC	249	597.5	2.5	600	11.728	38.3195
PLT	249	714	13	727	145.64	88.095
Urea	249	412	50	462	174.27	80.258
PRO	0					
PTI	111	22.9	1.1	24	12.705	2.6522
INR	111	1.62	0.08	1.7	1.0158	0.19733
PTT	111	100	2	102	36.425	12.3911
BIL	225	27.87	0.04	27.91	0.8173	1.90802
AST	11	505	10	515	125.09	193.731
ALT	223	1062	2	1064	61.05	149.072
ALP	224	911	9	920	157.38	123.209
T. protien	5	4.5	4.6	9.1	6.526	1.8243
ALB	225	4.83	1	5.83	2.8234	0.68552
PH	232	0.54	7.04	7.58	7.3421	0.08624
pco2	232	64.1	11	75.1	31.451	8.4439
Hco3	232	29.1	3.9	33	17.094	4.9297

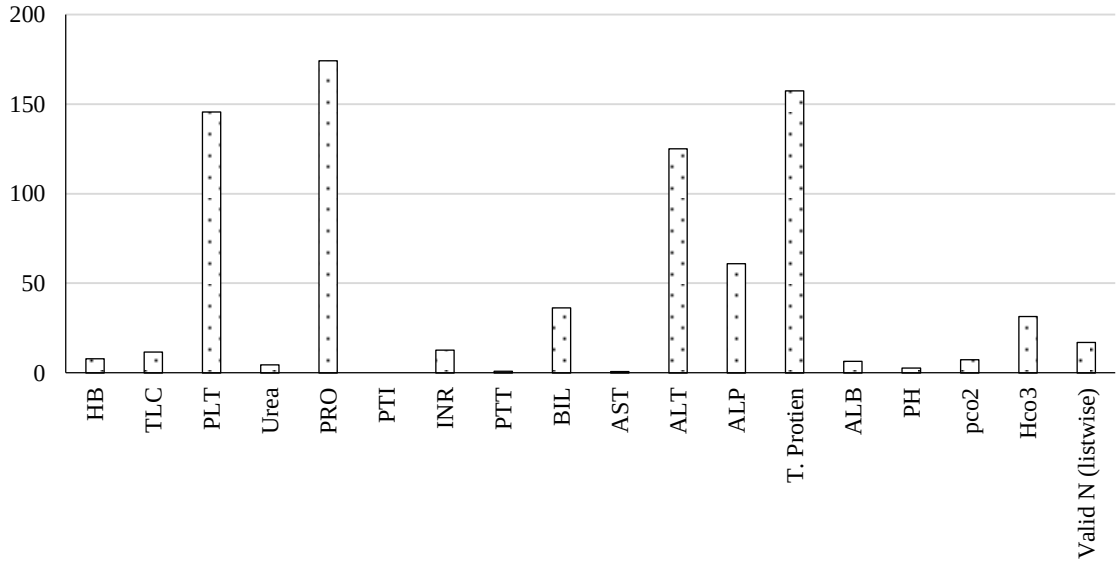

Figure 13. Represents the mean values of various lab parameters for patients.

Clinical Complications in Hemodialysis Patients

- Table 14 shows that the most common complication was hypotension (49.7%), followed by hypertension (14.2%), hypotension and vomiting (2.8%), nausea and vomiting (2.3%), hypoxia (0.9%), headache (0.9%), restless leg syndrome (0.4%), fever and chills (0.4%), hypoglycemia (0.4%), and sudden death (1.8%). These complications are shown in (Figure 14).

Table 14. Clinical complications of patients undergoing maintenance emergencies hemodialysis.

Clinically undergoing hemodialysis	**Complications maintenance**	**Of patients'emergencies**
	Frequency	**Percent**
Hypotension	39	18.4
Hypertension	30	14.2
Hypotension and vomiting	6	2.8
Nausea and vomiting	5	2.3
Hypoxia	2	0.9
Headache	2	0.9
Restless leg syndrome	1	0.4
Fever and chills	1	0.4
Hypoglycemia	1	0.4
Sudden death	4	1.8
No complications	105	49.7
*Multiple complications	15	7.1
Total sessions	211	100

**Multiple complications were found in 7.1% of patients, which included with two or more complications like hypotension, nausea and vomiting, headache, hypoglycemia, hypertension, hypoxia, fever and chills, back pain and chest pain, restless leg syndrome, seizures, etc.*

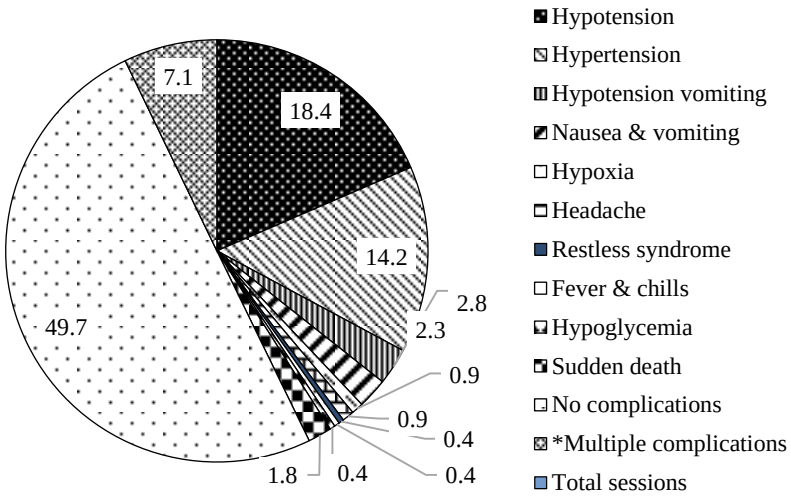

Figure 14. Shows clinical complications in patients undergoing maintenance emergency haemodialysis

Clinical Complications in Graft Rejection Patients

- Table 15 indicates that the most common complication was hypotension (9%), followed by hypotension and vomiting (1%) and hypertension (1%). These complica tions are illustrated in (Figure 15).

Table 15. Clinical complications in patients with graft rejection.

	Frequency	Percent	
Hypotension	9	50	
Hypotension and vomiting	1	5.5	
Hypertension	1	5.5	
No complication	4	22.2	
*Multiple complications	3	16.6	
Total sessions	18	100	

**Multiple complications were found in 3% of patients: hypotension, hypoxia, vomiting, headache, hypoglycemia, and rest less leg syndrome.*

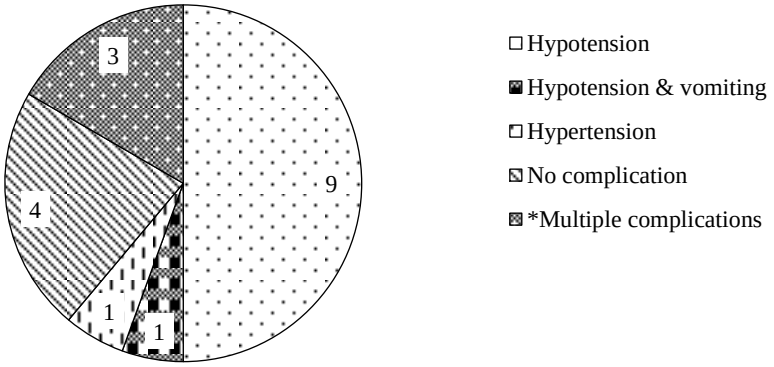

Figure 15. Shows clinical complications in graft rejection patients.

Clinical Complications in Renal Transplant Patients

- Table 16 lists the clinical complications in renal transplant patients, which are represented in (Figure 16).

Table 16. Clinical complications in renal transplant patients.

Complications	Frequency	Percent
Hypotension	1	5

No complication	19	95
Total sessions	20	100

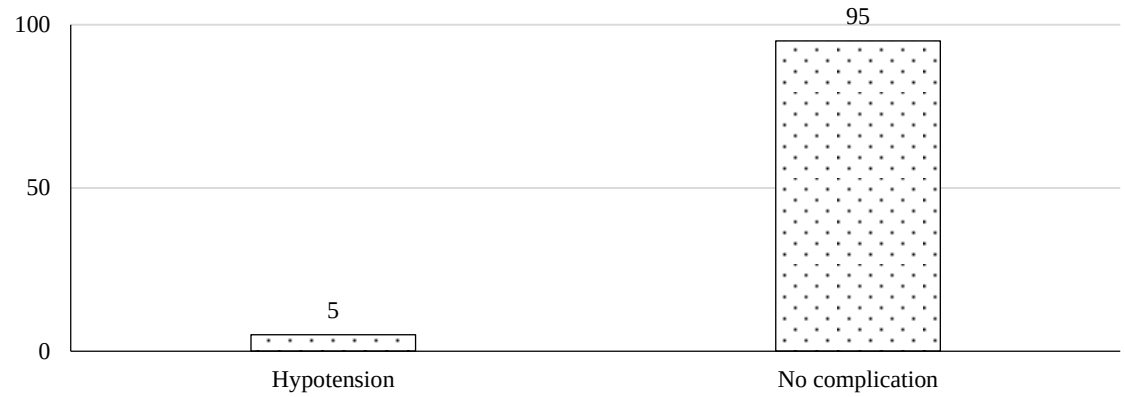

Figure 16. Shows clinical complications in renal transplant patients.

Vascular Access-Related Complications

- Table 17 shows that vascular access-related complications occurred in only 1.2% of patients, including femoral site hematoma, catheter tip migration, and pseudoaneurysm. This data is depicted in (Figure 17).

Table 17. Vascular access complications in patients undergoing maintenance hemodialysis.

Vascular access complications of maintenance hemodialysis Patients	**frequency**	**Percent**
Femoral site hematoma	1	0.4
Catheter tip migration	1	0.4
Pseudoaneurysm	1	0.4
No complication	208	98.5
Total sessions	211	100

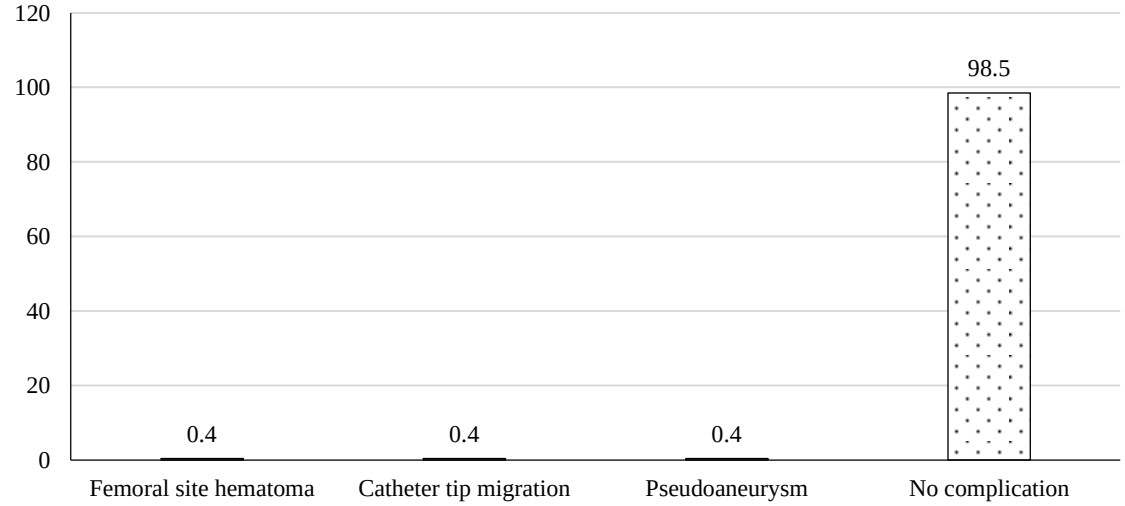

Figure 17. Shows vascular access related complications in maintenance hemodialysis patients.

Technical Complications in Hemodialysis Patients

- Table 18 indicates that technical complications occurred in only 2 (0.9%) patients receiving maintenance hemodialysis. This information is graphically represented in (Figure 18).

Table 18. Technical complications in patients undergoing maintenance hemodialysis.

Technical complications of hemodialysis in patients receiving maintenance hemodialyis		
	Frequency	***Percent***
Dialyzer clotting	2	0.9
No complication	209	99
Total sessions	211	100

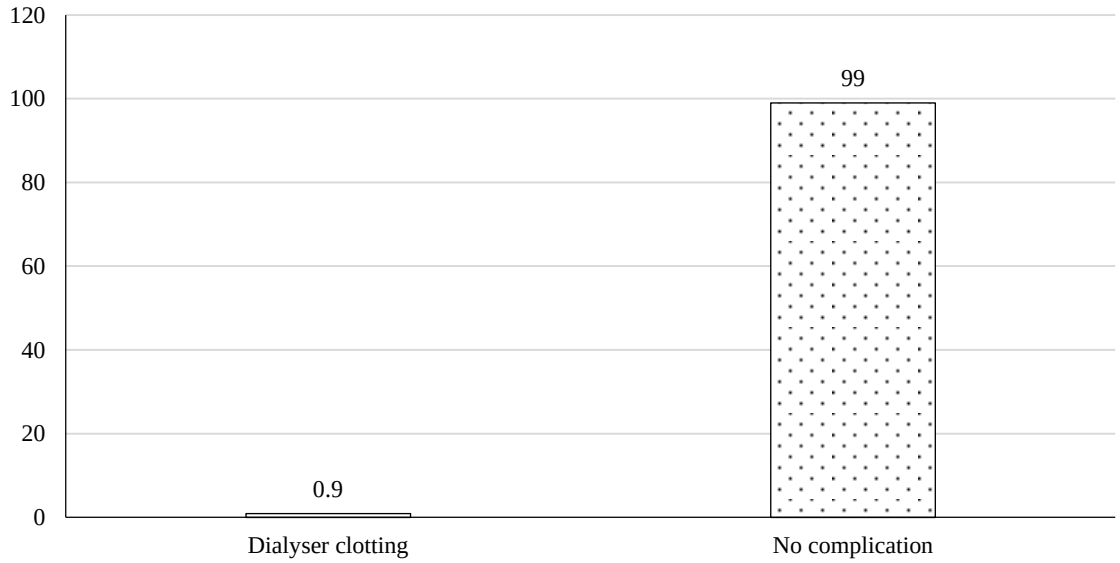

Figure 18. Shows a graphical representation of technical complications that occurred in maintenance.

Correlation of Clinical Complications with Age

- Table 19 shows that there is no significant correlation between clinical complicationsand age (P = 0.06)

Table 19. The correlation of clinical complications with age.

Complications	**0–18 years**	**18–35 years**	**36–60 years**	**Above 60 years**	**Total**
Hypotension	0	8	14	06	28
Hypotension and vomiting	0	1	1	02	04
Nausea and vomiting	0	0	2	01	03
Hypoxia	0	02	0	0	02
Fever and Chills	0	0	0	01	01
Headache	0	0	02	0	02
Hypoglycemia	0	0	01	0	01
Hypertension	01	04	10	03	18
Multiple complications	0	03	07	0	10
No complications	07	19	22	07	55
Total	08	37	59	20	124
P VALVE: 0.06					

Correlation of Clinical Complications with Gender

- Table 20 indicates that there is no significant correlation between clinical complications and gender (P = 0.40).

Table 20. Clinical correlation or clinical complications with gender.

Complications	Male	Female	Total
Hypotension	20	8	28
Hypotension and vomiting	0	04	04
Nausea and vomiting	0	03	03
Hypoxia	02	0	02
Fever and chills	01	0	01
Headache	0	02	02
Hypoglycemia	01	0	01
Hypertension	08	10	18
Multiple complications	07	03	10
No complications	36	19	55
Total	75	49	124
P value:0.40			

DISCUSSION

The present study was conducted in the Department of Nephrology at NephroPlus Dialysis Unit Healthsure Hospital Gharuan, Punjab, over a period of 6 months (January 2022 to June 2022) to ascertain the range of complications observed in patients undergoing hemodialysis. All the patients attending the nephrology clinic or being admitted to the nephrology ward or KTU were taken during the study. A total of 124 patients were taken during the study. These patients have undergone 249 conventional hemodialysis sessions [21].

In this study, the main etiology of CKD was found to be hypertension 46 (37.0%), hypertension and diabetes 30 (24.1%), unknown 18 (14.5%), diabetes 4 (3.2%), and ADPKD 4 (3.2%). This is consistent with the study of Hebas EL et al., where half of the patients were either hypertensive, diabetic or both.

The present study comprised an age group between 12 and 75 years, out of which 69 (55.6%) were males and 55 (44.3%) were females. The majority of the patients, 62 (50%), belong to the age group of 35–60 years, with a mean age of 40.67 ± 10.17 [22].

In this study, the majority of patients hail from rural areas, comprising 72 individuals (58%),with the remaining 52 (41.9%) originating from urban locales. The socioeconomic status of these patients was middle class 107 (86.2%), low class 11 (8.8%), and high class 6 (4.8%).

The main access for hemodialysis during this study was femoral 68 (54.8%), followed by AVF 42 (33.8%), jugular 12 (9.6%), and permacath 2 (1.6%). which is consistent with the study of Syed Marghoob Hasan et al., where 77% have femoral access and 23% have AVF; however, patients with jugular and permacath access were not found in the study.

Given that this study was conducted amidst the COVID-19 pandemic, the COVID-19 status of patients was assessed prior to dialysis. The percentage of positive COVID-19 status was (2.4%), and (97.5%) was negative. Among them (2.4%) were COVID-19 negative (recovered), (85.4%) were COVID-19 negative (naive) and (12.0%), had not been tested. However, CKD patients were dialyzed irrespective of their COVID-19 status with properly followed SOPs to prevent COVID-19 transmission.

In this study, the triple serology status of positive patients was (0%) for HIV, 4.8% for HCV, and 1.6% for HBsAG [Tables 8, 9, and 10]. Which is consistent with the study of Saud Mohammed Raja et, al., however, no positive patient for HBSag status was found in this study.

The routine maintenance hemodialysis patients, which comprised patients planned for renal transplantation, patients with graft rejection, or maintenance emergency hemodialysis patientswith any emergency indication, comprised 59 (47.5%) of the patients in this study. The percentage of other indications was AKI with hyperkalemia 3 (2.4%), drug intoxication AKI 3 (2.4%), CKD with fluid overload 16 (12.2%), CKD with hyperkalemia 4 (3.2%), CKD with uraemia 26 (20.9%), severe azotemia 9 (7.2%), and CKD with metabolic acidosis 4 (3.2%) [23–24].

The complications studied were divided into three groups: clinical, technical, and access-related. The patients were further categorized into three groups to examine the array of complications.

1. Patients needing maintenance emergency hemodialysis.
2. Patients with post renal transplant failure.
3. Patients planned for renal transplants.

The majority of the complications were clinical. Among the 211 sessions of maintenance emergency hemodialysis, 105 sessions (49.7%) remain uncomplicated, and complications were seen in 106 sessions. Among them, 91 sessions report a single complication, and 15 sessions of dialysis report multiple complications. The most common clinical complications in this study were hypotension 39 (18.4%), hypertension 30 (14.2%), hypotension and vomiting 6 (2.8%), nausea and vomiting 5 (2.3%), hypoxia 2 (0.8%), headache 2 (0.8%), rest less leg syndrome 1 (0.4%), fever and chills 1 (0.4%), hypoglycemia 1 (0.4%). Four deaths were reported during the course of my study. 15 (7.1%) sessions report multiple complications.

Multiple complications include patients with two or more complications, which include hypotension, nausea and vomiting, headache, hypoglycaemia, hypertension, hypoxia, feverand chills, back pain and chest pain, restless leg syndrome, seizures, etc. [25].

The clinical complications of post-renal transplant failure were reported in 14 sessions out of 18 sessions. Out of them, 11 sessions report a single complication, and 3 sessions report multiple sessions. The most common complication was hypotension 9 (50%), hypotension and vomiting 1 (5.5%), and hypertension 1 (5.5%). The 3 sessions (16.6%) show multiple complications. Multiple complications involve 2, 3, or more complications. Which includes hypotension, hypoxia, vomiting, headache, hypoglycemia, and rest less leg syndrome. Clinical complications in renal transplant patients were reported in only one session out of 20 sessions. The clinical complication was hypotension 1 (5%).

Access-related and technical complications were reported in patients needing maintenance emergency hemodialysis, which included femoral site hematoma 1 (0.45%), catheter tip migration 1 (0.4%), pseudoneuropathy 1 (0.4%). The technical complication includes dialyser clotting 2 (0.9%). There was no evidence of access-related or technical complications in post-renal transplant failure or renal transplanted patients. This study is consistent with the study of Syed Marghoob Hasan et al., where patients develop single and multiple complications; hypotension was a major complication, and the rate of technical and access-related complications was very low [26].

In our study, there was no correlation between clinical complications, age group, or gender, as the P value was greater than 0.05. This is in contrast with the study of Asif Mohammad et al., Where the effect of gender and age has a positive correlation with clinical complications like hypotension, cramps, etc.

The groups that have shown tendencies in chronic renal failure (CRF) were the following: Y one its consequences, namely hypertension, was apparent. This can be attributed mostly to the fact that the disease is chronic, and the hypertension that it results in may take a long time before it resolves. Volume -independent hypertension in hemodialysis can also be caused by other factors, such as high

ultrafiltration rates that cause volume depletion and increase the secretion of renin and angiotensin, hypercalciumaemia, which tends to increase inotropy and vascular tone, increased sympathetic nervous activity, especially during ultrafiltration and lastly, the withdrawal of hypertensive medications during dialysis [27].

SUMMARY AND CONCLUSION

A total of 124 patients were taken during the study who underwent 249 conventional hemodialysis sessions. To identify the spectrum of complications, the data was elucidated for further analysis. This information will assist those in the healthcare sector to determine why some complications occur in patients with diabetes and how they can address these complications; this will reduce morbidity and enhance the survival and quality of life among diabetics. The investigation produced the following findings: The investigation produced the following findings:

- The routine maintenance hemodialysis patients are comprised of patients planned for renal transplantation, patients with graft rejection, or maintenance emergency hemodialysis patients needing emergency hemodialysis.
- The majority of the complications were clinical. Among the 211 sessions of maintenance emergency hemodialysis, 105 sessions (49.7%) remain uncomplicated, and complications were seen in 106 sessions. Among them, 91 sessions report a single complication, and 15 sessions of dialysis report multiple complications. The most common clinical complication in this study was hypotension (39.4%), hypertension (30.2%), hypotension and vomiting (6.8%), nausea and vomiting (5.3%), hypoxia (2.8%), headache (2.8%), restless leg syndrome (1.4%), fever and chills (1.1%), and hypoglycemia (1.4%). Four deaths were reported during the course of my study.15 (7.1%) sessions report multiple complications. Multiple complications include patients with two or more complications, which include hypotension, nausea and vomiting, headache, hypoglycemia, hypertension, hypoxia, fever and chills, back pain and chest pain, restless leg syndrome, seizures, etc.
- The clinical complications of post-renal transplant failure were reported in 14 sessions out of 18 sessions. Out of them, 11 sessions report a single complication, and 3 sessions report multiple sessions. The most common complication was hypotension (90%), hypotension and vomiting (15.5%), and hypertension (15.5%). The three sessions (16.6%) show multiple complications. Multiple complications involve 2, 3, or more complications, which include hypotension, hypoxia, vomiting, headache, hypoglycemia,Restless leg syndrome.
- Clinical complications in renal transplant patients were reported in only one session out of 20. The clinical complication was hypotension 1 (5%).

Access-related and technical complications were reported in patients needing maintenance emergency hemodialysis, which included femoral site hematoma 1 (0.45%), catheter tip migration 1 (0.4%), and pseudoneuropathy 1 (0.4%). The technical complication includes dialyser clotting 2 (0.9%). There was no evidence of access-related or technical complications in post-renal transplant failure and renal transplanted patients.

The main limitation of my study was the small sample size and short time duration; otherwise, the results obtained might have been more confined and wide in variation.

Hemodialysis (HD) is associated with a diverse array of complications, some of which pose significant risks to patients' lives. However, with diligent monitoring, thorough patient assessment, and clinical expertise, early detection and timely management of these complications can be achieved without necessitating the discontinuation of this crucial life-saving treatment. The study's findings underscored the presence of complications among hemodialysis patients, despite advancements in technology and the presence of skilled healthcare professionals. These insights serve to pinpoint the underlying causes of complications, facilitating the implementation of alternative and complementary interventions within dialysisunits. Such measures, including exercise programs, yoga, meditation, and

counseling, aid patients in coping with their treatment regimen and contribute to an enhanced quality of life. Moving forward, larger-scale multicenter studies are recommended to deepen our understanding not only of hemodialysis complications but also of all facets of dialysis and kidney disease.

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