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Original Article

Prevalence of Acute Complications During the First Hemodialysis Session in Patients Initiating Hemodialysis

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ABSTRACT

Objective: To determine the frequency and types of acute complications in patients during their first hemodialysis session.
Study Design: Retrospective analytical study
Place and Duration of Study: Department of Internal Medicine and Dialysis Unit, Mufti Mehmood Memorial Teaching Hospital, Dera Ismail Khan, Pakistan, from Jan 24 to Feb 25.
Methodology: One hundred and twelve patients undergoing their first hemodialysis session were included through consecutive non-probability sampling. Demographic data, clinical diagnoses, and acute complications were recorded. Patients were closely monitored for acute complications during and immediately after dialysis. Data were obtained from hospital records. Statistical analyses were performed using chi-square, t-test, and ANOVA to evaluate the relationships between complications and patient characteristics.
Results: Acute complications were observed in 25(22.3%) patients. The most common complications were Dialysis Disequilibrium Syndrome (DDS) (7.14%), hematoma (3.57%), myocardial infarction (2.67%), and arrhythmia (1.78%). Gender was not significantly associated with overall complications (p=0.500); however, females had a higher prevalence of DDS and hypotension, whereas males experienced more hematomas and myocardial complications (p=0.031).
Conclusion: In this study, 22.3% of patients experienced acute complications during their first hemodialysis session, highlighting the need for vigilant monitoring and tailored protocols.
Keywords: Acute Kidney Injury; Arrhythmia; Complications; Dialysis; Myocardial Infarction.

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INTRODUCTION

Hemodialysis is a treatment that washes out waste products and extra fluid from the body when the kidneys are unable to work properly.[1] It is the most common form of renal-sustaining therapy, accounting for approximately 69% of kidney replacement therapy and 89% of all types of dialysis.[2] Patients treated with hemodialysis may experience many adverse effects, including pre-dialysis, intra-dialysis, and post-dialysis acute and chronic adverse effects.[3]

Studies on hemodialysis complications in US patients reported intradialytic hypotension (IDH) (76%), post-dialysis dizziness (63%), and headache (54%).[5] In a review article by Fatima et al., hypotension was the most commonly encountered intradialytic complication, occurring in nearly 10% of the sessions, followed by nausea and vomiting (5.24%), hypertension (5.06%), and headache (4.54%).6 A study by Patel *et al.*, reported intradialytic hypotension in 11.6% of HD sessions out of 1032 hemodialysis (HD) sessions.[7]

According to a study conducted in Pakistan, 45.54% of participants experienced problems. Complications in this study were headache (4.95%), atrial fibrillation (11.88%), and hypotension (17.82%).[8] Another study in Lahore reported common complications: hypotension (37.8%), hypertension (8.5%), headache (13.4%), shivering (57.3%), muscle cramps (70.7%), hypoglycemia (21.4%), and anaphylaxis (2.4%).[9]

A study in Lady Reading Hospital, Peshawar, reported headache (58%), nausea (30%), pulmonary edema (60%), pericardial effusion (45%), hypertension (40%), and sudden cardiac death (34%) as common complications.[10]

Despite global and local data on dialysis-related complications, there is scarce literature on complications arising specifically during the first hemodialysis session in resource-limited settings like ours. This study aimed to determine the frequency

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and types of acute complications in patients during their first hemodialysis session.

METHODOLOGY

This retrospective analytical study used consecutive non-probability sampling. It was conducted in the Department of Nephrology (Dialysis Unit) at Mufti Mehmood Memorial Teaching Hospital in Dera Ismail Khan, Pakistan, from Feb to Mar 2025. The Institutional Ethical Review Board granted ethical approval on March 7, 2025 (letter no. 218/JGMS/JC).

Informed consent was waived as the study involved retrospective analysis of anonymized patient records with no direct interaction. Informed consent was waived as the study involved retrospective analysis of anonymized patient records with no direct interaction. The sample size was calculated using the OpenEpi version 3.01, based on an expected prevalence of cardiac arrhythmias of 8%8 with a 95% confidence level and a 5.04% margin of error, yielding a required sample size of 112. The records of 120 patients were initially considered, but 8 were excluded due to incomplete records. A total of 112 patients' records were included in our study (Figure 1).

Inclusion Criteria: All patients undergoing their first hemodialysis session during study period, irrespective of age and gender, were included.

Exclusion Criteria: Patients with incomplete records were excluded.

A blood pressure lower than 90/60 mmHg, measured with a manual mercury sphygmomanometer, was considered hypotension. Cardiac arrest and arrhythmia were diagnosed using a 12-lead ECG. Myocardial infarction (MI) was diagnosed through serological tests (trop T and trop I) and a 12-lead ECG. Dialysis disequilibrium syndrome (DDS) was defined as a set of neurological complications manifested by symptoms such as nausea, headache, confusion, and more, particularly during the initial sessions of hemodialysis. Clinically suspected DDS was confirmed by papilledema on fundoscopy and brain edema on CT brain, further confirmed by comparing urea before and after HD; the ratio of reduction in most cases was > 40%.[9] Hypoglycemia was defined as blood glucose levels below 55 mg/dl (3 mmol/L).

Patients were started on hemodialysis using a temporary double-lumen dialysis catheter or arteriovenous fistula. The duration of dialysis was at least 1 hour and 40 minutes. All baseline investigations (blood urea, serum creatinine, hemoglobin, and serum electrolytes) were done before and after the first hemodialysis session. Weight, pulse, blood pressure, temperature, and general physical examinations were performed before and after the first dialysis session. Blood pressure and pulse were closely monitored after the initiation of dialysis. Blood flow was maintained at 150-180 ml/min. Heparin and ultrafiltration were managed according to the indications for each patient. All patients were monitored and observed by the doctor on duty for any complications and were treated promptly.

Data were collected from patient records in the Department of Nephrology. Data were entered into Microsoft Excel 365 and analyzed using Statistical Package for the Social Sciences (SPSS) version 23. Qualitative data (gender, diagnoses, number of complicated and uncomplicated cases, and frequency and type of complications) were expressed as numbers and percentages. Age was expressed as mean and standard deviation (SD). Normality was assessed using the Shapiro–Wilk test. Although age showed statistical non-normality (p = 0.005), the distribution was approximately symmetric (skewness = –0.035; mean ≈ median), and visual inspection of Q-Q plots confirmed acceptable normality. Given the sample size (n = 112) and robustness of parametric tests, age was analyzed using parametric methods.

The association between gender, the number of complicated and uncomplicated cases, and the type of complications was assessed using a chi-square test. The comparisons between age, the number of complicated and uncomplicated cases, and the type of complications were evaluated using t-tests and ANOVA, respectively. Complication types with only a single patient (AVF rupture and pneumothorax) were excluded from the ANOVA, as the test requires at least two cases per group to estimate within-group variance reliably. Post hoc analysis was not performed, as the overall ANOVA result was not statistically significant (p > 0.05). Statistical significance was considered at a p-value ≤ 0.05.

RESULTS

This study included 112 patients undergoing their first hemodialysis session. The mean age was 45.08±16.94 years, with a range of 13-78 years. The gender distribution was nearly equal, with 55(49.1%) females and 57 (50.9%) males (Table-I).

The most common underlying causes for initiating hemodialysis were chronic kidney disease

(86.6%), hypertension (67.9%), and diabetes mellitus (33%). Less common etiologies included acute kidney injury (8.0%), chronic heart failure (5.4%), and obstructive uropathy (4.5%). Several rare conditions, including vasculitis, sepsis, lupus nephritis, and genetic disorders, were also reported (Table-I).

Table-I: Demographic Profile, Diagnoses, and Type of Complications (n=112)

Characteristics	Values
Age in years	45.08±16.94
GENDER	
Female	55(49.1%)
Male	57(50.9%)
Total	112(100%)
DIAGNOSES OR CAUSES OF INITIATING DIALYSIS	
Chronic kidney disease (CKD)	97(86.6%)
Hypertension	76(67.9%)
Diabetes Mellitus (DM)	37(33%)
Acute Kidney Injury (AKI)	9(8%)
Chronic Heart Failure (CHF)	6(5.4%)
Obstructive Uropathy	5(4.5%)
Postpartum Hemorrhage (PPH)	5(4.5%)
Alport Syndrome	4(3.6%)
Autosomal Dominant Polycystic Kidney Disease (ADPKD)	3(2.7%)
Lupus Nephritis	3(2.7%)
Focal Segmental Glomerulosclerosis (FSGS)	3(2.7%)
Sepsis	3(2.7%)
Cerebrovascular Accident (CVA)	3(2.7%)
Vasculitis	2(1.8%)
Lower Respiratory Tract Infections (LRTI)	2(1.8%)
Neurogenic Bladder	2(1.8%)
GN secondary to NSAIDs	1(.9%)
Renal Cell Carcinoma (RCC)	1(.9%)
Diabetic Ketoacidosis (DKA)	1(.9%)
Hemolytic Uremic Syndrome (HUS)	1(.9%)
Thrombocytopenic Thrombotic Purpura (TTP)	1(.9%)
Uremic Encephalopathy	1(.9%)
Respiratory Distress	1(.9%)
Amyloidosis	1(.9%)
Urinary Tract Infection (UTI)	1(.9%)
Rapidly Progressive Glomerulonephritis (RPGN)	1(.9%)
Pre-eclampsia	1(.9%)
Asthma	1(.9%)
Kartagener syndrome	1(.9%)
Post-streptococcal Glomerulonephritis (PSGN)	1(.9%)
Post Nephrectomy	1(.9%)
Chronic allograft nephropathy (CAN)	1(.9%)
COMPLICATIONS (in 25 out of 112 patients)	
Dialysis Disequilibrium Syndrome (DDS)	8(7.1%)
Hematoma	4(3.6%)
Myocardial Infarction (MI)	3(2.7%)
Arrhythmias	2(1.8%)
Cardiac Arrest	2(1.8%)
Hypoglycemia	2(1.8%)
Hypotension	2(1.8%)
AVF Rupture	1(0.9%)
pneumothorax	1(0.9%)
Total	25(22.3%)

**GN - Glomerulonephritis, NSAIDs - Non-Steroidal Anti-Inflammatory Drugs*

Complications occurred in 25(22.3%) patients (Figure-2). The most frequent complication was Dialysis Disequilibrium Syndrome (DDS) (7.1%), followed by hematoma (3.6%), myocardial infarction (2.7%), and arrhythmia (1.8%). Other complications included cardiac arrest, hypoglycemia, hypotension, arteriovenous fistula (AVF) rupture, and pneumothorax, each affecting a smaller proportion of patients (Table-I).

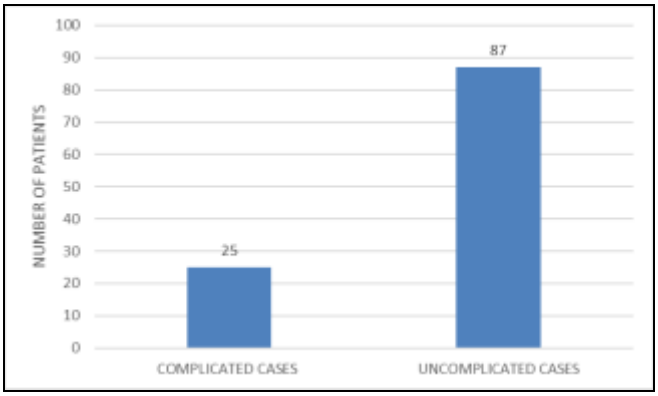


Figure-2: Frequency of Complicated and Uncomplicated Cases

Complications were observed in 11(19.3%) male and 14(25.5%) female patients. However, the association between gender and complication rates was not statistically significant (p=0.5) (Table-II). When analyzing individual complications, females had a higher incidence of DDS and hypotension, while males had a higher frequency of hematoma, myocardial infarction, and pneumothorax. The association between gender and specific complications was statistically significant (p=0.03). However, standardized residuals for any complication in any gender did not exceed 1.96, which means no complication in any gender is driving the overall significance (Table-II).

Table-II: Association of gender with complication rate and specific complications (n=112)

Variables	Male n (%)	Female n (%)	*p*-Value
Number of complicated cases (n=25)	11 (44)	14 (56)	0.5
Number of uncomplicated cases (n=87)	46 (52.9)	41 (47.1)	
Dialysis Disequilibrium Syndrome (n=8)	2 (25)	6 (75)	0.03
Hematoma (n=4)	0 (0)	4 (100)	
Myocardial Infarction (n=3)	1 (33.3)	2 (66.7)	
Arrhythmias (n=2)	1 (50)	1 (50)	
Cardiac Arrest (n=2)	2 (100)	0 (0)	
Hypoglycemia (n=2)	0 (0)	2 (100)	
Hypotension (n=2)	0 (0)	2 (100)	
Arteriovenous Fistula Rupture (n=1)	0 (0)	1 (100)	
Pneumothorax (n=1)	1 (100)	0 (0)	

The mean age of patients who developed complications (45.32 years (SD=13.43)) was not significantly different from those who did not (45.01 years (SD=17.89), *p*=0.93) (Table-III). Also, the comparison between age and specific complications was statistically insignificant (*p*=0.17) (Table-IV).

Table-III: Mean Comparison of Age With Complication Rate (n=112)

Parameters	Study Groups		*p*-value
	Complicated (n=25)	Uncomplicated (n=87)	
Age in years (mean ± SD)	45.32±13.43	45.011±17.89	0.93

Table-IV: Mean Comparison of age with Specific Complications (n=112)

Parameters	Arrhythmias (n=2)	Cardiac Arrest (n=2)	Dialysis Disequilibrium Syndrome (n=8)	Hematoma (n=4)	Hypoglycemia (n=2)	Hypotension (n=2)	Myocardial Infarction (n=3)	*p*-value
Age in years (Mean±SD)	37.5±3.54	51.0±12.73	46.0±12.59	32.5±16.66	57.5±3.54	35±0	55.67±14.01	0.17

DISCUSSION

This study was about the frequency and types of acute complications in patients initiating their first hemodialysis session. Our findings indicate that 22.3% of patients experienced complications, with Disequilibrium Syndrome (DDS) being the most common, followed by hematoma, myocardial infarction, and arrhythmias. The possible mechanism behind the high prevalence of DDS might be the rapid removal of urea, which causes brain edema, as confirmed by fundoscopy and CT brain in our case.[11]

Several studies have been done locally and internationally on complications in patients during hemodialysis. However, no studies have specifically investigated complications during the first hemodialysis session. A study by Jose *et al.,* on the American population reported higher rates of intradialytic hypotension (76%), headache (54%), cramping (76%), and post-dialysis dizziness (63%).[12] The larger sample size and inclusion of chronic HD patients likely account for these differences.

Study by Ali *et al.,* from Lady Reading Hospital, Peshawar, reported that intradialytic hypotension in 36 patients (17.7%), headache (58%), restless leg syndrome (32%), and anemia (20%) were prevalent. Deranged liver function (58.4%), nausea (30%), pulmonary edema (60%), pericardial effusion (45%), hypertension (40%), and sudden cardiac death (34%) were also noted.[13] These two studies also reported complication rates higher than ours, which might be due to the sample size being almost twice ours. Another reason might be that patients from the whole province are referred there, so comorbidities in such patients would be higher than in other small centers.

A study by Nookaew *et al.,* reported hypertension (n=16), chest pain (n=7), hypoglycemia (n=2), hypotension (n=27), nausea/vomiting (n=11), arrhythmia (n=2), and dialysis disequilibrium syndrome (n=1).[14] This study was similar to our study, with a sample size of 94 patients; hypotension in their study was higher, hypoglycemia and arrhythmia were almost similar to our study, and DDS was significantly lower in their study.

The most common complication in our study was DDS in 8 (32%) patients out of 25 patients with HD complications. A study by Dongelli *et al.,* reported the prevalence of DDS in the first session of HD in 20 (18.8%) patients out of 106 total patients, possibly due to differences in dialysis prescription protocols (e.g., duration, ultrafiltration rates, sodium profiling).[15]

The risk of cardiac arrest in patients with AKI was statistically significant (p=0.017). Karnik *et al.,* 16 studied cardiac arrest in patients undergoing HD for AKI. One of the causes reported by them is high ultrafiltration rates leading to hypotension and coronary hypoperfusion. Claure *et al.,* studied the following risk factors of sudden cardiac death in dialysis units: low dialysate potassium level, diabetes, old age, etc.17 In our study, one AKI patient had DKA (causing dehydration and cardiac hypoperfusion), while another presented with severe hyperkalemia, progressing to ventricular tachycardia and death. Electrolyte abnormalities in AKI are well documented.

This study reported acute complications during the first HD session, underscoring the need for standardized protocols for dialysis initiation, especially in resource-limited settings.[18] Because DDS was the most common complication, its prevalence can be reduced by optimal pre-dialysis assessment of volume status, electrolyte imbalances, and neurological symptoms before the first session, and by gradual initiation of HD (with lower initial blood flow rates, adjusted ultrafiltration targets, and sodium profiling in the dialysate).[3] Cardiac complications (e.g.,

MI, cardiac arrest, arrhythmias) also require close monitoring and timely intervention in case of any adverse event. District-level hospitals are usually understaffed and under-resourced, with a heavy patient load.[11]

Therefore, enhancing capacity and training for healthcare workers should focus on promptly recognizing such complications. Rosedee *et al.*, reported that hyperkalemia, severe metabolic acidosis, and mechanical ventilation were significantly associated with acute complications in emergency hemodialysis.[19]

The evolving field of artificial intelligence has made it possible to predict complications associated with hemodialysis. One study conducted by Othman *et al.*, found that machine learning models could, with 94% accuracy, identify intradialytic events such as hypotensive episodes within maintenance hemodialysis patients. Although these tools were intended for chronic dialysis patients, it is conceivable that they could also be utilized to forecast risks during the first few sessions of hemodialysis.[20]

LIMITATION OF STUDY

Some of the study's limitations were as follows: the study design was retrospective, and data were collected from hospital patients' records. While these records are detailed for clinical use, they may not include all the information needed for research. The sampling technique of the study was consecutive non-probability, and the results couldn't be generalized to the regional population. The study lacked follow-up of patients, which prevented us from assessing long-term outcomes and complications that might have developed over time. The study's results lacked generalizability because it was conducted at a single center.

CONCLUSION

In this study, 22.3% of patients experienced acute complications during their first hemodialysis session, indicating that a considerable proportion of patients may develop adverse events during the initiation of hemodialysis. These complications highlight the physiological challenges associated with the transition to renal replacement therapy, particularly in patients who may have limited tolerance to rapid fluid and solute shifts. The occurrence of such events underscores the importance of careful patient assessment before initiating dialysis, continuous monitoring of vital signs and clinical status throughout the procedure, and timely recognition and management of emerging complications.

PRESENTATIONS

This article was presented at the 3rd Gomal International Research Conference on April 10, 2025, at Gomal Medical College, D.I. Khan, and the International Medical Research Conference on May 24, 2025, at Ayub Medical College, Abbottabad.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

BKB & FA: Data acquisition, data analysis, critical review, approval of the final version to be published.

NS & MO: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MNAS & AU: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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